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Richard Allan CG8T 8" d/c roll surr. 8 ohm	£6.35
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2½" 75 ohm	.50
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10" x 6" 3, 8 or 15 ohm	£2.30

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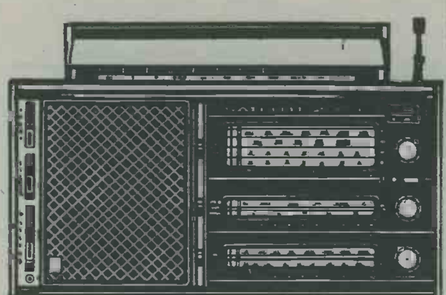

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Packs containing approx., 50sq. in. various sizes, all0·1 matrix 55p

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CH3. 7·5mH 31p CH4. 10mH 33p
CH5. 105mH 28p
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NORMAN ¼" Cores & Formers 8p
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1¼" and 20mm. 100mA, 200mA, 250mA, 500mA, 1A, 1·5A, 2A.
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BA6	3"	×	2"	×	1"	42p
BA7	7"	×	5"	×	2½"	85p
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P. & P. 15p on each box

BIB HI-FI ACCESSORIES

De Luxe Groov-Kleen
Model 42 £1.95
Chrome Finish
Model 60 £1.50

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

ANTEX SOLDERING IRONS
X25. 25 watt £2·05
CCN 240. 15 watt £2·48
Model G. 18 watt £2·26
SK2. Soldering Kit £3·25
STANDS: ST3, suitable for all models £1
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Bits No.		
102	For model CN240 $\frac{3}{32}$"	42p
104	For model CN240 $\frac{1}{8}$"	42p
1100	For model CCN240 $\frac{3}{32}$"	42p
1101	For model CCN240 $\frac{1}{8}$"	42p
1102	For model CCN240 $\frac{1}{4}$"	42p
1020	For model G240 $\frac{3}{32}$"	42p
1021	For model G240 $\frac{1}{8}$"	42p
1022	For model G240 $\frac{3}{16}$"	42p
50	For model X25 $\frac{3}{32}$"	48p
51	For model X25 $\frac{1}{8}$"	48p
52	For model X25 $\frac{3}{16}$"	48p

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

ANTEX HEAT SINKS 10p

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C3	50	Precision Resistors 0·1%, 0·01% mixed values	0·54
C4	75	⅛th W Resistors mixed preferred values	0·54
C5	5	Pieces assorted Ferrite Rods	0·54
C6	2	Tuning Gangs, MW/LW VHF	0·54
C7	1	Pack Wire 50 metres assorted colours	0·54
C8	10	Reed Switches	0·54
C9	3	Micro Switches	0·54
C10	15	Assorted Pots & Pre-Sets	0·54
C11	5	Jack Sockets 3 × 3·5m 2 × Standard Switch Type	0·54
C12	30	Paper Condensers preferred types mixed values	0·54
C13	20	Electrolytics Trans. types	0·54
C14	1	Pack assorted Hardware—Nuts/Bolts, Grommets, etc.	0·54
C15	5	Mains Slide Switches	0·54
C16	20	Assorted Tag Strips & Panels	0·54
C17	10	Assorted Control Knobs	0·54
C18	4	Rotary Wave Change Switches	0·54
C19	2	Relays 6—24V Operating	0·54
C20		Sheets of Copper Laminate To make approx. 200 sq. ins.	0·54

PLUGS AND SOCKETS

PLUGS		
PS 1	D.I.N. 2 Pin (Speaker)	0·11
PS 2	D.I.N. 3 Pin	0·12
PS 3	D.I.N. 4 Pin	0·15
PS 4	D.I.N. 5 Pin 180°	0·16
PS 5	D.I.N. 5 Pin 240°	0·16
PS 6	D.I.N. 6 Pin	0·17
PS 7	D.I.N. 7 Pin	0·18
PS 8	Jack 2·5mm Screened	0·18
PS 9	Jack 3·5mm Plastic	0·12
PS 10	Jack 3·5mm Screened	0·18
PS 11	Jack ¼" Plastic	0·15
PS 12	Jack ¼" Screened	0·22
PS 13	Jack Stereo Screened	0·36
PS 14	Phono	0·10
PS 15	Car Aerial	0·22
PS 16	Co-Axial	0·15
INLINE SOCKETS		
PS 21	D.I.N. 2 Pin (Speaker)	0·14
PS 22	D.I.N. 3 Pin	0·20
PS 23	D.I.N. 5 Pin 180°	0·20
PS 24	D.I.N. 5 Pin 240°	0·20
PS 25	Jack 2·5mm Plastic	0·16
PS 26	Jack 3·5mm Plastic	0·16
PS 27	Jack ¼" Plastic	0·30
PS 28	Jack ¼" Screened	0·35
PS 29	Jack Stereo Plastic	0·30
PS 30	Jack Stereo Screened	0·38
PS 31	Phono Screened	0·18
PS 32	Car Aerial	0·22
PS 33	Co-Axial	0·22
SOCKETS		
PS 35	D.I.N. 2 Pin (Speaker)	0·08
PS 36	D.I.N. 3 Pin	0·11
PS 37	D.I.N. 5 Pin 180°	0·11
PS 38	D.I.N. 5 Pin 240°	0·11
PS 39	Jack 2·5mm Switched	0·12
PS 40	Jack 3·5mm Switched	0·12
PS 41	Jack ¼" Switched	0·20
PS 42	Jack Stereo Switched	0·30
PS 43	Phono Single	0·08
PS 44	Phono Double	0·10
PS 46	Co-Axial Surface	0·10
PS 47	Co-Axial Flush	0·20

LEADS

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

CABLES

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

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

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0·1 watt 0·06 each
100, 220, 470, 1K, 2·2K, 4·7K, 10K, 22K, 47K, 100K, 220K, 470K, 1M, 2M, 4·7M.

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Holds 12. 10in × 3½in × 5in. Lock handle.

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Holds 14, 13 × 5 × 0 in. £1·95p
Holds 24, 13½ × 8 × 5½ in. £2·70p
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240V. Primary. Secondary voltages available from selected tappings 4V, 7V, 8V, 10V, 14V, 15V, 17V, 19V, 21V, 25V, 31V, 33V, 40, 50 and 25V–0–25V.

Type	Amps	Price	P. & P.
MT50/½	½	£1·93	45p
MT50/1	1	£2·42	48p
MT50/2	2	£3·30	60p

CARTRIDGES
ACOS
GP91-1SC 200mV at 1·2cm/sec £1·35
GP93-1 280mV at 1cm/sec £1·85
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J-2010C Crystal/Hi Output Compatible £1·20
J-2006S Stereo/Hi Output £1·75
J-2105 Ceramic/Med Output £1·95
J-2203 Magnetic 5mV/5cm/sec, including stylus £4·95
J-2203S Replacement stylus for above £3·00
AT-55 Audio-technica magnetic cartridge 4mV/5cm/sec £3·30

CARBON FILM RESISTORS
The E12 Range of Carbon Film Resistors, ⅓ watt available in PAKS of 50 pieces, assorted into the following groups:
R1 50 Mixed 100 ohms–820 ohms 50p
R2 50 Mixed 1k Ω–8·2k Ω 50p
R3 50 Mixed 10k Ω–82k Ω 50p
R4 50 Mixed 100k Ω–1M Ω 50p
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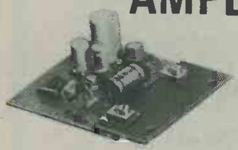
AL10 AL20 AL30 AUDIO AMPLIFIER MODULES



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

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

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

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

AUDIO AMPLIFIER MODULES

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

POWER SUPPLIES

PS 12. (Use with AL10, AL20, AL30)	95p
SPM 80. (Use with AL60)	£3·25
FRONT PANELS FP 12 with Knobs	£1·00

PRE-AMPLIFIERS

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

TRANSFORMERS

T461 (Use with AL10)	£1·60 P. & P. 22p
T538 (Use with AL20, AL30)	£2·30 P. & P. 22p
BMT80 (Use with AL60)	£2·75 P. & P. 40p

PA12 PRE-AMPLIFIER SPECIFICATION

The PA12 pre-amplifier has been designed to match into most budget stereo systems. It is compatible with the AL 10, AL 20 and AL 30 audio power amplifiers and it can be supplied from their associated power supplies. There are two stereo inputs, one has been designed for use with *Ceramic cartridges while the auxiliary input will suit most †Magnetic cartridges. Full details are given in the specification table. The four controls are, from left to right: Volume and on/off switch, balance, bass and treble. Size 152mm × 84mm × 35mm.

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

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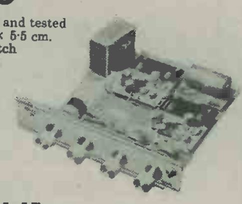
ALL PRICES INCLUDE V.A.T.

The STEREO 20



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

£14·45 p. & p. 45p

TC20 TEAK VENEERED CABINET
For Stereo 20 (front board undrilled) Size 10½" × 8¾" × 3", £3·95 plus 30p postage.

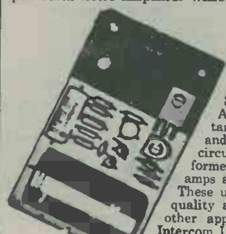
SHP80 STEREO HEADPHONES
4–16 ohms impedance. Frequency response 20 to 20,000Hz. Stereo/mono switch and volume controls, £4·95

NOW WE GIVE YOU 50w PEAK (25w R.M.S.) *PLUS* THERMAL PROTECTION! The *NEW* AL60 Hi-Fi Audio Amplifier FOR ONLY £4·25

- Max Heat Sink temp 90°C.
- Frequency Response 20Hz to 100KHz
- Distortion better than 0·1% at 1KHz
- Supply voltage 15-50 volts
- Thermal Feedback
- Latest Design Improvements
- Load — 3, 4, 8 or 16 ohms
- Signal to noise ratio 80dB
- Overall size 63mm × 105mm × 13mm

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

STABILISED POWER MODULE SPM80



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

TRANSFORMER BMT80 £2·75 p. & p. 40p

STEREO PRE-AMPLIFIER TYPE PA100

Built to a specification and NOT a price, and yet still the greatest value on the market, the PA100 stereo pre-amplifier has been conceived from the latest circuit techniques. Designed for use with the AL60 power amplifier system, this quality made unit incorporates no less than eight silicon planar transistors, two of these are specially selected low noise NPN devices for use in the input stages.
Three switched stereo inputs, and rumble and scratch filters are features of the PA100, which also has a STEREO/MONO switch, volume, balance and continuously variable bass and treble controls.

SPECIFICATIONS

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

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

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

ONLY £14·25

MK 60 AUDIO KIT
Comprising: 2 × AL60, 1 × SPM80, 1 × BTM80, 1 × PA 100, 1 front panel, 1 kit of parts to include on-off switch, neon indicator, stereo headphone sockets plus instruction booklets. Complete Price: £29·75 plus 45p postage.

TEAK 60 AUDIO KIT
Comprising: Teak veneered cabinet size 16½" × 11½" × 3½", other parts include aluminium chassis, heatsink and front panel bracket, plus back panel and appropriate sockets, etc. Kit price: £9·95 plus 45p postage.

All prices quoted in new pence Giro No. 388-7006
Please send all orders direct to warehouse and despatch department

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Postage and packing add 20p. Overseas add extra for airmail
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Guaranteed Satisfaction or Money Back

COMPONENTS

HOBBYIST - PROFESSIONAL - DOMESTIC - SURPLUS - INDUSTRIAL
JUST A FEW OF OUR BARGAINS ARE LISTED BELOW - SEND STAMPED ADDRESSED ENVELOPE FOR A QUOTE ON OTHER REQUIREMENTS. PAY US A VISIT. OVER 90% OF STOCK BELOW QUANTITY WHOLESALE PRICE. RETURN POSTAL SERVICE UNLESS CHEQUE.

Goods sent at customer's risk, unless sufficient payment for insurance included (2p per £1 Min 5p) U.K. only.

VALVE BASES

Printed circuit B9A – B7G **4p**
Chassis B7 – B9G – B7G **4p**
Shrouded chassis B7G – B9A .. **6p**
B8A – B9A chassis – B12A tube .. **6p**

Speaker, 6″ x 4″, 5 ohm, ideal for car radio etc. **£1**

TAG STRIP – 6 way **3p**
9 way **5p** Single **1p**

WRIST COMPASS
30p with Needle Lock

TO3 Mica Washer **2p**
18 volt 4 amp charger, bridge rectifier **50p**
GC10/4B Cold Cathode **£3.00**

Telescopic aerial
Closed 9½″, open 38½″ Fitted right angle TV plug, **50p**

1¼ glass fuses— 250 m/a or 3 amp (box of 12) **18p**
3″ tape spools **8p**
Brand new Boxed 6K7G **25p**
PVC or metal clip on M.E.S. bulb holder **5p**
Geared Knob, Inner to Outer Ratio 8:1 .. .. .. **60p**
Bulgin, 5mm Jack plug and switched socket (pair) **30p**
12 volt solenoid and plunger **40p**
250 RPM 50 c/s locked frequency miniature mains motor .. **50p**
200 OHM coil, 2¼″ long, hollow centre **10p**
Belling Lee white plastic surface coax outlet Box **30p**
R.S. 12 way standard plug and shell **30p**

SWITCHES

Pole	*Way*	*Type*	
4	2	Sub. Min. Slide	**18p**
6	2	Slide	**20p**
4	2	Lever Slide	**15p**
2	2	Slide	**10p**
1	3	+ off Sub. min. edge	**10p**
1	3	13 amp small rotary	**12p**
2	2	Locking with 2 to 3 keys	**£1.50**
2	1	2 Amp 250V A.C. rotary	**16p**
1	2	Toggle	**10p**
Wafer Rotary, all types			**30p**

S.P.S.T. 10 amp 240v. white rocker switch with neon. 1″ square flush panel fitting **30p**

PIANOKEY SWITCH UNIT

5 lever, interlocking 2 pole mains + 3 pole 2 way + 3 of 6 pole 2 way **15p**

COMPUTER AND AUDIO BOARDS

VARYING PANELS WITH ZENER, GOLD BOND, SILICON, GERMANIUM, LOW AND HIGH POWER TRANSISTORS AND DIODES, HI STAB RESISTORS, CAPACITORS, ELECTROLYTICS, TRIMPOTS, POT CORES, CHOKES ETC.
3lb. for **85p** + **60p** post and packing
7lb. for **£1.75** + **75p** post and packing

Skeleton Presets
Slider, horizontal or vertical standard or submin. **5p**

Clear Plastic Boxes
For component storage or projects, sliding lid. 1¾″ x 1½″ x 1″ **10p**

KNOBS

SILVER METAL PUSH ON WITH POINTER, OR WHITE PLASTIC, GRUB SCREW WITH POINTER AND SILVER CENTRE **8p** EACH.

ZM1162A INDICATOR TUBE

0-9 Inline End View. Rectangular Envelope 170V 2·5M/A **£2.00**

RESETTABLE COUNTER

English Numbering Machines LTD.
MODEL 4436-159-989
6–14 volt. 6 digit, illuminated, fully enclosed. **£2.50**

RESISTORS

$\frac{1}{8}$–$\frac{1}{4}$–$\frac{1}{2}$ watt .. **1p**
1 watt **2p**
Up to 5 watt wire **10p**
10 watt wire wound **12p**
15 watt **14p**

Philips transformer, safety fused. In 200-220-240v. Out 240v 60ma + 6.3v 1a approx 2″ x 2¼″ x 2½″ **£1.50**

POTS

Log or Lin carbon **12p**
Switched **23p**
Dual Pots **38p**
Dual & switch **50p**
Lin wirewound **25p**
Slider Pot **26p**
Dual Slider **45p**

THERMISTORS

VA1008, VA1034, VA1039, VA1040, VA1055, VA1066, VA1082, VA1100 **7p**
VA1077, **10p**
VA1005, VA1026 **15p**

RELAYS

12 volt S.P.C.O octal mercury wetted high speed **75p**
P.O. 3000 type, 1,000 OHM coil, 4 pole c/o **60p**
12 volt d.p.c.o. heavy duty octal **80p**

ELECTROLYTICS MFD/VOLT. Many others in stock

MFD	Up to 10V	25V	50V	75V	100V	250V	350V	500V
10	4p	5p	6p	8p	8p	12p	16p	20p
25	4p	5p	6p	8p	8p	15p	18p	20p
50	4p	5p	6p	9p	13p	18p	—	—
100	5p	6p	10p	12p	19p	20p	—	—
250	9p	10p	11p	17p	28p	—	—	—
500	10p	11p	17p	24p	45p	—	—	—
1000	13p	17p	40p	—	—	—	—	—
2000	23p	37p	45p	—	—	—	—	—

As total number of values are too numerous to list, use this price guide to work out cost of your actual value requirements, i.e. 2MFD, 30V would be 5p, or 330MFD, 50V would be 14p, etc. etc.
8/20, 10/20, 12/20 **Tubular tantalum 15p each**
16–32/275, 32–32/275, 100–100/150, 100–100/275 50–50/300 .. .. **20p each**
12,000/12, 32–32–50/300, 700/200, 100–100–100–150–150/320 .. .. **50p each**
20–20–20/350 .. .. **40p each**

INDICATORS

Bulgin D676 red, takes M.E.S. bulb **20p**
12 volt red, small pushfit **20p**
Mains neon, red, pushfit **16½p**

CAPACITOR GUIDE – maximum 500V

Up to .01 ceramic **2p.** Up to .01 poly **3p.** Up to 1000PF silver mica **5p.** 1,200PF up to .01 silver mica **10p.** .013 up to .25 poly etc. **4p.** .27 up to .68 poly etc. **6p**
Over 500 volt order from above guide and few others listed below.
6p. .1/600: **10p.** .01/1000, 1/350, 8/20, .1/900, .22/900, 4/16. .25/250 AC (600vDC) .1/1500 **40p.** 5/150, 9/275AC, 10/150, 15/150, 40/150.

TRIMMERS, 20p each

100PF Ceramic, 30PF Beehive, 12PF PTFE 2500PF 750 volt, 33PF MIN. AIR SPACED 5PF, MIN. AIR SPACED, 50PF CERAMIC.

CONNECTOR STRIP

Belling Lee L1469, 4 way polythene. **3p each**

Strong grey plastic box same design as die cast ali 4⅜″ x 2⅜″ x 1¼″ **40p**

1″ or 1⅜″ or ¾″ **CAN CLIPS** .. **2p**

MAINS DROPPERS

36+79 ohm **20p**
66+66+158 ohm, 66+66+137 ohm, 17+14+6 ohm, 266+14+193 ohm **25p**
50+40+1k5 ohm
285+575+148+35 ohm
25+35+97+59+30 ohm **35p**

5¼″ x 2¾″ Speaker, ex-equipment 3 ohm **30p**
2 Amp Suppression Choke **5p**
3 x 2½ x $\frac{1}{16}$″ **PAXOLINE** .. **2p**
4⅝ x ½ x ⅛″, ... **2 for 1p**
220K & 100 ohm 3 watt resistors .. **4p**
VALVE RETAINER CLIP, adjustable **2p**

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Sub-miniature Transistor Type .. **25p**
Valve type, centre tapped or straight **40p**

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Drive Cord **1p per yd.**

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Full spec. marked by Mullard, etc. Many other types in stock

AC107	14p	BC178A/B	13p	BF178/9	25p
AC127/	11p	BC179B	14p	BF180/1/2/3	22p
AC128/176	8p	BC186/7	20p	BF184/5	15p
ACY28	18p	BC213L	10p	BF194/5/6/7	8p
AD149	40p	BC327/8	19p	BF194A	12p
AD161/2 matched pr.	69p	BC337/8	14p	BF200	20p
AF116/7	12p	BC547/8	11p	BF262/3	23p
AF124/6/7	20p	BC558A	11p	BF336	25p
AF139/178	30p	BCX20	13p	BFS28 Dual Mosfet	92p
AF180/1	30p	BCX32/36	12p	BFW10/11 F.E.T.	45p
AF239	20p	BCY40	60p	BFX29/30	16p
ASY27/73	25p	BCY70/1/2	9p	BFX84/88	16p
BC107A or B	9p	BD112/3/5/6	50p	BFY50/1/2	11p
BC107/8/9	7p	BD131	24p	BFY90	50p
BC108A/B/109B/C	10p	BD132	30p	BR101 (Programmable Unj Junction)	30p
BC147/8/9	7p	BD135	28p	BRY39 (Programmable Unj Junction)	34p
BC147A/B	8p	BD201/2/3/4	£1.00	BRY56 (Programmable Unj Junction)	34p
BC148A/B, 9B/C/S	8p	BD232/4/5	49p	BSV64	40p
BC157/8/9	9p	BDX77	£1.40	BSV79 F.E.T.	£1
BC158A/B	11p	BF115	15p	BSV80 F.E.T.	90p
BC159B/C, 157A	11p	BF167/173	20p	BSV81 Mosfet	90p

BSX20	13p
BSX21	16p
BU105/01	93p
CV7042 (OC41 OC44, ASY63)	7p
GET111	40p
OC35	$32\frac{1}{2}$p
ON222	30p
2N393/MA393	30p
2N706	8p
2N987	35p
2N2219	18p
2N2401 (ASY26-27)	20p
2N2904/5/6/7	13p
2N2907A	15p
2N3053	13p
2N3054	35p
2N3055 (or equiv.)	33p
2N3819 FET	16p
2N5036	60p
TIS88A FET	33p
ZTX 300	13p
40250	60p

OTHER DIODES

IN916	6p
IN4148	$1\frac{1}{2}$p
BA145	14p
Centercel	10p
BZY61	10p
BB110 B Varicap	20p
BA182	24p
OA5/7/10	10p
BZY88 Up to 33 volt	6p
BZX61 11 volt	15p
BR100 Diac.	19p

INTEGRATED CIRCUITS

741 8 pin d.i.l.	25p
TAD100 AMRF	£1.00
TAA570	£1.20
CA3001 R. F. Amp	£1.00
TAA300 1wt Amp	£1.25
NE555v Timer	48p
TAA550 Y or G	41p
TAA263 Amp	65p
SN7483 TTL	82p

BRIDGE RECTIFIERS

Amp	Volt			Amp	Volt		
½	1,600	BYX10	30p	2	30	LT120 type	30p
1	140	OSH01-200	30p	0.6	110	EC433	15p
1.4	42	BY164	35p	5	400	Texas	75p

TRIACS

Amp	Volt		
6	400	Plastic	74p
25	900	BTX94-900	£5.00
25	1200	BTX94-1200	£7.00

RECTIFIERS

	Amp	Volt	
IN4004	1	400	5p
IN4005	1	600	6p
IN4006	1	800	7p
IN4007	1	1,000	7p
SR100	1.5	100	7p
SR400	1.5	400	8p
REC53A	1.5	1,250	14p
LT102	2	30	10p
BYX38-600	2.5	600	40p
BYX38-300R	2.5	300	36p
BYX38-900	2.5	900	45p
BYX38-1200	2.5	1,200	50p
BYX49-600	2.5	600	34p
BYX49-300	2.5	300	26p
BYX49-900	2.5	900	40p
BYX49-1200	2.5	1,200	52p
BYX48-300	6	300	40p
BYX48-600	6	600	50p
BYX48-900	6	900	60p
BYX48-1200	6	1,200	80p
BYX72-150R	10	150	35p
BYX72-300R	10	300	45p
BYX72-500R	10	500	55p
BYX42-300	10	300	30p
BYX42-600	10	600	65p
BYX42-900	10	900	80p
BYX42-1200	10	1,200	95p
BYX46-300*	15	300	£2.00
BYX46-400*	15	400	£2.50
BYX46-500*	15	500	£2.75
BYX46-600*	15	600	£3.00
BYX20-200	25	200	60p
BYX52-300	40	300	£1.75
BYX52-1200	40	1,200	£2.50

*Avalanche type

Parmeko 20H ·12A potted choke 60p

RG4-1250 Mercury vapour rectifier £5.00

1″ Terryclips chrome finish 4p

Cinch 10-way terminal block 15p

Pair of LA2407 Ferrox cores with adjuster 25p

Chrome Car Radio facia 15p
Rubber Car Radio gasket 5p

DLI Pal Delayline 80p

Relay socket 10p
Take miniature 2PCO relay

B7G or B9A valve can 2p

0-30, or 0-15, black pvc, 360° dial, silver digits, self adhesive, $4\frac{1}{4}$″ dia. 10p

OPTO ELECTRONICS

ORP12	44p
BPX40	65p
BPX42	£1.50
BPY10 (VOLTIAC)	£1.00
BPY68 / BPY69 / BPY77 Diodes	£1.00

Photo transistor

BPX29	£1.00
OCP71	35p

BIG L.E.D. 0.2″ 2v 50m/A max.
RED 15p
ORANGE / GREEN / YELLOW 16p

PHOTO SILICON CONTROLLED SWITCH BPX66 PNPN 10 amp £1.00

THYRISTORS

Amp	Volt		
1	240	BTX18-200	50p
1	400	BTX18-300	65p
1	240	BTX30-200	40p
6.5	500	BT102-500R	75p
10	700	BT106	85p
15	500	BT107	£1.00
6.5	500	BT101-500R	90p
6.5	500	BT109-500R	90p
20	600	BTW92-600RM	£3.00
15	800	BTX95-800R Pulse Modulated	£10.00
30	1000	28T10 (Less Nut)	£4.00

.3″ red 7 segment L.E.D. 14 D.I.L. 0-9 + D.P. display 1.9v, 10m/a segment 83p

CQY11B L.E.D.
Infra red transmitter £1
One fifth of trade

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Holdersorpads 50pper100

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1MFD	250 volt	15p
2MFD	250 volt	20p
10MFD	500 volt	80p
4MFD	250 volt	20p
15MFD	150 volt	50p

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Multicore - $2\frac{1}{2}$p foot

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18	3p
20-24	2p
26-42	1p

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GCS23T Crystal Stereo Cartridge £1.00

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Rotor with neon indicator, as used in Seafarer, Pacific, Fairway depth finders 20p each

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Fairway 18009 Coax. socket 3p

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12 way edge socket 10p

1lb Mixed nuts, bolts, washers etc. 35p

Philips Iron Thermostat 15p
Bulgin 2-pin flat plug and socket 10p
McMurdo PP108 8-way edge plug 10p

TO3 HEATSINK
Europlec HP1 TO3B individual 'curly' power transistor type. Ready drilled 20p

Tested unmarked, or marked ample lead ex new equipment

ACY17-20	8p	OC71/2	5p
ASZ20	8p	OC200-5	10p
ASZ21	15p	TIC44	24p
BC186	11p	2G240	2-50
BCY30-34	10p	2G302	6p
BCY70/1/2	8p	2G401	10p
BF115	10p	2N711	25p
BY127	8p	2N2926	7p
BZY88 series	5p	2N598/9	6p
HG1005	2p	2N1091	8p
HG5009	2p	2N1302	8p
HG5079	2p	2N1907	2-50
L78/9	2p	Germ. diode	1p
M3	10p	GET120 (AC128 in 1″ sq. heat sink)	20p
OA81	3p		
OA47	2p		
OA200-2	3p	GET872	12p
OC23	20p		

8 way Cinch standard 0.15 pitch edge socket 20p

U.E.C.L. 10 way pin connector 2B6000 OA1P10 10p

U.E.C.L. 20 way pin connector 2A60000A1P20 20p

U.E.C.L. 10 way pin socket 2B606001R10 10p

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If you are interested in the hobby of receiver construction and short wave listening this is the book for you. It covers the whole field of s.w.l'ing from construction to operating – both Broadcast and Amateur bands. It explains how the circuits work, how to assemble the parts, how to wire-up the circuits with point-to-point wiring diagrams, step-by-step instructions and how to test and operate the completed projects.

by F. A. Baldwin

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etc. etc.

140 Pages **80p** P. & P. 12p

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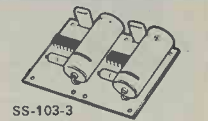

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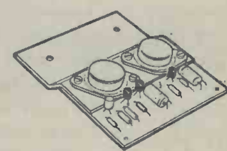

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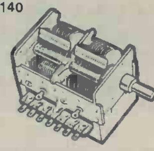

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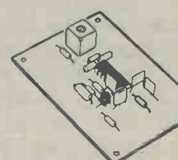

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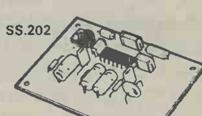

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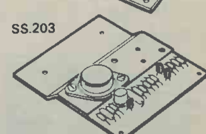

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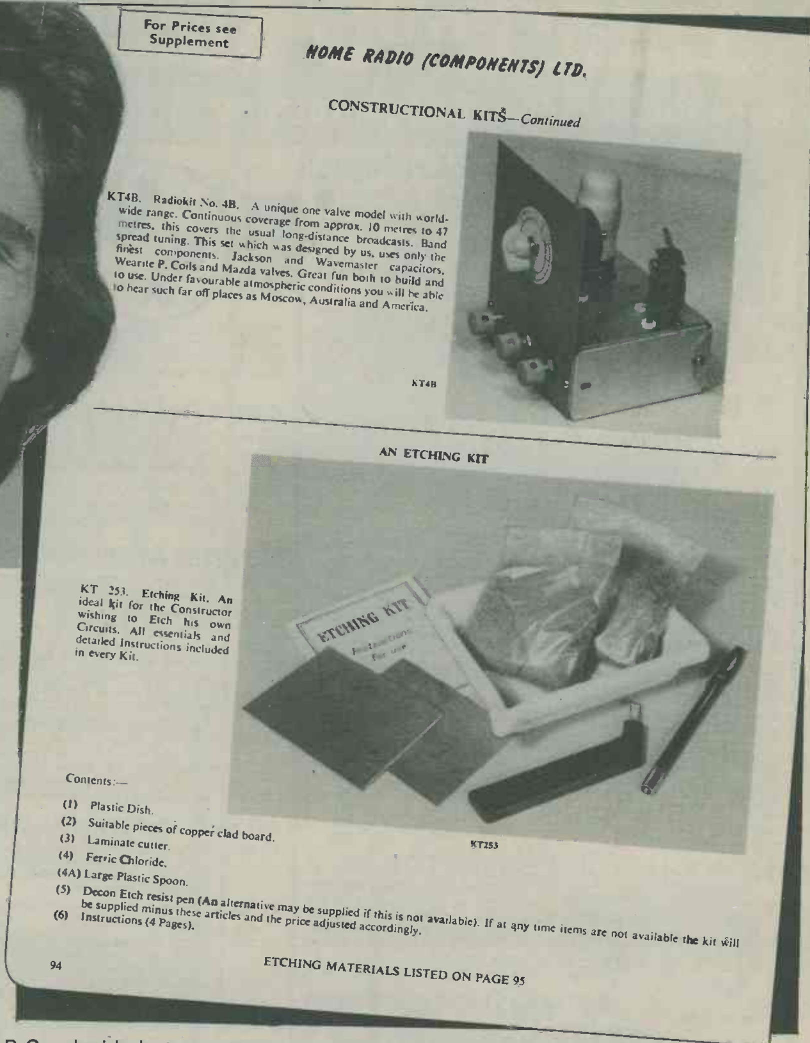

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(6) Instructions (4 Pages).

94

ETCHING MATERIALS LISTED ON PAGE 95

Recently I've been telling you just why I've been a customer of Home Radio Components for so long. I've given special emphasis to their superb catalogue, and now it's time to show you a typical page. The problem is . . . which one? There are 240 to choose from – for example, 17 pages of capacitors, 6 of resistors, 10 of switches and 8 of stylii. These are run-of-the-mill things, but here's a page that's specially interesting . . . page 91, showing a Short Wave Kit and an Etching Kit.

The managing director of Home Radio Components tells me there's quite a story behind these items. Briefly, Home Radio Components always listed a SW Kit, but eventually the firm making them ceased trading so H.R.C. decided to produce their own. When they looked around for an Etching Kit they were unable to find any at a sensible price, so again they said "Right, we'll make our own!" Sounds simple, but the managing director told me that if you produce any kit within 12 months of deciding to go ahead you're doing very well. "As for the problems of producing an Etching Kit," he said, "I could write a book about it!" Incidentally, if you want to order either of these kits the prices are:

KT4B, S.W. Kit, £4.75 plus VAT, plus 35p for p & p.
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Technical Queries. We regret that we are unable to answer queries other than those arising from articles appearing in this magazine nor can we advise on modifications to equipment described. We regret that such queries cannot be answered over the telephone; they must be submitted in writing and accompanied by a stamped addressed envelope for reply.

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CONTENTS

VOLTAGE CONTROLLED OSCILLATOR by A. Foord — 590

CAN ANYONE HELP? — 595

NEWS AND COMMENT — 597

SEQUENTIAL LAMP CIRCUIT (Suggested Circuit 294) by G. A. French — 598

CATALOGUE — 602

RECENT PUBLICATIONS — 603

FOUR CHANNEL SYNTHESISER – Part 2 by R. A. Penfold — 604

ELECTRONIC EGG TIMER by R. J. Caborn — 605

MAINS TABLE RADIO by A. P. Roberts — 608

SHORT WAVE NEWS – For DX Listeners by Frank A. Baldwin — 614

VERSATILE VERTICAL FOR TOP BAND by V. S. Evans — 616

THE 'SLIDE RULE' RECEIVER CUM CAPACITANCE METER – Part 1 by Sir Douglas Hall, K.C.M.G. — 620

RADIO TOPICS by Recorder — 626

IN YOUR WORKSHOP – Inexpensive A.M. Receivers — 628

NEW PRODUCTS — 634

CONSTRUCTOR'S DATA SHEET No. 98 (Common Musical Terms II) — iii

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VOLTAGE CONTROLLED OSCILLATOR

By A. Foord

Using basic linear i.c. principles, this ingenious design is capable of being controlled over a frequency range of 100 to 1. Outputs are square and triangular, and the addition of a converter enables a sine wave output to be produced as well

VOLTAGE CONTROLLED OSCILLATORS ARE USEFUL IN many applications. Typical of these are the recording of very low frequency signals on a normal tape recorder, swept frequency response measurements, and electronic music.

A v.c.o. should have good stability, excellent linearity and a wide frequency range. There are several possible circuit approaches, depending on the maximum operating frequency and other parameters chosen. Unfortunately, integrated circuits such as the NE566 function generator can only be modulated over a 10 to 1 frequency range. This article describes how an integrator, a comparator and an inverting amplifier can be used to produce a waveform generator which can be voltage controlled over a range of 100 to 1.

BASIC V.C.O.

The basic form for this v.c.o. is shown in Fig. 1. The input voltage range is 0 to 10 volts and IC1 provides a unity gain inversion for the input. IC2 is the integrator with IC3 as a comparator.

Initially assume that V3 is negative and TR1 turned off. The input signal V1, which must be positive, forces a current through R2 into the summing junction of the integrator. The output voltage of IC2 will slew negatively at a rate which depends on V1, R2 and C1. When it reaches –V the comparator output, V3, will go positive. This switches on TR1 and changes the comparator reference to +V.

With TR1 turned on a current is drawn, through R1, out of the summing junction which is twice that supplied into the junction through R2. This results in a net current out of the summing junction which is equal to, but opposite in magnitude to the previous current. V2 now slews positively. When it reaches +V the comparator will again switch to the –V level, which cuts off TR1. This allows the cycle to repeat.

For the conditions shown, where IC1 forms a unity gain inverter and there are equal currents into and out of the integrator capacitor for each half-cycle, the waveform is symmetrical. The frequency is given by the equation included in the diagram.

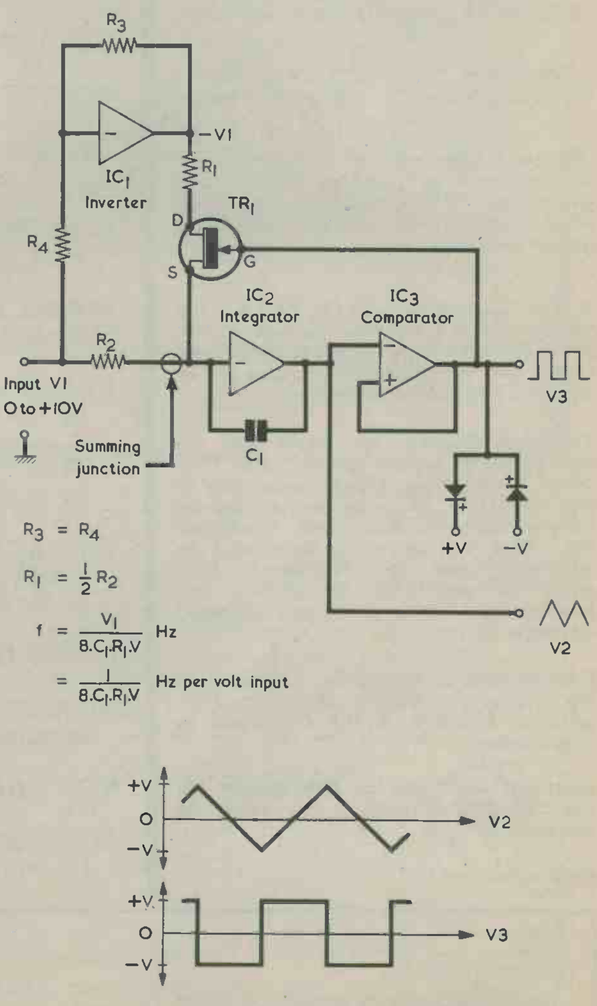


Fig. 1. A basic voltage controlled oscillator

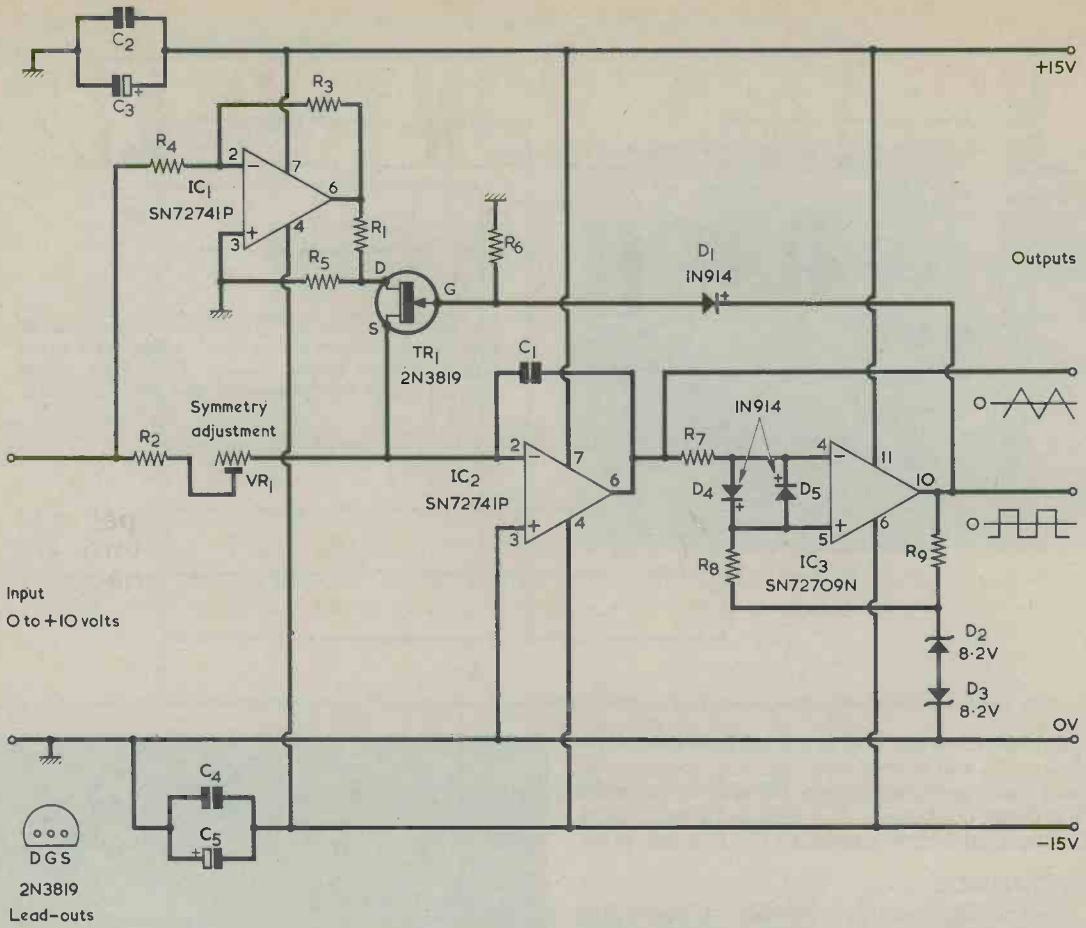


Fig. 2. The practical voltage controlled oscillator

COMPONENTS

Resistors
(All fixed values ¼ watt 5%)

R1	10kΩ	R12	270Ω
T2	18kΩ	R13	390Ω
R3	10kΩ	R14	220Ω
R4	10kΩ	R15	220Ω
R5	2.2kΩ	R16	390Ω
R6	22kΩ	R17	270Ω
R7	10kΩ	R18	120Ω
R8	10kΩ	R19	2.2kΩ
R9	1.8kΩ	R20	27kΩ
R10	2.2kΩ	R21	12kΩ
R11	120Ω	R22	8.2kΩ

VR1 10kΩ multiturn
VR2 10kΩ multiturn

Capacitors
C1 1,000pF and 470pF in parallel, 5%
C2 0.1μF ceramic
C3 10μF electrolytic, 16 V. Wkg.
C4 0.1μF ceramic
C5 10μF electrolytic, 16 V. Wkg.

Semiconductors
TR1 2N3819
D1 1N914
D2 8.2V zener, 400mW
D3 8.2V zener, 400mW
D4–D13 1N914, 10 off

Integrated Circuits
IC1 SN72741P
IC2 SN72741P
IC3 SN72709N
IC4 SN72741P

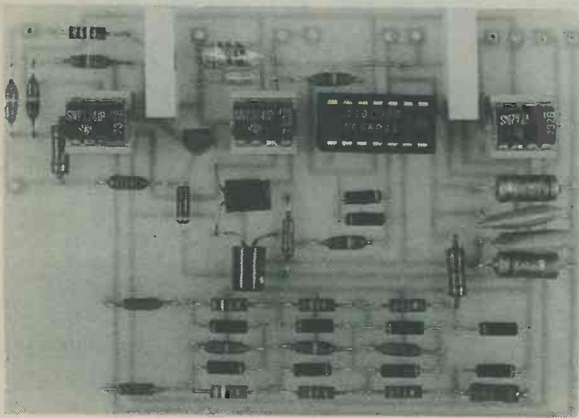
Miscellaneous
Printed circuit board, 7.5 x 10.25cm.

PRACTICAL CIRCUIT

A practical circuit for 0.1 to 10kHz operation is shown in Fig. 2. For the 8.2 volt zener diodes, V3 will be limited to about plus or minus 8.8 volts. With C1 at 1,470pF, R1 at 10kΩ and V at 8.8 volts:

f = 0.97kHz per volt input.

R5 attenuates the drain voltage of TR1 so that it can be held off even for high values of V1. This resistor will not affect the magnitude of the current injected into the



The voltage controlled oscillator and triangular to sine wave converter are both assembled on a single printed circuit board. This then offers square wave, triangular and sine wave outputs

summing junction when TR1 is on because one end is referred to earth and cannot inject or remove current at the virtual earth summing point. R7 and R8 with D4 and D5 prevent latch-up of IC3 during turn-on transients. R9 limits the output current of IC3 to a safe value.

PERFORMANCE

The input voltage against frequency characteristics for two values of C1 are shown in Fig. 3. These rates are about 8% lower than the theoretical values due to component and other tolerances. For example, the inverter IC1 may not give exactly unity gain, and the f.e.t. has an 'on' resistance of about 200Ω. The setting up procedure using VR1 produces a symmetrical waveform but allows errors in the theoretical rate. If an exact rate is required this may be achieved by trimming C1 or by scaling the input voltage. The accuracy of the circuit was plus or minus 5% over the range of 100Hz to 10kHz for a value of 1,470pF in C1.

The accuracy at low input voltages is limited by voltage and current offsets in the integrated circuits. For example, an input voltage of 100mV might give a frequency of 100Hz in theory. However, an integrated circuit offset error of 5mV would give a 5% error in frequency.

Consequently, the performance measured on the prototype for low input voltages is better than that to be expected in general from such a circuit, where no attempt is made to balance out offset errors.

SINE WAVE CONVERTER

The triangular waveform is converted to a sine wave by a diode function generator. This provides the facility of approximating a non-linear relationship with a series of straight line segments. The point where two straight line segments join is called the 'break point', and may be altered, together with the slope of each segment, to provide the required non-linear function. A complete network of resistors, diodes and bias supplies may be used on its own or connected around an amplifier.

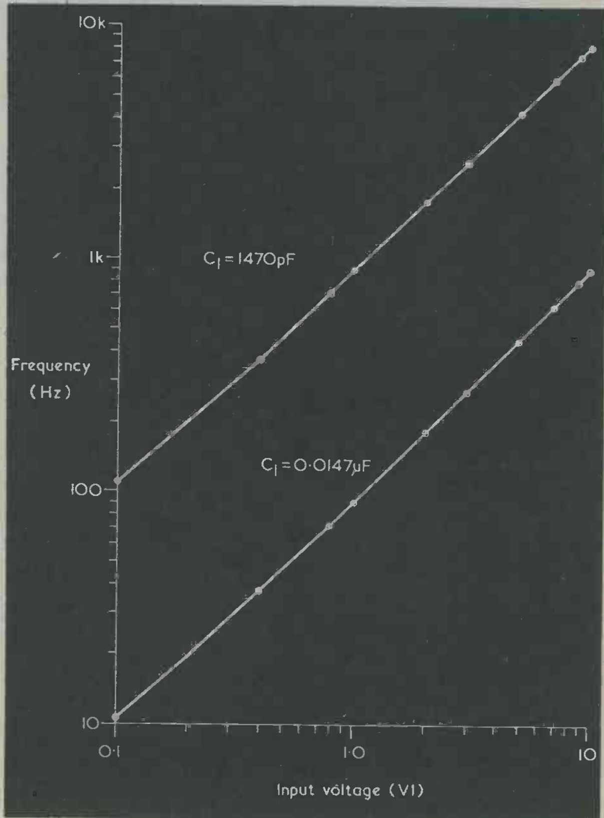


Fig. 3. Voltage-frequency characteristics for two values of C1

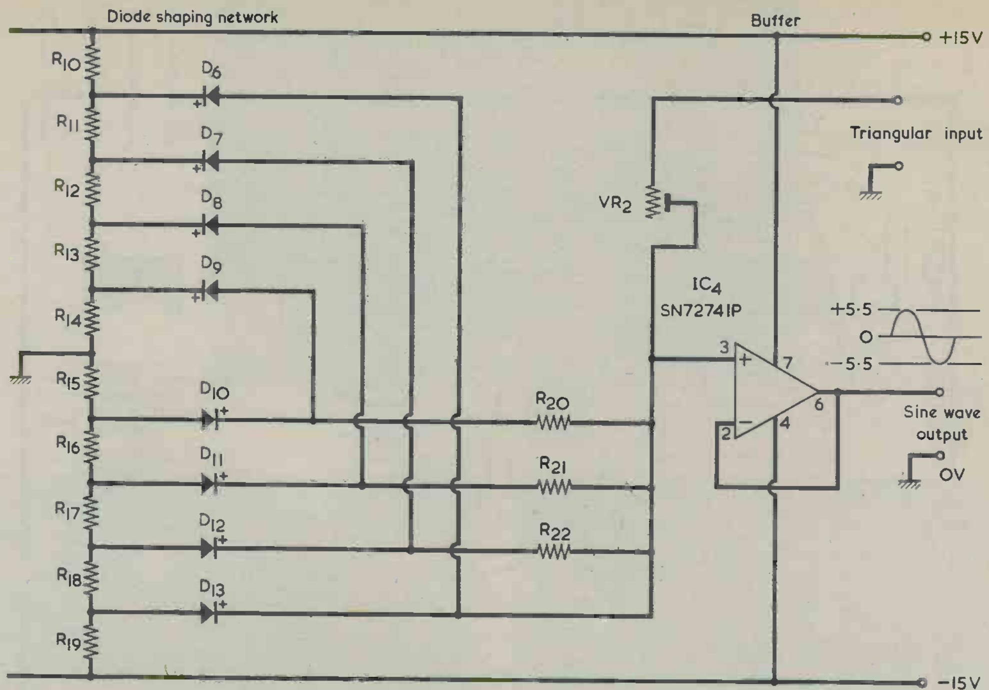


Fig. 4. A triangular to sine wave converter

A triangular to sine wave converter is shown in Fig. 4, and is followed by a buffer amplifier.

When the input in Fig. 4 is initially zero then all the diodes are reverse biased. If the triangular waveform is rising linearly then the output is progressively reduced as D9, D8, D7 and D6 conduct. As the input voltage decreases back towards zero each diode is cut off in the reverse order to give the second quarter of the sine wave. For negative half-cycles diodes D10, D11, D12 and D13 conduct in a similar manner.

The points at which the slopes change are not sharp but are rounded by the non-linear forward characteristics of the diodes. One of the difficulties of this approach is that the adjustment of the slope of each line segment influences all the following segments, and it is impossible to just 'touch up' an intermediate slope.

VR2 should be adjusted for the best possible waveform.

The Table shows the relative amplitudes of the sine wave fundamental, at 5kHz, and the harmonics. It can be seen that the second harmonic is 39dB down on the fundamental, so that the sine wave is quite distorted at a total harmonic distortion of 1.8%.

CONSTRUCTION

The circuits of Figs. 2 and 4 are combined in a single unit, and this may be assembled on a printed circuit board, as in Fig. 5. The copper pattern is reproduced full-size in Fig. 6, which can be traced. Small multi-turn potentiometers are required for VR1 and VR2, and suitably dimensioned components are miniature 15-turn Cermet Trimpots available from Doram Electronics, Ltd. Before preparing the printed circuit, confirm the positioning of the connection points shown in Fig. 6 for the potentiometers with the actual potentiometers to be used. If there are any differences modify the printed circuit pattern to agree with the actual components.

IC1, IC2 and IC4 are the 8-pin d.i.l. version of the 72741. IC3 is the 14-pin d.i.l. version of the 72709. There is room on the board for two capacitors in parallel for C1.

The completed unit has the following performance.

Input impedance	=	6.6kΩ
Square wave output	=	±13 volts
Triangular output	=	±8.8 volts
Sine wave output	=	±5.5 volts.

TABLE

Harmonic content for a 5kHz sine wave

Frequency (kHz)	Relative Amplitude (dB)
5	0
10	–39
15	–43
20	–56
25	–38
30	–59
35	–76
40	–76
45	–77
50	–68

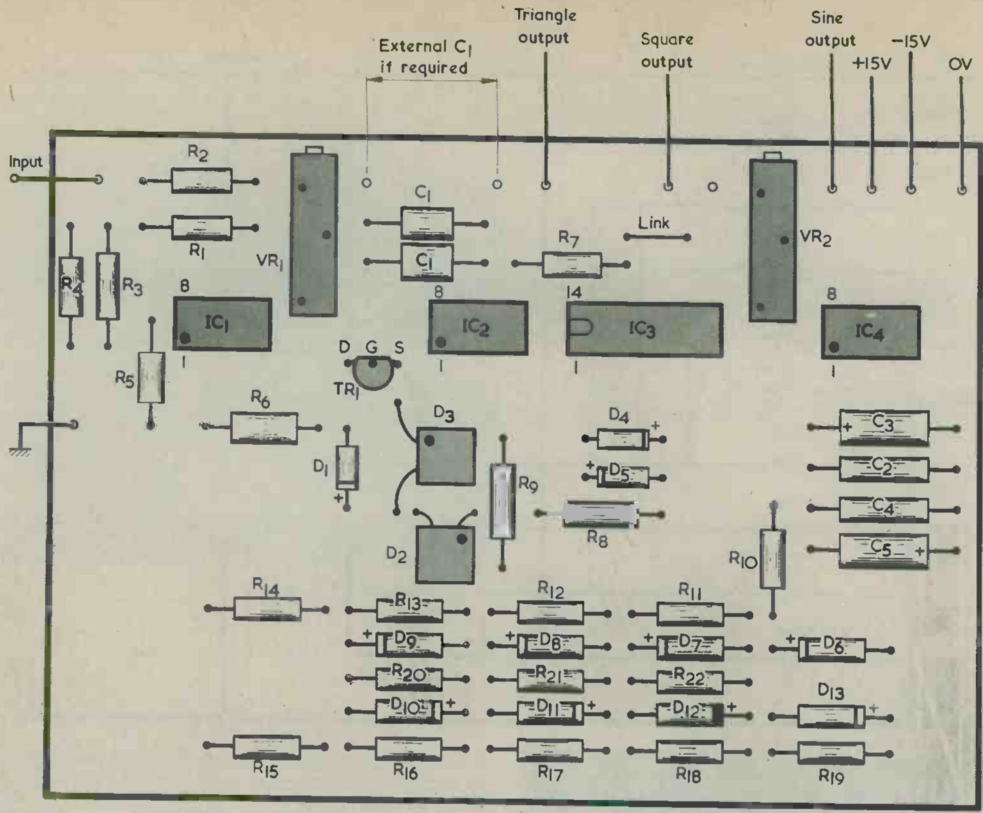


Fig. 5. The component side of the printed circuit board

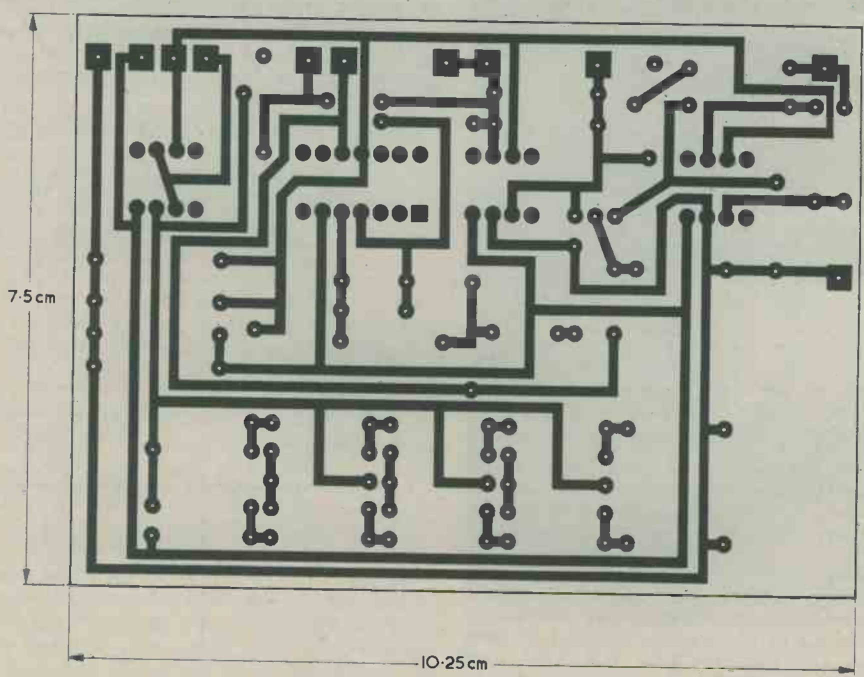
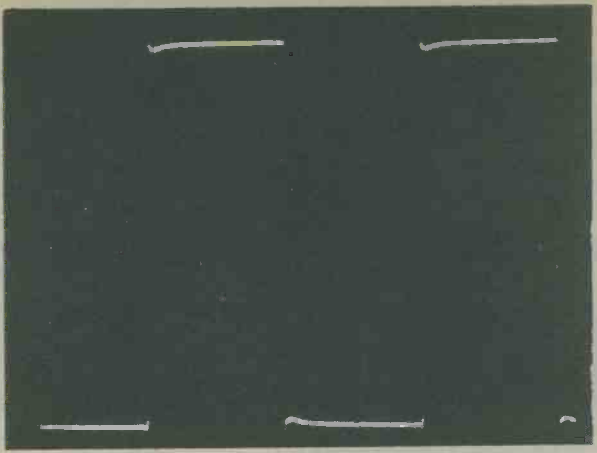
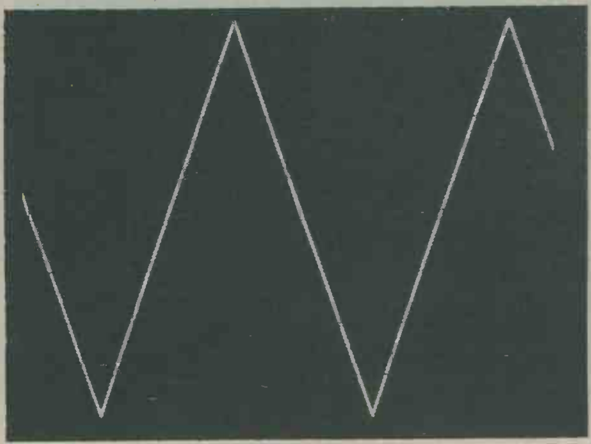


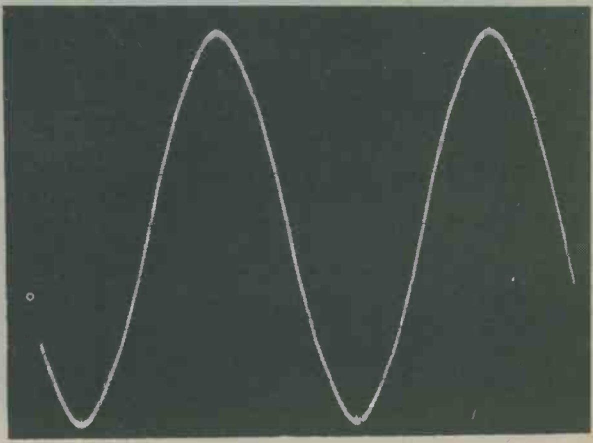
Fig. 6. The copper side of the p.c. board. This is reproduced full size and may be traced



The square wave produced at 5kHz



5kHz triangular wave



The sine wave output at 5kHz

The accompanying photographs show the completed unit and the three output waveforms. The latter were all taken at 5kHz. ■

CAN ANYONE HELP?

Requests for information are inserted in this feature free of charge, subject to space being available. Users of this service undertake to acknowledge all letters, etc., received for to reimburse all reasonable expenses incurred by correspondents. Circuits, manuals, service sheets, etc., lent by readers must be returned in good condition within a reasonable period of time.

Geloso Front End Converter 10-80 Metres – S. Crabtree, 48 Southfield Road, Middlesborough, Cleveland. – Circuit or any other details, to borrow or purchase.

Ex-Service Wireless Set No. 19 MK III – G. Ellis, 9 Fraser Gardens, Southbourne, Emsworth, Hants, PO-108-PY – Circuit diagrams, operating instructions or any information.

DST 100 MK III Communication Receiver – W. H. Hale, 83 Merthyr Road, Pontypridd, Glamorgan – Circuit or any other data to borrow or purchase.

Microvolter 10b, Service No. 503 and Philco Battery 1 Valve Signal Generator – F. Higgins, 4 Rural Cottages, Shrawardine, Shrewsbury. – Any information or circuit diagrams.

Bendix RA – 10RX and R101 – B (ARN-6) – A. D. Beresford, 49 Blake Road, Gt. Yarmouth, Norfolk. – Circuits or any data.

Radio Constructor, April 1968 issue – R. A. Read, 7A The Close, Salisbury, Wilts. – Loan or purchase.

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It is believed the kit is the first of its kind in this country and is from a concept originated in Germany by FranckH'sche Verlagshandlung Kosmos. It is being made to the original specification and copyright by Logix Enterprises of Montreal, and Patterson Edwards Ltd. (makers of Leeway Toys) are the sole distributors in the U.K.

Approximate retail price including VAT, £17.95.

MARCONI MARINE 75 YEARS OLD — THE EARLY DAYS

The Marconi International Marine Company Limited, the world's first marine wireless company, celebrated the 75th anniversary of its inception on 25th April.

Created in 1900 on the 26th birthday of its founder Guglielmo Marconi, The Marconi International Marine Communication Company Limited, with offices in London and Brussels and agencies in Paris and Rome, began as it has continued – a world leader in the marine communications field.

The business was established to offer to ship-owners an entire service whereby wireless apparatus, operators and use of Marconi stations ashore were provided on a rental basis. This service still operates today with the exception of the Marconi shore stations which are now under Post Office control.

Marconi's chief interest had always been wireless for those at sea, and just prior to the formation of the company, he took the first major step in achieving one of his foremost ambitions, to end the isolation of ships at sea. Working from a point on the South Wales coast near Penarth he succeeded in sending a message to an island in the Bristol Channel – a distance of just three-and-a-half miles. Thus began the chain of events which brought marine radio communication to vessels sailing the world's seven seas.

In 1901 came further experiments which achieved communication over 198 miles between the Isle of Wight and the Lizard, and then, Marconi's greatest achievement the successful transmission of Morse code from Poldhu, Cornwall, to St. John's, Newfoundland.

A short time later further tests were carried out between Poldhu and the American liner *Philadelphia* when messages were received up to a distance of 1,551 miles.

The British and Italian navies had quickly adopted Marconi wireless and the system had been introduced to the USA, where a company was registered later to become the Radio Corporation of America.

INCREASE IN V.A.T.
The Budget statement announcing increases in V.A.T. was made too late for advertisers to alter their copy.
Therefore prices should be checked with advertisers before placing orders.

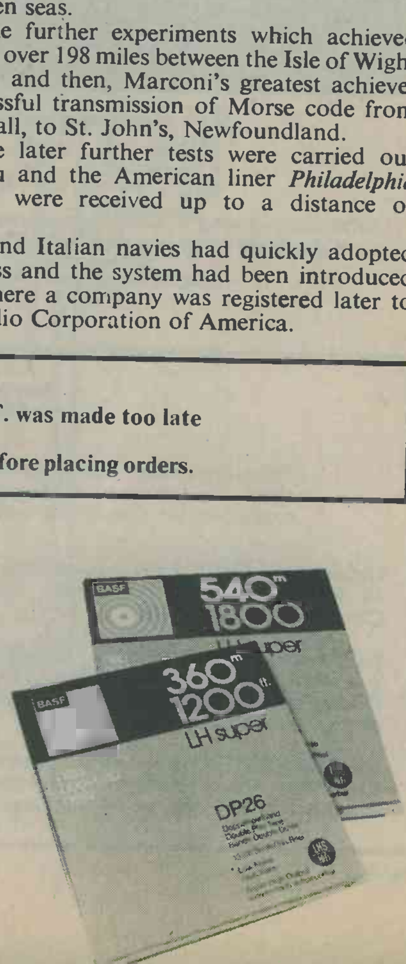
NEW OXIDE AVAILABLE ON REEL

LH-Super, BASF's newest tape coating using maghemite in its purest form, is now available as a reel-to-reel tape in long play and double play versions.

Both versions, product-named LP35 LH-Super and DP26 LH-Super, come in three reel sizes – 5in, 5¾in, and 7in – and are packaged in plastic swivel boxes.

LH-Super contains even smaller and more evenly sized oxide particles than ordinary LH tape. This results in a 2 dB reduction in tape hiss; a 3 dB increase in permissible recording level (at 5% harmonic distortion); greatly reduced headwear; and virtually no drop-outs.

Recommended retail prices of reel-to-reel LH-Super are: LP35 LH-Super, £2.66 (5in); £3.20 (5¾in) and £4.54 (7in). DP26 LH-Super, £3.50 (5in); £5.08 (5¾in) and £6.28 (7in). All prices exclude VAT.



. . . COMMENT

WIRELESS MUSEUM AT STATELY HOME

The Vintage Wireless Museum of the Wireless Preservation Society is being transferred from its former site in South Lincolnshire to a stately home in the Isle of Wight, which is open to the public throughout the year – Arreton Manor, the home of Count and Countess Slade de Pomeroy.

The manor, which dates back to the Middle Ages, already houses a folk museum, exhibition of domestic and agricultural bygones, as well as a superb collection of dolls, dolls' houses and toys.

Established a few years ago, the Wireless Preservation Society is exclusively devoted to the collection, preservation and restoration of wireless, electronic and sound reproducing equipment, including gramophones and television receivers, for purely cultural, educational and historical purposes.

An entirely non-profit-making organisation, all its officers are honorary. The curator and secretary is Mr. D. Byrne, G3KPO, who has now moved to No. 32 Luccombe Road, Shanklin from whom further information can be obtained.

QUOTE

"Now that Parliament is to be broadcast on the radio, may we hope that the two sides of the House will be distinguishable by means of stereo?"
From a reader's letter published in the *Radio Times*.

CAR STEREO CASSETTE PLAYER

The sound of the '70s comes through loud and clear on the new Beltek MW/LW Car Stereo Cassette Player introduced by Eagle International of Wembley, Middlesex.

Designated Model M6680 this latest extension to the Beltek range of precision engineered home and car stereo equipment has been added due to the rapidly increasing popularity of the series. Both new and existing car stereo owners are turning to versatile Beltek units for their next experience of in-car entertainment.

M6680 gives top quality reproduction at 8 + 8 watts power output. It has fast forward, rewind and eject; medium and long wave radio; illuminated function indicators; push button MW/LW switching; end of tape run indicator; instant play loading mechanism. Recommended retail price is £66 + VAT.

TRANSISTOR HEATER

An unusual heating technique is employed in a temperature stabilizer circuit which is described in *Mullard Outlook* No. 2 for 1974. The function of the circuit is to maintain a small metal block at a constant temperature. Components such as quartz crystals may then be housed in a cavity in the block, whereupon they run at the constant temperature.

The temperature sensing device in the control circuit is a thermistor which is clamped to the block. This is connected in a bridge circuit which couples to an operational amplifier. In its turn, the output of the latter connects, via a current limiting resistor, to the base of a p.n.p. silicon power transistor type BD132.

A clever feature of the design is that the transistor itself acts as the heater which raises the temperature of the metal block to the desired level. For close thermal coupling the transistor is clamped to the block alongside the thermistor. When the temperature of the block falls, the corresponding changing bridge voltages cause the op-amp output to go negative, thereby making the transistor conductive. When the block temperature rises the op-amp output swings positive, thereby turning the transistor off. A typical operating temperature is around 69°C.

To have a power transistor driving a resistive heater element would be a common approach in a set-up of this nature. But to use the transistor itself as the heating element strikes me as being one of the most ingenious ideas we've bumped into for quite a long time.

"A time like this - and all he can think of is inventing something he calls 'Ark Welding'!"

THE GREEKS HAD A WORD FOR IT

Did you know that the derivation of the word stereo comes from the Greek word *stereos* meaning solid?

SEQUENTIAL LAMP CIRCUIT

By G. A. French

Suggested Circuit 294

MOST READERS WHO HAVE ATTENDED fairgrounds or visited large cinemas or halls will have seen a form of display lighting in which individual lamps in a rectangle are successively lit and extinguished in a manner which gives the impression that the light from the lamps is moving around the rectangle in one direction. The scheme is shown on a small scale in Fig. 1 at a particular instant in time. In this diagram, every third lamp is extinguished. Shortly afterwards, the extinguished lamps will light up and the lamps next to them in the direction of the arrows will be extinguished, after which the subsequent lamps along the rectangle will be extinguished, and so on. The extinguishing of every third bulb proceeds continually along the lamps, and the overall effect is that the light itself is in motion.

This month's Suggested Circuit presents a simple means of achieving a small sequential lamp switching display in this manner, the controlled lamps being standard m.e.s. torch bulbs. The resulting display can be employed in a shop window display, as a novelty in a small discotheque or for any similar purpose. The circuit is classed in the experimental category because the oscillator controlling the lamps requires capacitors having a performance not covered in manufacturers' specifications, and because this oscillator runs at a frequency approaching its higher limit.

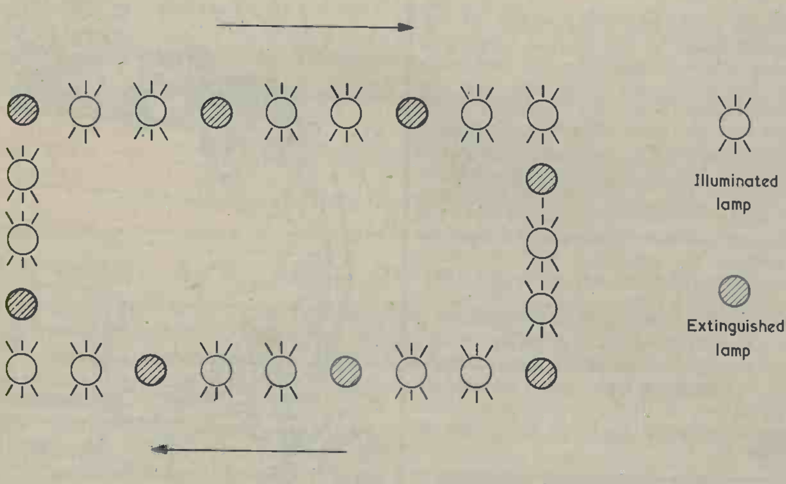


Fig. 1. A layout of twenty-four lamps illustrating the 'moving light' effect

FOUR WIRE SYSTEM

A series of lamps offering the effect illustrated in Fig. 1 may be controlled by a four wire system, as illustrated in Fig. 2 (a). This shows six lamps. The four wires continue to the right, coupling to succeeding lamps which are connected up in the same manner as the six illustrated. If the lamps form a rectangle, the first lamp, PL1, may be any lamp in that rectangle. The lamps then proceed in groups of three arriving eventually at a group of three which is immediately followed by PL1. Any number of lamps may be employed, provided that the total is a multiple of three. All lamps share a common return wire. If a voltage is applied to Input 1 and the Common wire, the first lamps in all the groups of three are lit. Should a voltage be applied to Input 2 all the second lamps in the groups of three are lit, and if a voltage is applied to Input 3 all the third lamps in the groups of three are lit.

Fig. 2 (b) shows the waveforms which need to be applied to the three inputs to achieve sequential switching of the lamps.

Between points A and B in Fig. 2 (b) Input 1 is off and Inputs 2 and 3 are on, with the result that the first lamps in each group of three are extinguished and the second and third lamps are lit. Between points B and C, Inputs 1 and 3 are on whilst Input 2 is off. The consequence is that the second lamps in the groups of three are unlit whilst the first and third are illuminated. Both Inputs 1 and 2 are turned on between points C and D whilst Input 3 is off, causing the third lamps of each group to be extinguished, and the first and second to be lit. Between points D and E the situation reverts to that given between points A and B, and another cycle has commenced.

The length of a complete control cycle is that between points A and D, after which it repeats once more and continues to repeat. The lamps can, in consequence, give the desired 'moving light' effect if the three waveforms of Fig. 2 (b) are applied to Inputs 1, 2 and 3 of Fig. 2 (a).

CONTROL OSCILLATOR

The basic circuit of a suitable control oscillator appears in Fig. 3. In this arrangement the three transistors turn off successively and, between transitions from one state to the next, two transistors are always turned on and one transistor is always turned off.

To explain oscillator operation let us examine the circuit of Fig. 3 at an instant when TR1 is turning off. Both TR2 and TR3 are turned on. As TR1 turns off its collector goes negative, causing C1 to charge via R2 and the base-emitter junction of TR2. C1 acquires a charge which is nearly equal to the supply voltage. After a period TR1 turns on again whereupon its collector takes the negative terminal of C1 towards the lower supply rail. The positive terminal of C1, which is now charged, takes the base of TR2 positive of the lower supply rail, with the result that TR2 turns off. As with TR1, TR2 collector goes negative, thereby allowing C2 to charge via R4 and the base-emitter junction of TR3. At the same time, C1 is discharging via R3. When C1 is nearly fully discharged the base of TR2 will become sufficiently negative for this transistor to pass collector current. It turns on, whereupon its collector goes positive and, by way of the charged C2, takes TR3 base positive and turns off TR3. The cycle then continues, with TR3 turned off until C2 has discharged into R5. TR3 then turns on and turns off TR1, and so the cycle repeats. Each transistor turns off in turn following the sequence TR1, TR2, TR3, TR1, TR2, TR3, and the length of time that each transistor is turned off depends upon the values of the capacitor and the resistor in its base circuit. If all the capacitor and resistor values are equal, then each transistor is turned off for the same length of time.

There is no regenerative feedback in this three-transistor oscillator as occurs in a two-transistor multivibrator and, indeed, the coupling from one collector to the following base would be degenerative if the transistors were allowed to function as linear amplifiers. In consequence, the oscillator will only run at relatively very low frequencies which allow the transistors to operate as switches, with at least one transistor always turned hard on to break any linear amplification chain through the three. It is necessary for the collector resistors to have significantly lower values than the following base resistors in order that the capacitor between them charges more rapidly than it discharges. The three transistors are germanium instead of silicon types for the following two reasons. Firstly,

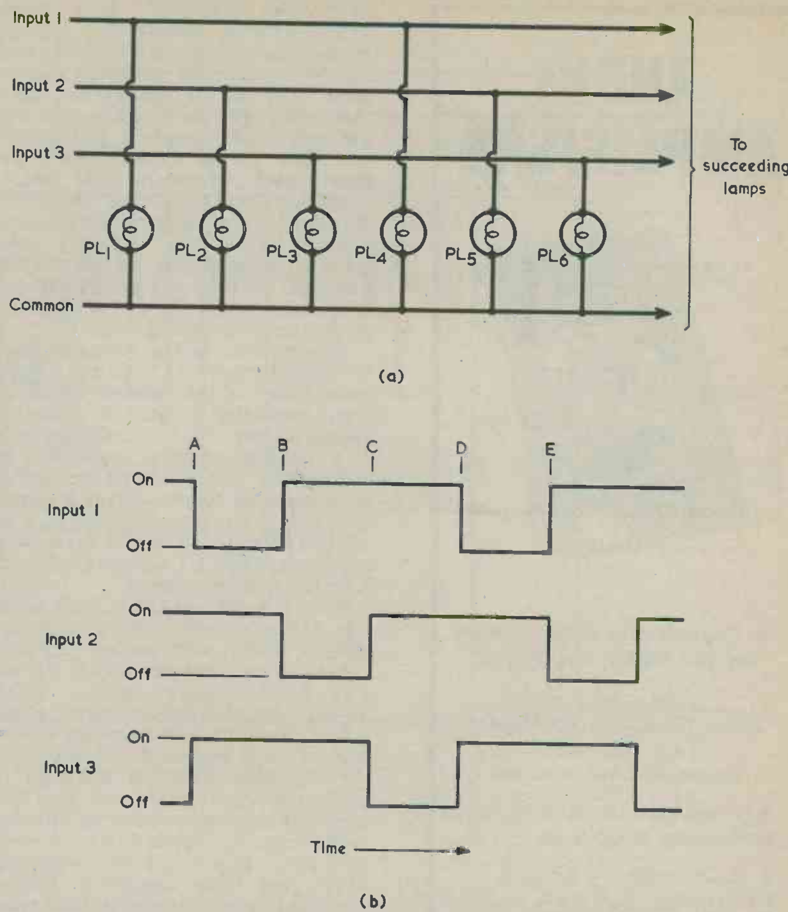


Fig. 2(a). The lamps may be connected in groups of three in a four wire system
(b). The waveforms which need to be applied to the three input wires

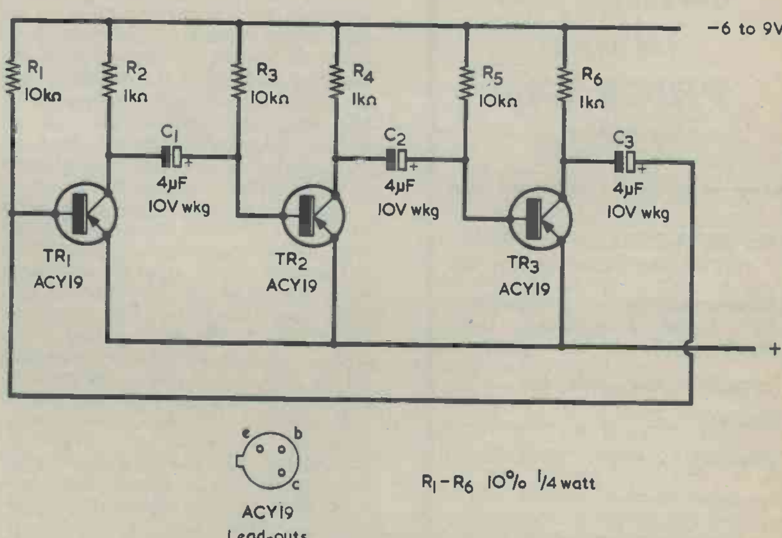


Fig. 3. An unusual oscillator, in which each transistor turns off successively

germanium transistors have much higher reverse base-emitter voltage ratings than do silicon transistors and so they present no problems due to zener effect at the base-emitter junctions. Secondly, the base and collector voltages of a turned-on germanium transistor are at approximately the same level whereas, with silicon transistors, the base of a turned-on transistor is at a higher voltage than the collector. If silicon transistors were used in the oscillator the electrolytic capacitor between any two turned-on transistors would have a voltage of reverse polarity applied across it.

The oscillator of Fig. 3 runs particularly satisfactorily if C1, C2 and C3 are given values of the order of 100μF. It then completes a cycle in about 2 seconds. Interestingly, despite the lack of obvious regenerative feedback it is self-starting, and will begin oscillation both when the supply voltage is raised gradually from zero volts or if it is applied abruptly. Whatever capacitors are employed for C1, C2 and C3 should have low leakage currents.

With C1, C2 and C3 at 4μF, as in Fig. 3, the frequency rises to approximately 12Hz, and leakage current requirements in the electrolytic capacitors become more rigorous. The author's circuit failed to operate when a 4μF capacitor with a leakage resistance of 1MΩ was employed in one of the capacitor positions, although it performed very reliably and gave the same self-starting operation as with the 100μF capacitors when 4μF capacitors with much higher leakage resistances were used. The capacitors finally employed were miniature Mullard type C426 components. There is no reason to doubt that other makes and type of capacitor would have been equally suitable if they had been available. If, incidentally, an ordinary multimeter switched to an ohms range is used to measure the leakage resistance of an electrolytic capacitor, the meter positive lead should be connected to the negative lead-out of the capacitor and the meter negative lead to the positive lead-out. The meter needle will, of course, take some time to reach its final setting as the capacitor charges from the battery in the meter.

The maximum leakage current quoted by Mullard for a 4μF 10 volt type C426 capacitor is 4.1μA, which corresponds to a leakage resistance, with 10 volts across the capacitor, of a little more than 2MΩ. The capacitors employed by the author had much higher leakage resistances than this figure and it has been the writer's experience that this is a general characteristic of C426 capacitors, although it cannot of course be guaranteed. The author has not tried the circuit with tantalum electrolytic capacitors or with plastic foil capacitors of the same value.

A second factor which makes the circuit of Fig. 3 experimental is concerned with the highest frequency at which it will run. Here, the author has not had experience with a quantity of oscillators employing the circuit and can only relate to his practical experience with the prototype. It was found that the oscillator continued to oscillate, at a higher frequency, when one of the 4μF capacitors was replaced by a 1μF capacitor, but that it refused to operate when a 0.5μF capacitor was substituted. This argues that, with 4μF capacitors, the circuit is approaching the upper limit at which it can run.

These points having been made, the author can state that the prototype oscillator ran very reliably, as should others made up to the circuit, but that it may be necessary to select coupling capacitors. The transistors do not appear to have any noticeable effect on oscillator running although it is conceivable that low gain or excessively leaky specimens may cause difficulties. In the writer's view, the advantage given by the extreme simplicity of the oscillator considerably outweighs the disadvantage that components are a little critical.

It will ease construction if the oscillator of Fig. 3 is initially made up and checked for correct operation. Oscillation will be indicated if a voltmeter is connected across R2, R4 and R6 in turn and it is found that the meter needle flicks at oscillation frequency in all three instances. The circuit can be powered temporarily by a 6 or 9 volt battery. Once the oscillator is running satisfactorily, the remaining parts may be obtained and assembled.

SEQUENCE SWITCHING

The full sequence switching circuit appears in Fig. 4. Here, the oscillator of Fig. 3 is slightly modified by inserting lamp switching transistors in the collector circuits. TR1 to TR3, C1 to C3 and R1 to R6 are the same as in Fig. 3, and have the same type numbers or values. A 6.3 volt heater transformer, T1, is now incorporated to power both the oscillator and the lamps. The oscillator supply is given by rectifier D1 and the reservoir capacitor C4.

When TR1 is turned on its collector current flows into the base of TR4, causing TR5 to become fully conductive. Current may then flow, on mains half-cycles when the lower end of T1 secondary is positive, through silicon rectifier D2, through the lamps connecting to Input 1, and through TR5 to the upper end of T1 secondary. When TR1 is turned off so also are TR4 and TR5, and no current flows in Input 1. The lamps connected to Input 2 and Input 3 similarly turn on and off in sympathy with TR2 and TR3 respectively.

It is necessary to insert D2 in series with the Common line because, otherwise, negative half-cycles could be applied to the collectors of TR5, TR7 and TR9. Forward current would then flow in the collector-base junctions of these transistors and could upset circuit operation. When a resistive load

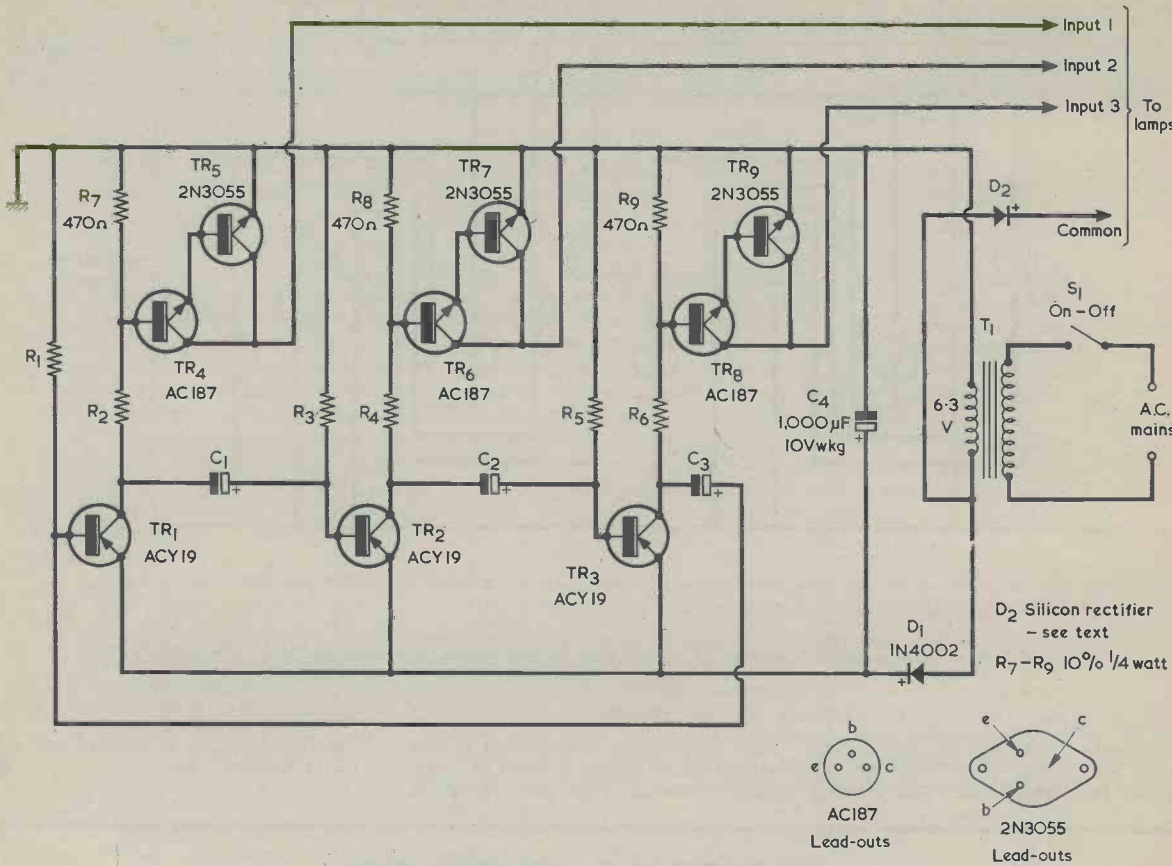


Fig. 4. The oscillator employed in the sequential light switching circuit

is connected via a diode to a sine wave alternating voltage, the effective heating voltage across the resistor is equal to 0.7 times the r.m.s. value of the alternating voltage. This relationship holds true regardless of the current in the load. In consequence the effective heating voltage applied to the lamps is 0.7 times 5.1 volts (6.3 volts minus about 1.2 volts dropped across D2 and the switching transistor) or 3.6 volts. The lamps could, in consequence be 6 volt types, whereupon they would be significantly underrun, or 3.5 volt types, whereupon they would be overrun by a negligible amount. Alternatively, 2.5 volt lamps could be used in series, as shown in Fig. 5. When a voltage is applied to Input 1 of Fig. 5 both PL1 and PL4 light up, whilst applying a voltage to Input 2 causes PL2 and PL5 to be illuminated. A voltage at Input 3 lights up PL3 and PL6. This arrangement has the advantage that inexpensive lamps are employed at a voltage not excessively lower than their nominal rating, whereupon they should have a long life. Also, overall current consumption is low, being effectively a little less than 0.15 amp per lamp. The only disadvantage is that the total number of lamps must be a multiple of six instead of three.

The number of lamps which can be controlled is limited by lamp switching surge currents to 30, using the circuit arrangement of Fig. 5. The actual number of lamps is left to the constructor to decide, and the current rating of T1 secondary should be adequate for the total lamp current. This should be considered as the current consumed by *all* the lamps, and not by just two-thirds of them. D2 should have a forward current rating of at least twice the total lamp current to take up surges as the lamps are turned on. It may have a p.i.v. of 50 or 100 volts. The maximum collector current rating of transistors TR5, TR7 and TR9 is 15 amps, which should be more than adequate for present purposes.

TR5, TR7 and TR9 are turned on and off fairly rapidly and, when the associated oscillator transistor is conductive, pass collector current for half the time only. The dissipation in each of these transistors is low and they will probably require heat sinks only when a large number of lamps are to be controlled. A check on their temperature should be maintained when the circuit is initially switched on, and heat sinks employed if it is found that the transistors run warm.

The author's prototype circuit incorporated 12 lamps using the arrangement of Fig. 5, and this is probably the minimum number of lamps which will enable the 'moving light' effect to be produced. The fact that the lamps run on half-cycles of a.c. does not produce any flicker. If the lamps are formed up in a rectangle they should be positioned accurately in straight lines. They could alternatively be laid out in a circle, whereupon the lamps should be

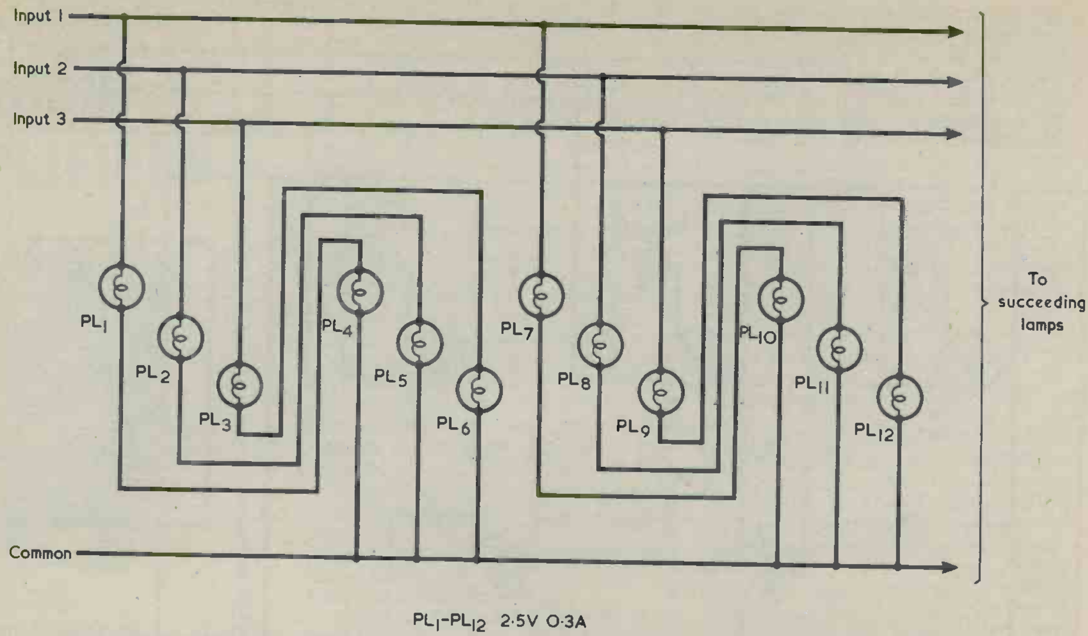
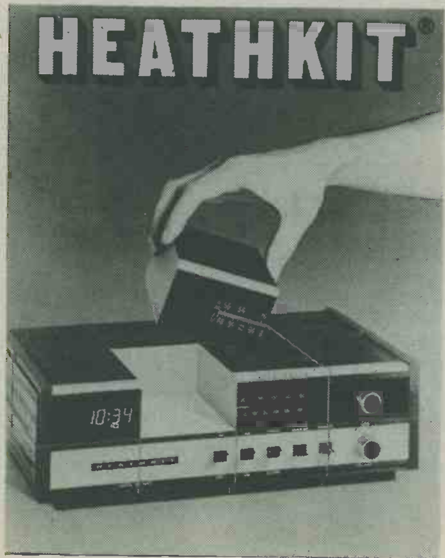


Fig. 5. A recommended method of connecting up the lamps in a practical four wire system

accurately positioned on that circle. Also, the lamps should be equally spaced from each other. The 'moving light' impression is enhanced if they are mounted behind a sheet of translucent material. With only 12 lamps, the 2N3055's ran quite cool and did not require heat sinks. ■

CATALOGUE



A NEW HEATHKIT CATALOGUE IS NOW AVAILABLE, THIS giving details of the latest kits available from Heath (Gloucester) Limited. An exceptionally wide range of kits is listed, these including hi-fi equipment, testers and analysers for the motorist, calculators, intercoms, burglar alarms, digital clocks, metal locators, amateur radio transmitters and receivers, oscilloscopes, meters and signal generators. Also available are kits for scientific work, for marine electronics, for radio control of models, and for transistor radios and a monochrome television receiver.

Amongst the new items introduced in this 64-page catalogue are an exhaust gas analyser, a triggered dual-trace oscilloscope, a function generator, a desk-top slide rule calculator, an s.s.b. transceiver with digital readout and an s.s.b. linear amplifier.

The catalogue is available free from Heath (Gloucester) Limited, Bristol Road, Gloucester, GL2 6EE. Alternatively, it can be collected at the Heath Gloucester showroom, which is next to the Bristol Road factory, or at the London Heathkit Centre at 233 Tottenham Court Road. ■

RECENT PUBLICATIONS

RADIO CONTROL FOR MODELS. By R. H. Warring. 220 pages, 245 x 190 mm. ($9\frac{1}{2}$ x $7\frac{1}{2}$ in.) Published by Sir Isaac Pitman & Sons, Ltd. Price £5.50

This large and well illustrated hard cover book is stated to be the most comprehensive yet produced on the subject of model control. It has a very attractive presentation, with many photographs of models, equipment and rallies, together with clear line drawings illustrating mechanical and electrical modes of operation.

At the start the book deals with some of the earlier radio control methods, such as those incorporating multi-channel reeds, and then takes the story all the way up to modern proportional control. This is a good approach, particularly for the newcomer to the hobby, as it shows the developments which have taken place over the years and illustrates how shortcomings in performance have been gradually and successfully designed out of radio control systems.

The work commences with a short review of all the radio control systems then, after dealing with radio fundamentals and single channel operation, carries on to a large section devoted to proportional control. This is followed by details of aircraft installations, radio control engines, and radio controlled boats and vehicles. The book concludes with advice on batteries and workshop procedure.

RADIO SERVICING POCKET BOOK, Third Edition. By Vivian Capel. 236 pages, 185 x 120 mm. ($7\frac{1}{4}$ x 5 in.) Published by Newnes-Butterworth. Price £1.95.

The first edition of this book appeared in 1955 and the second in 1962. Over the last thirteen years there have been wide changes in domestic radio receiver design, and this book has been entirely rewritten to take these in for its current third edition. Large amounts of new material have been added and much obsolete matter, now out-dated, has been dropped. The result is a very practical book which is almost entirely concerned with receivers incorporating transistors and integrated circuits. As any service engineer will confirm, valves have not entirely faded from the servicing scene. Quite a few families still cherish their old valve radios, and a 20 page chapter in the book covers the essential details that are required here.

Approximately the first half of the book deals with household and car radios of all types, components, stereo broadcasting, aerials and interference. The contents then turn to workshop practice, test equipment and workshop techniques, carrying on to fault diagnosis and alignment. The last two chapters cover useful data and provide a directory of service depots, or addresses where service replacements and information may be obtained, for over 140 radio manufacturers.

The book, which is in hard cover, provides a considerable amount of very useful technical information, and this is interlaced throughout with good common-sense advice. The section on workshop organisation takes in not only the running of a servicing centre employing a number of engineers but also the situation in which the serviceman is running his own one-man business. Attention is paid to the rapid location of faults, an essential feature of economic servicing. The book will be of particular value to the younger service engineer who is starting in the career, and also to the spare time serviceman who carries out repairs for friends and acquaintances.

AMATEUR RADIO TECHNIQUES, Fifth Edition. By Pat Hawker, G3VA. 304 pages, 245 x 185 mm. ($9\frac{1}{2}$ x $7\frac{1}{4}$ in.) Published by Radio Society of Great Britain. Price £2.

A 'huff and puff' stabilizer is a device which holds a *variable* frequency oscillator to within a few cycles of its adjusted frequency by means of t.t.l. chips. The oscillator frequency is applied to a 7400 gate so controlled by a crystal oscillator and divider chain that it opens for precise periods of time. A 74191 binary counter 'counts' the number of cycles from the v.f.o. passing through the gate and the logic number on one of its outputs is then checked. For decimal digits of 0 to 7 the output at pin 7 of the 74191 will be a logic zero and for digits from 8 to 15 the output will be a logic 1. At the pin 6 output, digits 0 to 3 give an output of zero whilst 4 to 7 give logic 1. The v.f.o. is then made to swing between the zero and 1 conditions from either of these two outputs by way of a varactor diode. The overall effect is that the v.f.o. is tuned by hand to the desired frequency, after which the stabilizer takes over and holds the oscillator frequency at the nearest value which lies between the zero and 1 logic output conditions.

This stabilizer is only one of many hundreds of circuits, ideas and tips which are to be found in the fifth edition of the book under review. Made up from items in the 'Technical Topics' feature of *Radio Communication*, the volume includes over 700 diagrams, and the text runs to about a quarter of a million words. Intended primarily for the amateur transmitting enthusiast, the book will be of value to anyone working in electronics. It is a veritable treasure-chest of information, both for reference and as a source of ideas.

FOUR CHANNEL SYNTHESISER

Part 2

By R. A. Penfold

In this concluding article, details are given for obtaining correct phasing of the two rear speakers. Also discussed are adjustments for optimum volume and balance

In last months' issue the construction and principle of operation of the synthesiser were described. We now carry on to details of setting up the unit.

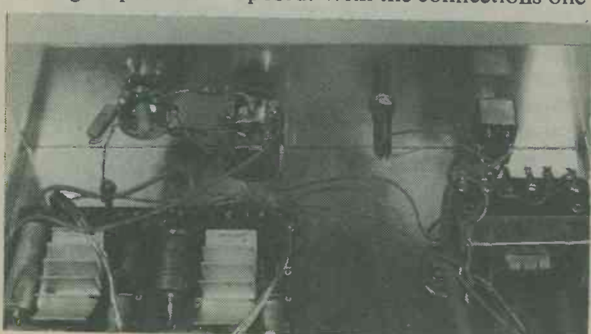
NOTES ON USE

Carefully check all the synthesiser wiring before switching it on. When it has been ascertained that all is correct, the two rear 8Ω speakers may be connected. The synthesiser input is then coupled to the stereo amplifier in the manner described in the preceding article.

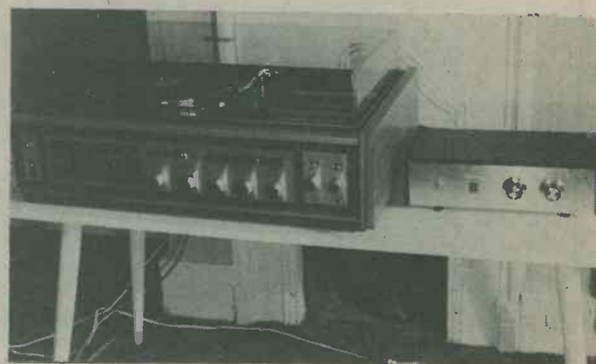
Speaker phasing may next be checked. It is assumed that the phasing of the two front speakers is correct already. When checking the speaker phasing of a stereo system a common practice consists of playing a record or tape which has plenty of bass content, then playing it again after having transposed the connections to one speaker. Unfortunately, this approach is not feasible here as the synthesiser works on a frequency selective basis.

The method used by the author was to deal first with the right front and rear speakers and then with the left front and rear speakers.

Turn the synthesiser balance control fully clockwise to favour the right hand channel, and similarly adjust the balance control of the stereo amplifier. Play part of a record, then play it again with the connections to the rear right speaker transposed. With the connections one way round the sound will appear to come either from the front or the rear with little or nothing of the signal appearing to originate between the two. With the connections the other way round there should be a noticeable effect with which the sound appears to come from between the speakers. This second method of connection provides the correct phasing for the right rear speaker.



A rear view of the front panel of the synthesiser



The synthesiser coupled up to a hi-fi Music Centre

When this procedure has been completed for the right front and rear speakers the two balance controls are turned to fully favour the left front and rear speakers and the process is repeated. This time the connections to the left rear speaker are changed over to find the method of connection which provides the desired effect. The system is then ready for use.

In normal operation the stereo amplifier volume and balance controls should be set up for correct reproduction from the front left and right speakers. The synthesiser controls are then adjusted for best results from the rear speakers. These are intended to complement the sound from the front speakers, and the synthesiser volume control should not be set too high or the overall effect will be unrealistic. The synthesiser volume and balance controls are best set up when the system is reproducing a *tutti* passage of music, during which a large orchestra is fully employed. ■

ELECTRONIC EGG TIMER

By R. J. Caborn

The 555 dons yet another hat.

ALTHOUGH THE RATHER LIGHT-HEARTED DESIGN described in this article is intended primarily as a quite attractive egg timer, the basic principles can be applied to more serious use. Of interest to the experimenter will be the fact that the circuit employs that versatile i.c., the 555, in a novel and unusual manner. The 555 i.c. is available, incidentally, as NE555V, LM555CN or as the R.S. Components '555 type' timer.

The device is operated simply by turning on a switch, whereupon a light-emitting diode on its front panel becomes illuminated. After 3½ minutes a loudspeaker produces a loud tone which rises continually in frequency until, after some 15 seconds, it is at a peak both in terms of frequency and volume. The siren-like character of the tone readily catches the attention, and the tone ceases when the device is switched off. The device is then at once ready for another cycle of operation.

THE 555

The egg timer incorporates a 555 i.c. in conjunction with a single transistor. The 555 produces the audible tone, whilst the transistor provides the 3½ minute timing run.

The block diagram for the 555 internal circuitry will be familiar to many readers, and it is reproduced again in Fig. 1. The reader's attention is drawn to the infrequently used Reset facility which is available at pin 4. This pin connects to the base of an internal p.n.p. transistor, whose collector couples to the base of the internal n.p.n. Discharge transistor. When pin 4 of the i.c. is taken close to earth potential the p.n.p. transistor turns on and its collector drives a high base current through the n.p.n. Discharge transistor. The result is that the n.p.n. transistor turns hard on and discharges any capacitance which is connected between pin 7 and earth.

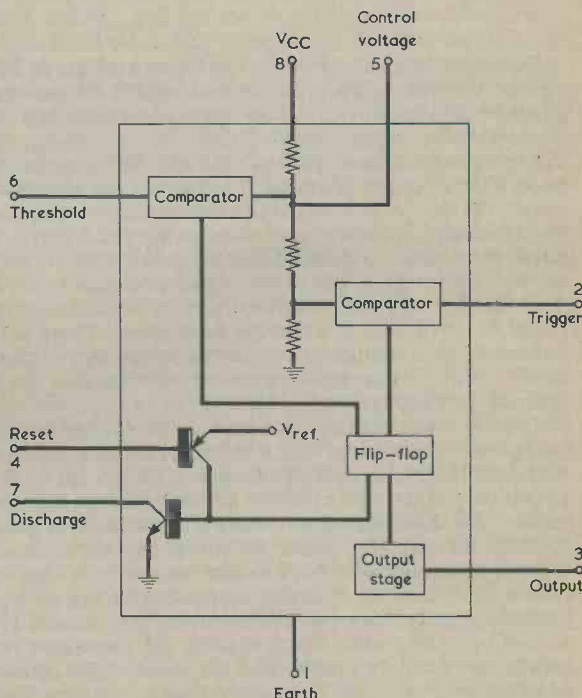


Fig. 1. The internal circuitry of the 555 i.c., with particular emphasis placed on the Reset facility

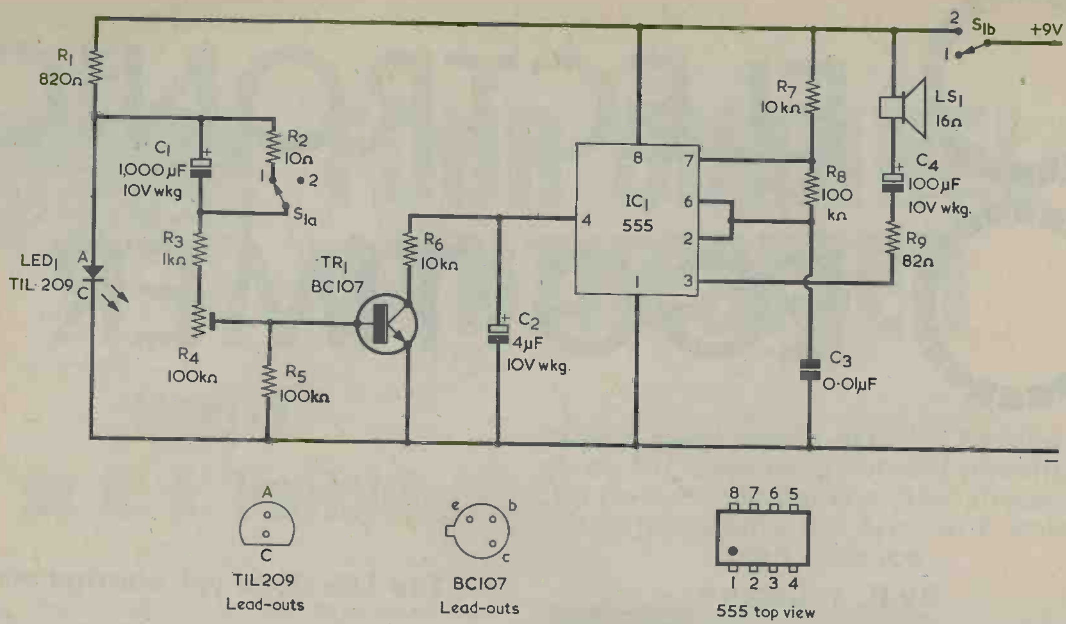


Fig. 2. The complete circuit of the timer. The i.c. functions as an a.f. multivibrator which is controlled by the external transistor

The complete circuit of the egg timer appears in Fig. 2, and it will be helpful to initially consider the network given by R7, R8 and C3. These appear in a standard 555 multivibrator configuration. When C3 is charging, the charging current flows through R7 and R8 in series. As soon as the upper plate of C3 reaches the threshold voltage at pin 6 the internal flip-flop changes states and the Discharge transistor turns on, taking pin 7 nearly to earth potential. C3 then discharges into R8 on its own until its upper plate falls to the trigger potential at pin 2. The flip-flop changes state again, the Discharge transistor turns off and C3 charges once more. There is in consequence a triangular waveform on the upper plate of C3. With the component values chosen, this has a frequency of approximately 700Hz.

The flip-flop also feeds into the output stage of the i.c. and a near-square wave which changes state in sympathy with the flip-flop is available at pin 3. This is fed to the 16Ω loudspeaker via capacitor C4 and current limiting resistor R9. The near-square wave is reproduced at good level by the speaker, whilst R9 limits any initial surge current to about 100mA. A louder output tone can be obtained, if desired, by using a speaker having an impedance greater than 16Ω and reducing the value of R9 accordingly. The sum of the speaker d.c. resistance (as measured by an ohmmeter) and the value of R9 should be of the order of 90Ω. The author found, however, that the output volume given with the component values shown was perfectly adequate.

RESET CONTROLS

The circuit, as so far described, represents an orthodox 555 multivibrator driving a speaker, with the exception that pin 4 of the i.c. is not, as would normally be the case, returned to the positive supply rail. Pin 4 is usually taken to the positive supply to ensure that the Reset transistor of Fig. 1 is cut off, whereupon this transistor has no effect on circuit operation.

The Reset transistor also has no effect if pin 4 of the i.c. is left open-circuit, because there is still no bias current applied to its base. If, on the other hand, pin 4 is connected to the negative supply rail the multivibrator oscillation stops, since the Reset transistor in the i.c. then turns the Discharge transistor hard on and the multivibrator capacitor cannot charge.

In an initial experiment, the author wired up the multivibrator and loudspeaker components, then took pin 4 of the i.c. to the slider of a potentiometer connected across the supply rails as shown in Fig. 3. It was found that the multivibrator operated for all potentials at pin 4 above 0.8 volt, and that it ceased functioning for all potentials at pin 4 below 0.8 volt. As the voltage at pin 4 was reduced, the multivibrator oscillation ceased abruptly at the 0.8 volt level. The oscillation commenced similarly abruptly as pin 4 voltage was raised past the 0.8 volt level. There was no hysteresis between the turning-off and turning-on voltage levels.

An RC timing control circuit which held pin 4 below 0.8 volt for 3½ minutes could be coupled directly to this pin, but it was felt that more reliable results would be given by employing a buffer transistor between the timing circuit and the i.c. This would then take up possible differences in Reset transistor base current between one i.c. and the next.

TIMING CIRCUIT

The timing circuit is quite simple and incorporates the components which are shown to the left of the i.c. in Fig. 2. When on-off toggle switch S1(a)(b) is in position 1, timing capacitor C1 is short-circuited via current

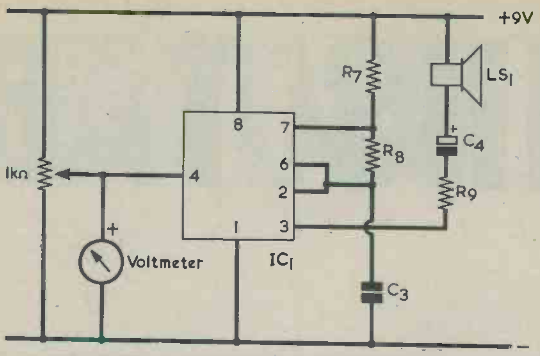


Fig. 3. An experimental circuit which demonstrates that the multivibrator can be stopped or started by the voltage applied to pin 4 of the i.c.

limiting resistor R2 and is consequently discharged. Setting S1(a)(b) to position 2 switches on the unit, and the short-circuit is taken off C1. A stabilized voltage of about 1.6 volts appears across the illuminated light-emitting diode LED1. This voltage is also applied, via the discharged C1, to the upper end of R3, whereupon current flows via R3 and R4 into the base of TR1, turning this transistor on. A small proportion of the current also flows in R5. TR1 collector now assumes a voltage slightly positive of the negative supply rail. Pin 4 of the i.c. is similarly held at a low potential, whereupon multivibrator oscillation is inhibited and there is no sound from the loudspeaker.

C1 commences to charge via R3, R4, R5 and the forward biased base-emitter junction of TR1. As C1 charges, the current drawn by TR1 base reduces and eventually becomes the small bias current needed to maintain pin 4 of the i.c. below the 0.8 volt level. The base current drawn by the internal Reset transistor in the i.c. also reduces when TR1 collector voltage rises, until the condition is reached where nearly all the charging current for C1 flows through R5. Finally, a stage is reached where the voltage at TR1 base falls below cut-off, whereupon there is no collector current from TR1 for the base of the Reset transistor in the i.c. The Reset transistor also cuts off, allowing the i.c. multivibrator to run and the tone to be reproduced by the loudspeaker.

In practice, the multivibrator oscillation does not commence at full level because there is a relatively gradual transition from the fully on to the fully off state in the i.c. Discharge transistor. The first few oscillations are at low level, but they soon rise to nearly full amplitude, after which the frequency of oscillation increases until the multivibrator settles down to its final frequency. The initial low multivibrator frequency is probably the result of shift in reference voltage levels in the i.c. resulting from the small remanent emitter current in the Reset transistor. The rise in frequency occurs over a 15 second period, which is reasonably short considering that it takes place after a 3½ minute timing run. The rise in frequency is, indeed, an advantage, because it draws attention to the tone from the loudspeaker.

TR1 collector cannot be connected direct to pin 4 of the i.c. because there would then be an unbroken amplifier chain consisting of TR1 and the Reset and Discharge transistors inside the integrated circuit. The circuit could then go through a period of instability during the timing run if all three transistors happened to be in a state between the fully on and fully off conditions. R6 and C2 are included to break the amplifier chain. It is necessary for C2 to be a good quality component to ensure that there is negligible base current in the Reset transistor at the end of the timing run. It might appear desirable to have a high value resistor, of say 1MΩ, between pin 4 of the i.c. and the positive supply rail to ensure that pin 4 is taken further positive at the end of the timing run, and the author tried the effect of adding a resistor of this value between these two points. The resistor slightly reduced the length of the timing run but otherwise had no effect. Such a resistor can be added in other units built up to the circuit, if it is found that the Reset transistor in the i.c. does not cut off fully.

TIMING ADJUSTMENTS

The length of the timing period is adjusted with the aid of R4. Varying R4 offers two conflicting effects, and these may be more readily understood when it is remembered that the timing run commences with TR1 turned on and it ends when TR1 base voltage is so low that this transistor turns off. When R4 is set to insert zero resistance into circuit, the charging current for C1 is at its highest and it charges most quickly. At the same time, the highest proportion of the voltage between C1 negative plate and the negative supply rail is applied to TR1 base whereupon C1 has to charge to a relatively high voltage before the run terminates. Conversely, when R4 is set to insert maximum resistance into circuit the charging current for C1 is at its lowest level, but against this is the fact that the lowest proportion of the voltage on its negative plate is applied to TR1 base. Of these two effects the first has greater precedence, and the outcome is that R4 has a much lower control over the length of the timing run than a first examination of its value in conjunction with R3 would indicate. With the prototype, the timing run was about 60 seconds when R4 inserted minimum resistance and just over 4 minutes when R4 inserted maximum resistance. Intermediate settings of R4 produced intermediate timing periods.

When the unit has been completed, R4 should be set to insert minimum resistance and the timer operated over several timing runs. These will prove circuit operation without having to wait too long for each timing run to end, and will also help to 'form' C1 if this is a new component which has been in store for a long time. R4 is then experimentally adjusted until the desired timing period, which will normally be 3½ minutes, is given. This last process is a little tedious but is unavoidable. If it is found impossible to obtain a sufficiently long run with R4 in the maximum resistance position, a second capacitor may be connected across C1, as required. If it is needed, the second capacitor will probably only be of the order of 100 or 200μF.

The current drawn from the 9 volt supply by the author's unit was 15mA during the timing run, rising to 30mA at the end of the run with the multivibrator operating. Due to the relatively low currents in TR1 base and collector circuits, the unit should be housed in a box which gives reasonable protection against the ingress of steam and moisture from cooking operations. All fixed resistors are 10% in tolerance and, with the exception of R9, may be ¼ watt types. R9 should be rated at 1 watt. The variable resistor, R4, can be a small skeleton potentiometer. ■

MAINS TABL

By A. P

By taking advantage of two popular integrated circuits this receiver can be assembled with only a small quantity of discrete components. Reception is given on medium and long waves at an output power level considerably higher than that offered by the more conventional battery powered radio

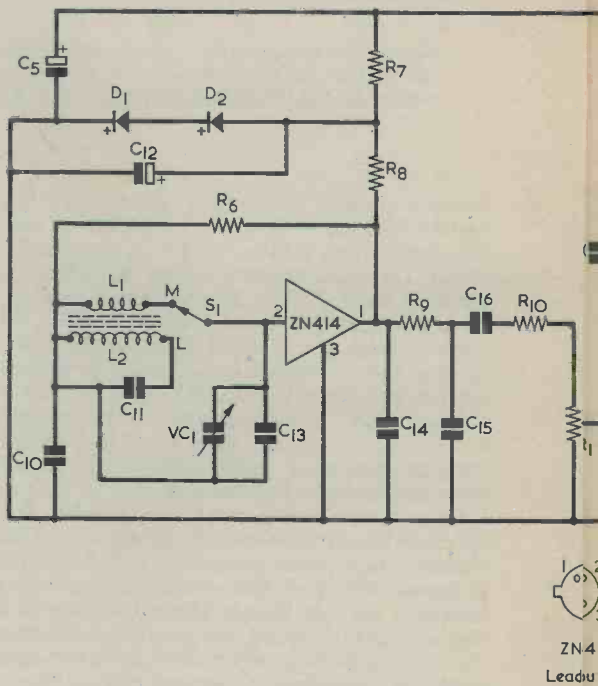


Fig. 1. The r.f. and a.f. stages of the mains table reciv on the printed circu b

WITH THE ADVENT OF THE PORTABLE TRANSISTOR RADIO and the stereo f.m. receiver, the popularity of the broadcast band mains table type of receiver has diminished considerably. This is perhaps a pity, because receivers of this type were capable of a better quality of reproduction than the smaller transistor portables which superseded them, and they also had a higher output power. Further, since they were mains powered their running costs were extremely low.

This article describes a simple medium and long wave receiver incorporating two integrated circuits which can be regarded as a modern equivalent of the earlier valve table receivers. Apart from the necessity of connecting to the mains, it is self-contained, and it is capable of a maximum r.m.s. output power of about 4 to 5 watts. The quality is good due to the wide bandwidth of the t.r.f. front end and the use of a high fidelity integrated circuit audio amplifier. The combined maximum total harmonic distortion for the two i.c.'s is 3%, and is typically somewhat less than this. An internal speaker of up to 8 by 5 in. can be used.

Full coverage of the medium and long wave band is given, and a number of Continental stations can be received at very good volume in addition to the usual B.B.C. transmissions. The construction of the set is simple and straightforward.

THE CIRCUIT

The circuit of the receiver is shown in Fig. 1. A basically similar circuit has been discussed earlier in this journal.*

* M. J. Darby, 'Radio Receivers Using Two Integrated Circuits', *Radio & Electronics Constructor*, December 1973 and January 1974.

The front end section is based on the popular ZN414 i.c., and this provides all the r.f. amplification in the receiver, together with the detection and a.g.c. functions. D1 and D2 are two forward biased silicon diodes and they provide a stabilized voltage for the ZN414 of about 1.3 volts. L1 and L2 are the medium and long wave aerial coils respectively, and are part of a ready-made ferrite aerial. S1 is the wavechange switch and VC1 the tuning capacitor. C11 and C13 are included in circuit to provide the correct frequency range.

The detected a.f. output of the ZN414 is taken from its pin 1. In order to avoid instability, any r.f. signal which is present here must be well filtered out before coupling the signal to the a.f. amplifier section. C14, R9, C15, R10 and C2 form a comprehensive r.f. filter. VR1 is the volume control.

A Sinclair Super IC-12 is employed as the a.f. preamplifier and output stage. The IC-12 consists basically of an operational amplifier having a Class AB power output stage. The audio signal from the volume control

AINS TABLE RADIO

By A. P Roberts

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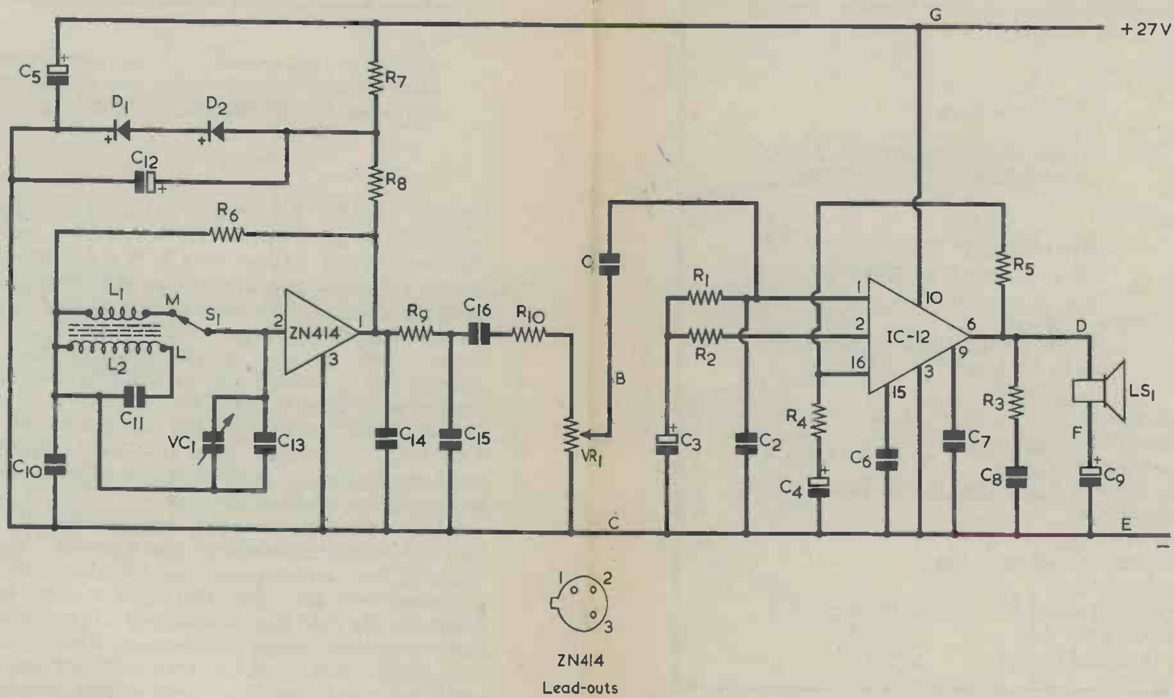

Fig. 1. The r.f. and a.f. stages of the mains table receiver. The letters 'B' to 'G' refer to connection points on the printed circuit board for the IC-12

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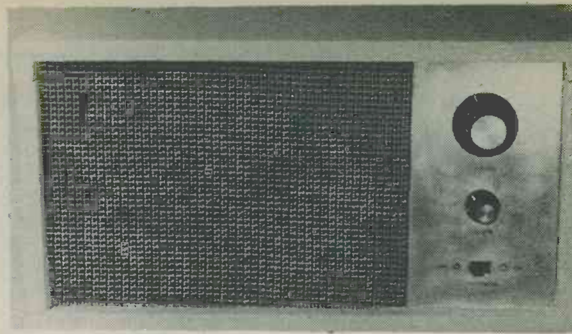
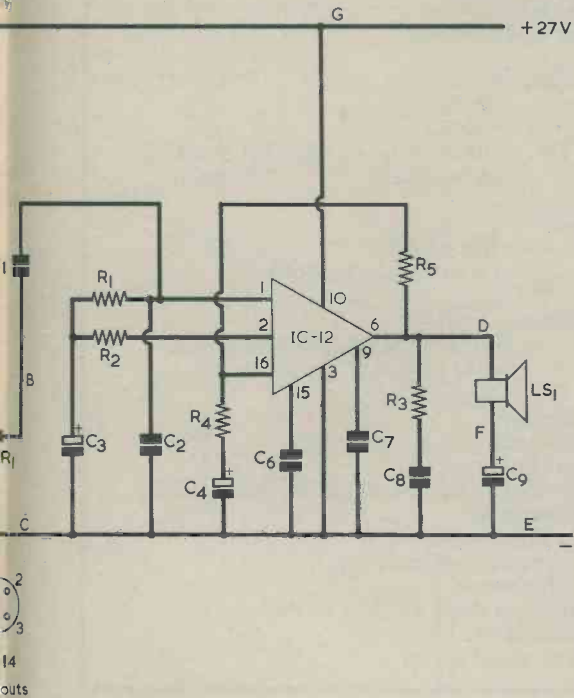
E RADIO

Roberts





eiver. The letters 'B' to 'G' refer to connection points
board for the IC-12

POWER SUPPLY UNIT

Fig. 2 shows the circuit of the simple unregulated power supply unit. The mains transformer has a 9–0–9 volt secondary, and the total secondary winding feeds an r.m.s. voltage of 18 volts to the bridge rectifier given by D3 to D6. The rectified output is then coupled to the smoothing circuit consisting of C17, R11 and C18, from which a low ripple output is available for the receiver. It will be noted that C5 of Fig. 1, which is on the IC-12 printed circuit board, is in parallel with C18. The power supply ensures that there is a low level of hum in the complete receiver.

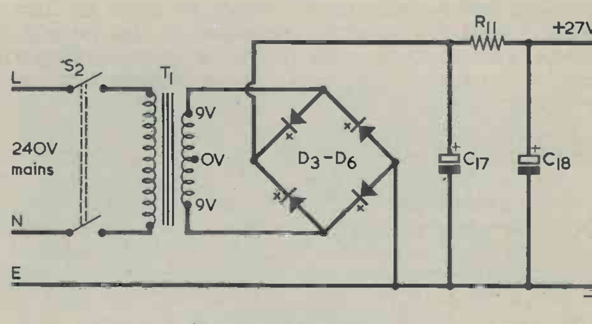
Theoretically, the output from the power supply should not be able to rise above some 24 volts under no-load conditions, but in practice the voltage across C18 under quiescent loading is about 27 volts. This somewhat greater figure is presumably due to the fact that the mains transformer is wound to offer slightly higher than its nominal secondary voltage under low loading conditions. Since the absolute maximum voltage rating for the IC-12 is 28 volts, a mains transformer having a nominal secondary voltage greater than 18 volts must not be used. The transformer employed by the author was an Osmabet MT9V, which is available from Home Radio.

S2 is the on-off switch for the receiver, and this is ganged with the volume control, VR1.

The smoothing resistor, R11, is specified as 1Ω at 1 watt. It may be difficult to obtain this low value in 1 watt, whereupon it will be necessary to employ a 1Ω

is coupled to the non-inverting input of the i.c. at pin 1. Negative feedback is provided between the output at pin 6 and the inverting input at pin 16 via R4 and R5, the values of which determine the overall gain of the amplifier. C6, C7, C8 and R3 are compensating components which maintain stable operation. R1 and R2 provide a suitable bias voltage for the non-inverting input from an internal potential divider. C3 and C5 provide supply decoupling.

The circuitry incorporating R1 to R5 and C1 to C9 is that recommended by the manufacturers of the IC-12, and the resistor and capacitor suffix numbers in Fig. 1 agree with the suffix numbers in the Sinclair circuit. This eases construction since the IC-12 is supplied with a printed circuit board whose non-copper side is marked out in terms of resistor and capacitor numbers. A few of the component values in Fig. 1 differ from those in the Sinclair circuit. The values shown are intended to meet present circuit requirements and the altered values are all within the permissible range of variation.



D3 – D6 bridge rectifier

Fig. 2. The receiver circuit is completed by the power section, which is shown here

COMPONENTS

Resistors
(All fixed values $\frac{1}{4}$ watt 10% unless otherwise stated)

R1	27kΩ
R2	150kΩ
R3	15Ω
R4	100Ω
R5	47kΩ
R6	100kΩ
R7	22kΩ
R8	560Ω
R9	220Ω
R10	820Ω
R11	1Ω 1 watt (see text)
VR1	5kΩ potentiometer, log, with switch S2

Capacitors

C1	0.22μF plastic foil
C2	82pF ceramic
C3	10μF electrolytic, 16 V. Wkg.
C4	100μF electrolytic, 15 V. Wkg.
C5	100μF electrolytic, 30 V. Wkg.
C6	0.001μF paper or plastic foil
C7	0.001μF paper or plastic foil
C8	0.01μF plastic foil
C9	1,000μF electrolytic, 16 V. Wkg.
C10	0.01μF plastic foil
C11	150pF silvered mica
C12	500μF electrolytic, 2.5 V. Wkg.
C13	15pF silvred mica
C14	0.047μF plastic foil
C15	0.047μF plastic foil
C16	0.47μF plastic foil, type C280 (Mullard)
C17	1,500 or 1,600μF electrolytic, 30 V. Wkg.
C18	1,500 or 1,600μF electrolytic, 30 V. Wkg.
VC1	300–360pF variable, air-spaced (see text)

Inductors

L1, L2	medium and long wave ferrite rod aerial type FRA. 1 (Denco)
T1	mains transformer, secondary 9–0–9V at 1A, type MT9V (Osmabet)

Integrated Circuits
ZN414 (Ferranti)
Super IC-12 (Sinclair)

Semiconductors

D1	1N4002
D2	1N4002
D3–D6	silicon bridge rectifier, P.I.V. 100V, 1A minimum

Switches

S1	slide switch
S2	d.p.s.t. toggle (part of VR1)

Loudspeaker

LS1	8–15Ω impedance, 5 watt rating, up to 8 x 5 in.

Miscellaneous
1 large knob
1 small knob
Perforated s.r.b.p. panel, 0.1 in. matrix (R.S. Components)
6-way tagstrip (see Fig. 4)
3-core mains lead and plug
$\frac{1}{2}$ in. chipboard
Aluminium sheet, 22 s.w.g. or thicker
Speaker fabric
$\frac{1}{2}$ x $\frac{1}{2}$ in. wood batten

resistor of a higher wattage rating. Alternatively, a number of higher value resistors could be connected in parallel, and suitable results would be given by four 3.9Ω $\frac{1}{4}$ watt 5% resistors connected in this fashion. There is ample space in the receiver to accommodate a higher wattage resistor, or a number of lower wattage resistors in parallel.

CASE CONSTRUCTION

The case is constructed from $\frac{1}{2}$ in. (or 12 mm.) chipboard with an aluminium front panel, and constructional details are shown in Fig. 3. The photographs will also be helpful in illustrating how the case is assembled, and it should be noted that the centre and left hand area of the aluminium panel is covered on the front with speaker fabric.

There are two options open to the constructor in dealing with the front panel. In the prototype, the front panel was common with the moving vanes of VC1, since the capacitor frame was not insulated from the panel. The moving vanes of VC1 connect to the negative

A view giving the general layout of sections inside the case supply rail via C10. At the same time, the mains earth connects to the negative supply rail also, with the result that the panel was not connected direct to the mains earth but was instead connected thereto by way of C10. This arrangement worked quite adequately and there were no problems due to hand capacitance or similar effects.

Although the whole receiver circuits are isolated from the mains by the mains transformer, it may be considered more desirable by some readers to have the front panel connected to the mains earth. When this is done it is then necessary to devise an insulated mounting for VC1 which will ensure that its moving vanes are insulated from the panel. This second approach will result in increased protection against accidental shock.

The first process in making the case consists of cutting out and drilling the front panel. The prototype employed 22 s.w.g. aluminium sheet, but a slightly thicker gauge can be used if this is more readily available. The rectangular cut-out for S1 can be made by first drilling a central $\frac{1}{4}$ in. hole, and then filing this out to the required shape. The actual dimensions required depend upon the particular switch which is employed. The speaker cut-out for the prototype was made with a fretsaw.

A $\frac{3}{8}$ in. hole is required for VR1. Only the centre of VC1 spindle is dimensioned in Fig. 3, as the hole or holes required here depend upon the particular capacitor to be employed and whether or not it is to have an insulated mounting. The precise capacitance of VC1 is not critical, and any air-spaced component with a value between 300 and 360pF may be employed. If necessary, a 2-gang capacitor may be used with its two sets of fixed vanes connected together. Thus a 2-gang 176+176pF capacitor, giving a total of 352pF, could be used. There is adequate space for any capacitor of reasonable size.

As already mentioned, the centre and left hand side of the panel are covered with a piece of speaker fabric. It is best to cut this a little too large so that it can be left overhanging at the top, bottom and left hand side. The fabric can be secured with any general purpose household adhesive, and when this has dried the overhanging edges of the fabric are trimmed with scissors. Three battens of $\frac{1}{2}$ by $\frac{1}{2}$ in. cross-section are then glued to the rear of the panel, as indicated in Fig. 3.

The chipboard sides and base may next be cut out and assembled to the front panel. The panel is set back by about $\frac{3}{8}$ in., as indicated in the photographs. Any good quality woodworking glue may be employed here. The case back, and the three pieces for the lid, may also be cut out at this stage, but they are not assembled yet. There is greater access to the interior of the case during construction if the back is fitted later.

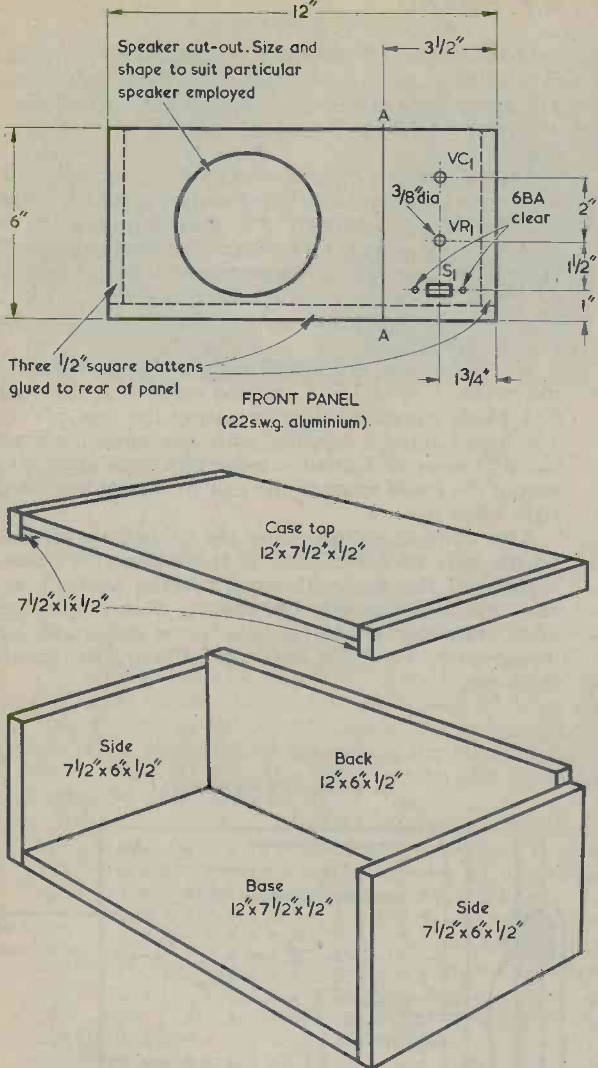


Fig. 3. Details of the front panel and the case. The area of the front panel to the left of line A-A is covered with speaker fabric

P.S.U. CONSTRUCTION

The internal layout of the receiver can be seen from the photographs. Fitted to the base with woodscrews are, from left to right, the mains transformer T1, the power supply components on a tagstrip, the printed circuit board for the IC-12 and a perforated board for the ZN414 section. The ferrite rod aerial is at the back.

With the exception of T1 and S2, all the power supply unit components of Fig. 2 are wired up on a 6-way tag-

Close-up view of the mains transformer and power supply components

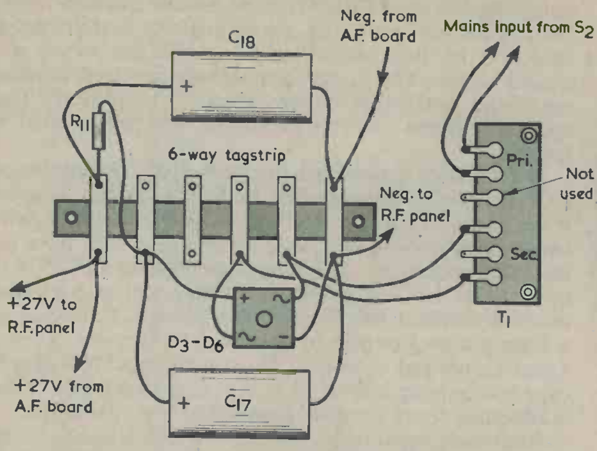


Fig. 4. The wiring of the power supply section

strip having a mounting hole at each end. The necessary connections are illustrated in Fig. 4. The tagstrip should be wired up before it is mounted on the base of the cabinet. T1 and the tagstrip are each secured with two woodscrews. Small spacing washers are fitted over the woodscrews under the tagstrip to keep the tag undersides clear of the chipboard and to prevent strain on the strip. The connections to T1 primary are made later.

Next, VC1, VR1 and S1 are mounted on the front panel. The speaker is glued in position behind its cut-out, using a powerful epoxy resin adhesive such as Araldite.

AUDIO STAGE

The IC-12 components are next assembled on its printed circuit board, and these provide the audio stage. As stated earlier, the component reference numbers here correspond with those in Fig. 1. It is therefore merely necessary to mount and connect the components in their marked positions.

The polarities of electrolytic capacitors are indicated, except for C3 which has its positive end towards R5 and its negative end towards the i.c. Be sure to connect the i.c. right way round. A dot after the legend 'Sinclair Super IC-12' on the heatsink indicates pin 1 of the i.c., and the position of pin 1 is marked on the printed circuit board. Alternatively, an identification groove on the plastic body of the i.c. indicates the pin 1 end.

Before the printed circuit board is mounted in position the following connections need to be made to the points indicated by the letters. The wiring is carried out with suitable lengths of insulated lead. Points 'D' and 'F' on the board connect to the speaker tags. Point 'G' connects to the positive output of the power supply unit, and point 'E' to the negative output of the supply unit. Point 'B' connects to the slider and point 'C' to the earthy tag (minimum volume end) of VR1. The printed circuit board is then fitted to the cabinet base, with small spacing washers underneath. These should be thick enough to ensure that there is no strain on the board when it is screwed in position.

R.F. BOARD

Most of the r.f. circuitry is contained on a plain perforated panel of 0.1 in. matrix having 16 by 27 holes. The component layout of this panel and the remaining wiring of the r.f. section, apart from C13, are shown in Fig. 5.

The panel is cut from any larger piece by means of a Junior hacksaw, and the two mounting holes are drilled. The various components are then mounted in the appropriate positions. Their lead-outs are bent over flat against the underside of the panel and soldered together to conform with the wiring details given in Fig. 5. Wiring under the panel is represented by the broken lines in the diagram.

When the panel is finished it is wired up to the rest of the circuit. C11 and C13 are also wired in at this stage, C13 being connected directly across the tags of VC1. The ferrite aerial is supplied with two mounting brackets. By means of 4 small woodscrews these are used to mount the aerial towards the rear of the cabinet on the right hand side.

After completing the wiring, the r.f. panel is mounted on the base of the cabinet. It is necessary to space it slightly off the base with small spacing washers, as it may otherwise fracture. The spacing washers employed in securing the various sections to the chipboard may, incidentally, be 4BA nuts, or similar, of suitable thickness.

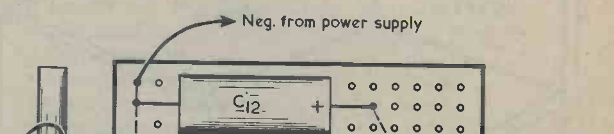
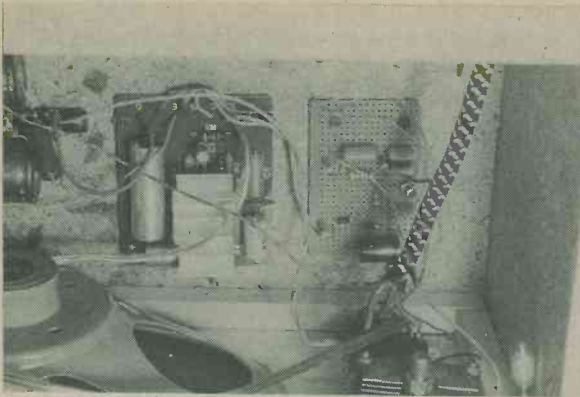


Fig. 5. Layout and wiring on the r.f. panel. For convenience of presentation, the ferrite aerial and switch S1 are shown on either side of the panel. In the actual receiver layout, C12 is towards the front of the receiver and the ferrite aerial is behind it



The a.f. and r.f. boards. The orientation of the a.f. board can be readily observed here

COMPLETING THE RECEIVER

The mains lead may next be connected. Its live (brown) and neutral (blue) leads are soldered to S2, and its earth (green-yellow) lead to the earthy tag of VR1. This is the tag to which point 'C' of the IC-12 board was connected earlier. If the tag positioning of S2 is unknown, identify the correct tags with an ohmmeter or continuity tester before connecting the mains wires. A short length of twin flex then couples the remaining tags of S2 to the primary of T1.

If VC1 is insulated from the aluminium panel, the panel is also connected to the mains earth. The connecnection is made from the earthy tag of VR1 to a solder tag held under one of the mounting nuts of S1.

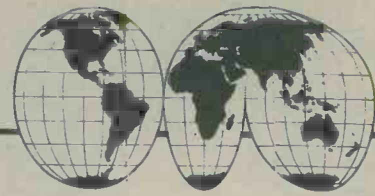
Next drill a hole in the case back to allow the mains lead to pass through, then glue the back in position. Preferably, the mains lead should be anchored inside the case by a plastic clamp screwed to the adjacent side. The three pieces comprising the top are next glued together, and the receiver finished by painting the chipboard or covering it with a self-adhesive plastic material such as Fablon. As a finishing touch, legends taken from 'Panel Signs' Set No. 4 may be affixed to the front panel. The prototype had the legends 'Tuning', 'Volume' and 'Waveband' below VC1, VR1 and S1 respectively. The legend 'Off' was affixed at the appropriate point alongside VR1 knob, and 'MW' and 'LW' were positioned on either side of S1.

TESTING AND ADJUSTMENT

Before turning the receiver on, check all the wiring thoroughly, paying particular attention to the power supply section. Confirm also that the polarities of D1 and D2 are correct. If either or both of these is connected wrong way round, the ZN414 will probably be destroyed.

Having fully examined the wiring, the receiver can be switched on and checked on both bands. The only adjustment that is required is to slide the two aerial coils along the ferrite rod to find a setting which gives correct frequency coverage. When the required settings have been found, the coils may be taped to the rod to maintain them in position. The receiver is then ready for use. ■

SHORT WAVE NEWS
FOR DX LISTENERS



By Frank A. Baldwin

Times = GMT   *Frequencies* = kHz

In the last issue, mention was made of some Asian-based clandestine transmitters, the promise also being made that some non-political European clandestines would be listed – here they are.

All of these stations operate just above the 6MHz band and most of them are to be heard in full cry (and that just about describes the noises they emit) on Sunday mornings. Programme content is mostly of pop records.

Radio Passad **6210** operates from 1000 to 1200.
BBMS **6210** from 1100 to 1300 and from 1400 to 1530.
Radio Freedom **6220** from 0900 to 1000.
Thames Radio International **6225** schedule not known.
West Coast Radio **6225** from 1000 to 1030.
Radio Victoria International **6225**, from 1140 to 1205 and from 1935 to 2005.
Radio London **6230** from 1500, sign-off time not known.
Radio King Kong **6230** from 1000 to 1030.
Jesus Radio **6234** from 1100 to 1200.
Time Radio **6235** from 1000 to 1100.
Tower Radio **6240**, Sundays only.
ABC-Europe **6250** 0800 to 1300.
United Radio Europe **6255** from 1030, sign-off time not known.
Radio Star **6260** schedule not known.

I am indebted to Poul Foged of the Danish Short Wave Clubs International writing in his Pop and Pirate Radio page in their journal "Short Wave News" January issue, for the above information.

But we haven't finished with the clandestines yet; how about another Asian-based transmitter – "Voice of the Revolutionary Party for Reunification". This one operates mostly in Korean, so you can easily guess what it is all about and the transmissions emanate (what – no surprise!) from North Korea. Probably the best chances of hearing this one, according to the time of year, would be from around 1500 to 1600 and from 2200 to 2300 when they are in Korean to South Korea and from 2300 to 2330 when they are in English, all on **4557**.

Coming nearer home, try the Voice of the Communist Party of Turkey, "Tuerkiye Komunist Partisinin Sesi", which may be heard on Tuesday and Sunday from 0810 to 0840 on **6200**.

Or, how about the PLO "Voice of Palestine, Voice of the Palestine Revolution", transmitted by Radio Baghdad from 1600 to 1635 on **7300**.

Then we have "Voice of Palestine", which can be heard in Arabic from 1200 to 1300 on **6662**.

One we have mentioned from time to time is the "Voice of the People from the Heart of the Arabian Peninsular". This Arabic-language, anti-Saudi station has recently been reported on **11800** from 1200 to 1230.

A new one is "Phnom-Penh National United Front of Cambodia" which broadcasts in Cambodian anti-government material in the same manner as "Voice of the National United Front of Cambodia" from a location thought to be in North Vietnam. For the Phnom-Penh station, listen on **7287**, the schedule being from 0100 to 0130, 0700 to 0730 and from 1300 to 1330.

The VNUFC (Voice of the United Front of Cambodia) is reported currently radiating on variable frequencies centred on **4675, 6142, 7015, 9985, 10080, 10120** and on **12005** from 0001 to 0100, from 0100 to 0200, from 0400 to 0500, from 1030 to 1130, from 1130 to 1230 and from 1330 to 1430.

From Zambia there is a broadcast presented by the African National Congress (ANC) under the title "Radio Freedom" on **9580** from 1700 to 1800 in English, Afrikaans and vernaculars, this being radiated from the Radio Zambia studios at Lusaka.

CURRENT SCHEDULES

● TURKEY

Radio Ankara – "The Voice of Turkey" has an English transmission directed to Europe, North Africa and North America from 2200 to 0115 on **11880**. Ankara also operates a service in Turkish for Turks abroad from 0400 to 0600, 0900 to 1330 and from 1630 to 2100 on **11880**, also from 0400 to 2200 on **9515**.

● MALAYSIA

The "Voice of Malaysia", Kuala Lumpar, broadcasts in English to South East Asia in the External Service from 0625 to 0855 on **6173** and **11900**, also on **15280** from 0830. Kuala Lumpur can also often be heard on **15295** from 1530 to 1630 when radiating in Arabic, listen for the tuning signal prior to 1530, a series of chimes repeated.

● SRI LANKA

A broadcast in English from Colombo is beamed to Europe from 1900 to 2030 on **9720, 11800** and on **15120**. See also under Around the Dial.

● NIGERIA

The "Voice of Nigeria", Lagos, has an English programme from 1800 to 1930 on **7275, 11710** and on **15120**, see also under Around the Dial.

● CHINA

Radio Peking has minority languages schedules in the domestic service, these currently being as follows – in Kazakh from 0130 to 0225 and from 1400 to 1455 on **6620** and on **8565**; relayed by Urumchi on **4970** and on **5440**. In Korean from 2130 to 2225 on **4620** and **6550**; from 0400 to 0455 on **6560** and **8260**; from 1000 to 1055 on **4620** and **6560**. In Tibetan from 2330 to 0025 on **6620** and **7360**; from 1100 to 1155 on **8565** and on **9820**, relayed by Lhasa on **4035, 9490** and on **9655**. In Uigher from 1300 to 1355 and from 0030 to 0125 on **6620** and **8565**, relayed by Urumchi on **4110** and on **7050**.

● SOUTH YEMEN

From Aden, the "Radio of the People's Democratic Republic of Yemen" transmits a Home Service in Arabic from transmitters at al-Hiswah from 0300 to 0530 on **5060** and **7190**; from 1100 to 1500 on **5060** and **11770**; from 1500 to 1730 on **5060, 7190** and on **11770**; from 1730 to 1900 on **5060, 5970** and on **7190** and from 1900 to 2200 on **5060**.

● ARGENTINA

"Radiodifusion Argentine al Exterior" (RAE), Buenos Aires, beams a programme in English to Europe (except Saturdays and Sundays) from 2100 to 2200 and from 2300 to 2355 on **11710**.

● CHILE

"Radio Nacional – La Voz de Chile", Santiago, operates a service in English, the evening transmission of which is from 2210 to 2230 on **11810** and on **15150**. Other transmissions in English are from 0030 to 0050, 0230 to 0250 and 0430 to 0450 on the same channels.

● SPAIN

The "Spanish National Radio" (RNE), Madrid, presents a service in English to North America from 0100 to 0345 on **6065** and **11925**.

● SPANISH SAHARA

"Radio Sahara", Al'Uyun, has recently been broadcasting test transmissions on **6095** from 1945 to 2215 in Arabic with Spanish announcements after 2200, also with test transmissions on **11805** from 0800 to 1800.

● EGYPT

Radio Cairo broadcasts to Africa in English in the "Voice of Africa" service from 1715 to 1830 on **17890** and from 2030 to 2200 on **17725**.

AROUND THE DIAL

● NORTH KOREA

Radio Pyongyang at 1210 when radiating a commentary in English to South East Asia, the schedule of this being from 1200 to 1440, logged on **9370** but the transmission is also in parallel on **3560, 7580** and **15630**.

● INDONESIA

Medan on **4764** at 1504 at which time a talk in Malindo was being radiated and just audible under some utility interference.

● INDIA

AIR Delhi on **3925** at 1610, OM with a talk in English about the recent war with Pakistan and the aftermath.

● NEPAL

Radio Nepal, Kathmandu, at 1622 on **3425**, OM with a talk and announcements in Nepali.

● MALDIVES

Radio Maldives on **4740** at 1643, light music programme with OM announcer in English.

● GHANA

Ejura on **3350** at 1936, colourful local music complete with female chorus. This is the National Service the evening transmission of which is from 1600 to 2300.

● CLANDESTINE – 1

Azad Kashmir on **3380** (formerly on **3915**) at 1616, OM with talk in a local dialect. Azad (Free) Kashmir programmes are thought to be radiated via the facilities of Radio Pakistan.

● MALAYSIA

BBC Tebrau on **3915** at 1608, OM with a newscast in English for S.E. Asia.

● AUSTRALIA

ABC Brisbane on **4920** at 0800, 6 pips, short march then OM with "Here is the National News".

● CLANDESTINE – 2

Radio Pathet Lao on a measured **6212.5** at 1537, YL in Lao, local music and songs at 1543 then YL in Lao again until sign-off at 1600.

● SOUTH AFRICA

Johannesburg on **9525** at 2100, identification and a newscast in English, mainly about African affairs, directed to West Africa and Europe.

● U.S.S.R.

The "Voice of Armenia", Yerevan, on **4990** at 1513, YL with identification in Arabic in a programme for the Arabic world from 1500 to 1530, also in parallel on **6085**.

● PORTUGAL

Radio Portugal, Lisbon, on **6025** at **2230** with identification and schedule announcements, also in parallel on **9740**.

● NIGERIA

"Voice of Nigeria", Lagos, on **15120** at 1830 with station identification and a newscast in English.

● SRI LANKA

Colombo on **11800** at 1915 with a newscast in English during a test transmission directed to Europe and the U.K., announced in parallel on **9720** and **15120**.

● MEXICO

Radio Fiesta on **15110** at 2300 with identification in Spanish (formerly Radio Tricolour), announcements then into local pop music programme.

VERSATILE VERTICAL FOR TOP BAND

By V. S. Evans

A neat aerial design primarily intended for mobile working on Top Band

The smart appearance of the Top Band vertical, as fitted to the author's car. It can be readily removed and replaced by a broadcast aerial when not required

THE LOADED VERTICAL AERIAL FOR THE 160 METRE BAND has been around for a very long time. Many are the types and methods of construction, these varying from really Heath Robinson assemblies to sophisticated commercial models. A varying assortment can be seen adorning participating vehicles at almost any Amateur Mobile Rally, including the 6 ft. fibre glass whip waving around wildly in the breeze and the gruesome 2 in. diameter steel scaffold pole secured in the bumper region with hefty steel brackets.

The author has evolved what could become a standard method of construction for the amateur, using readily available materials and parts. The result is neat and aesthetically pleasing. The overall length of the basic antenna is about $4\frac{1}{2}$ ft., and it can be employed for mobile or fixed station use. It is possible that with a modification to the loading coil the system of construction could be applied to other frequency bands, although for higher power than that permitted for 160 metres in the U.K. the plastic tubing used may need to be changed. The coil would also have to be wound with thicker wire.

Various methods of mounting the aerial will be suggested, but in this respect it is left to the constructor to decide his own requirements.

CONSTRUCTION

The main materials used are round wood dowelling, white plastic conduit tubing, aluminium or aluminium alloy tubing, and Jubilee hose clips. Also required are enamelled copper wire for the coil, a roll of plastic insulating tape and a tube of conductive grease. The tools needed are of the simplest, and consist of a screwdriver, hammer, hand drill and small hacksaw.

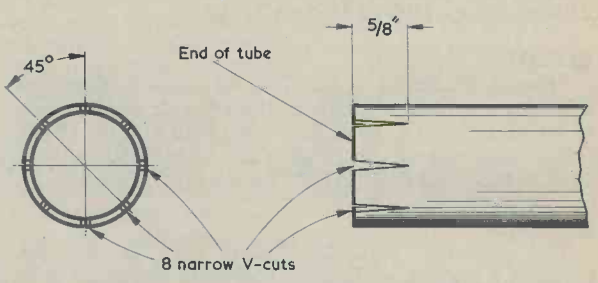


Fig. 1. Where necessary, tubing ends are given 8 V-cuts in the manner shown here

Where necessary, tube ends, both aluminium and plastic, have 8 narrow V-cuts made in them as illustrated in Fig. 1. A tube end prepared in this manner then has a hose clip placed over it, whereupon the end is capable of being tightened up securely onto a slightly thinner tube inserted inside it.

The aerial consists basically of a lower and upper aluminium tube with the loading coil between them. At the top of the upper tube is a short telescopic section, this consisting of a third aluminium tube which can be moved in or out to finally tune the aerial. This third tube will be referred to as the 'top tube'.

First obtain a 21 in. length of $\frac{1}{2}$ in. diameter round wood dowelling. Give it two coats of varnish. When dry, it is wrapped over its length with plastic insulating tape laid edge to edge, i.e. not overlapping.

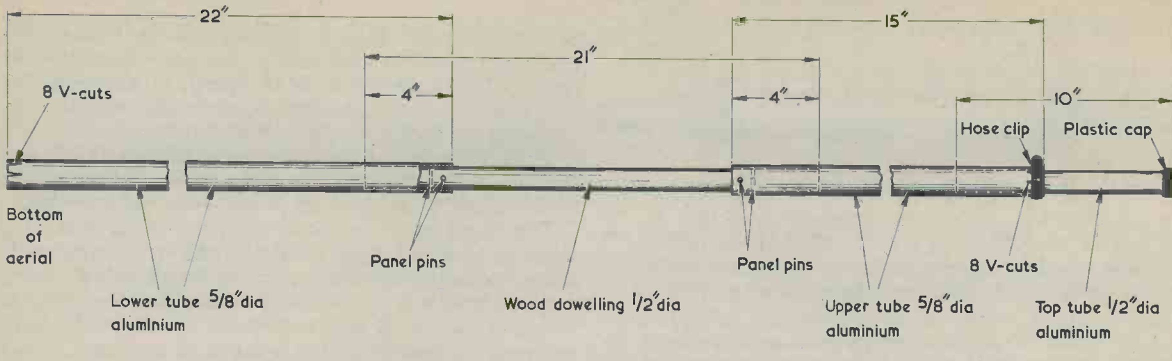


Fig. 2. The three aluminium tubes and the wood dowelling which form the basic parts of the aerial. For convenience, thicknesses are drawn twice scale size

The lower tube consists of a 22 in. length of ⅝ in. o.d. aluminium tube, and the upper tube consists of a 15 in. length of the same tube. The lower tube has 8 V-cuts at its lower end, as in Fig. 1. These enable it to be fastened later to a ½ in. mounting rod or tube. The upper end of the upper tube also has 8 V-cuts. These enable the upper end to be clamped tight around the top tube.

The upper end of the lower tube is passed over the ½ in. wood dowelling to a depth of 4 in., as in Fig. 2. Two small holes are drilled through the tube and dowelling at right angles to each other, one hole being ½ in. from the end of the tube and the other ¾ in. from the end of the tube. Panel pins are driven through the holes and cut off flush both sides. They should be a tight fit.

The lower end of the upper tube is passed over the dowelling for 4 in. also. It is secured to the dowelling with panel pins in exactly the same manner. The top tube consists of 10 in. of ½ in. o.d. aluminium tube and it is inserted into the upper end of the upper tube to any depth. A hose clip around the upper end of the upper tube is tightened to hold the top tube firm. A plastic cap, cork or rubber bung is fitted to the top of the top tube to keep out rain. The assembly should now be as shown in Fig. 2. For ease of presentation all tube diameters in Figs. 2 to 5 are shown approximately twice as wide as they would be if drawn to scale.

LOADING COIL

The former for the loading coil consists of a 16 in. length of 20mm. plastic conduit tube. (20 mm. is equal to 0.787 in.) It has 8 V-cuts at both ends. The winding starts 2½ in. from one end and finishes 2½ in. from the other end. The wire is 30 s.w.g. enamelled copper, and is close-wound in a single layer with all turns touching and none overlapping. A 2 oz. reel will provide sufficient wire. Bands of insulating tape secure the winding ends, and there should be 4 in. free wire at both ends for connections. The enamel is cleaned off the wire ends and these should be tinned over most of their length. Small holes are drilled in the plastic tube near the coil ends and the wires are passed through these to the inside and brought out. Do not be tempted to varnish the coil. It is shown in completed form in Fig. 3.

Next to be prepared is the protective cover for the coil. This consists of 14½ in. of 25 mm. plastic conduit tube. (25 mm. is equal to 0.984 in.) It has 8 V-cuts at both ends. It is passed over the coil former, positioned centrally and lightly clamped at both ends with hose clips, as in Fig. 4.

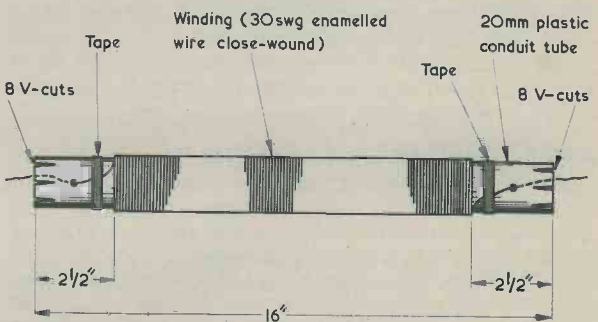


Fig. 3. The central loading coil wound on its former

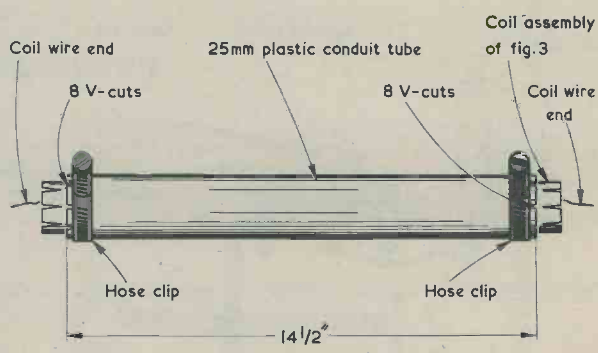


Fig. 4. A protective cover is fitted over the loading coil

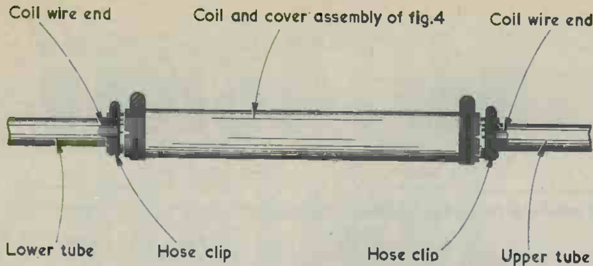


Fig. 5. The loading coil and cover assembly mounted centrally over the wood dowelling

A hose clip should be loosely placed over each end of the coil former, after which the completed assembly of Fig. 4 is passed over the lower end of the assembly of Fig. 2 and continued up until it lies centrally over the wooden dowelling, as illustrated in Fig. 5. Positioning is such that the lower and upper tubes each penetrate the coil former by 1½ in. Indeed, the lower and upper tubes can be previously marked 1½ in. from their ends as a guide. Before finally securing the coil former move it slightly to one side and then to the other to allow the sections of the aluminium tubes which will be covered to be smeared with conductive grease. This is Electrolube 2G-X (Home Radio). The hose clips at the ends of the former are tightened, and it should be noted that the coil wire ends pass out from the inside of the former and are then folded back and clamped under these hose clips. Also tighten the two hose clips which secure the protective cover over the coil. Apart from providing a means of mounting, the aerial is now complete.

EXPERIMENTAL MOUNTING

For testing and experimental purposes a base mount may be made with a cheap G-cramp. A piece of ½ in. o.d. aluminium tube 2 in. long is also required, together with a 2½ in. bolt, nut and ½ in. washer. The bolt head should not be wider than ½ in. The G-cramp is drilled near one end with a clearance hole for the bolt. Three further holes are drilled to take a block of insulating material on which is mounted a coaxial socket. The insulating block may be wood, Perspex or any other suitable material, and the complete mounting is illustrated in Fig. 6. The coaxial socket is secured with two countersunk bolts in suitably recessed holes, thus ensuring that there is no contact between the outer connector of the socket and the G-cramp. A short length of wire connects the centre connector of the socket to the cramp at the end of the 2½ in. bolt.

The bottom end of the lower aerial tube can be passed over the 2 in. length of ½ in. tube on the cramp, and is then secured by a hose clip passed over the 8 V-cuts.

The G-cramp is common with the aerial and so it must be clamped to an insulated object. Alternatively, some insulating material, such as tough rubber sheet, must be interposed between the cramp and the object to which it clamps. A lead connected to one of the bolts securing the coaxial socket is taken to a ground rod or other suitable earth.

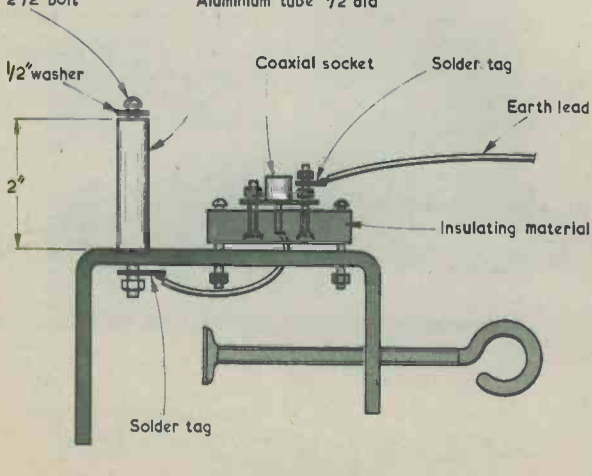


Fig. 6. A simple temporary mounting for the aerial

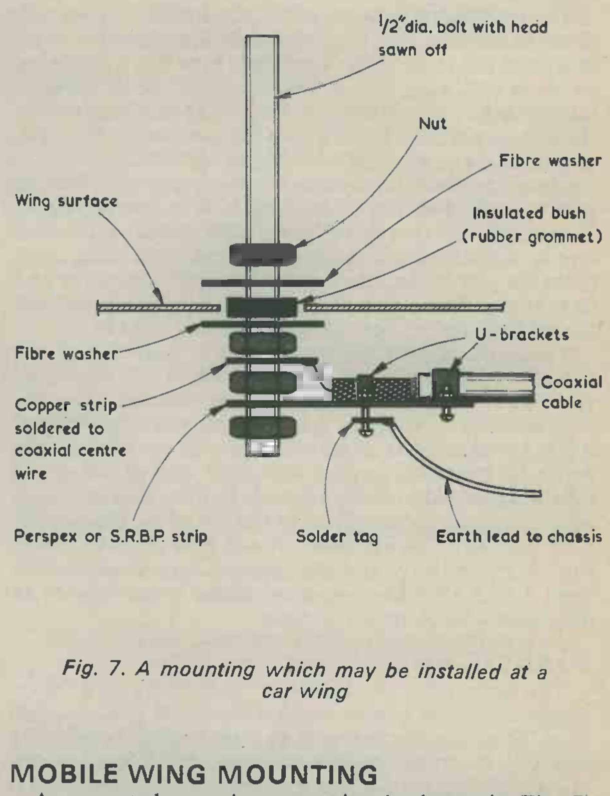


Fig. 7. A mounting which may be installed at a car wing

MOBILE WING MOUNTING

A suggested car wing mounting is shown in Fig. 7. Rear wing mounting is less likely to incur trouble with electrical interference from a forward engine compartment, and vice versa. As the aerial angle cannot be adjusted with this arrangement, the surface chosen for the mount must be flat and horizontal if the aerial is to be vertical. The author obtained a ½ in. diameter 6 in. long brass bolt from a boat-builder for his version of the mounting, this having the head sawn off. A cadmium plated or Sherardized bolt would also be acceptable.

An advantage with this mounting is that a simple aluminium tube acting as an aerial for broadcast reception can be fitted in place of the 160 metre aerial when the latter is not required.

BUMPER MOUNTING

Bumper mounting involves the use of a bottom extension tube to bring the loading coil above the general car body area. A piece of ¾ in. o.d. aluminium tube with 8 V-cuts at the top is needed, and this can be some 3 to 4 ft. in length. For insulation, a tight fitting rubber hose is passed over it at its lower end. As will be seen from Fig. 8, a metal plate drilled with four holes

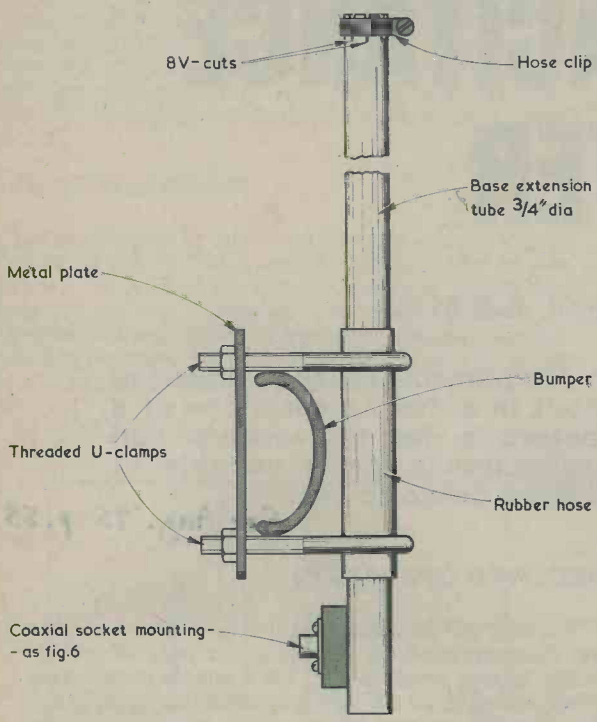


Fig. 8. Mounting the aerial to a car bumper

and two threaded U-clamps are required. The clamps can be obtained as exhaust brackets or television aerial fittings. The lower end of the aerial is inserted in the ¾ in. tube and the hose clip at the top of this tube is then tightened.

A coaxial socket and insulating block similar to that employed in Fig. 6 is fitted to the bottom of the extension tube. This arrangement is more suitable for 'static mobile' operating than for road travelling.

FIXED STATION MOUNTING

A similar arrangement to the bumper mount can be adapted for attachment to a wooden mast. In this case the coaxial socket earth lead will be taken to earth at a copper ground rod, buried metal plate or other suitable earth point. A gable end of the house, chimney stack or even the garage roof can be utilised. In these instances, television fittings could be put to good use.

USING THE AERIAL

Having set up the aerial system, a coaxial feed line is taken from its coaxial socket to the transmitter. The first operation is to locate a point of resonance with the s.w.r. meter. Initially, the top tube should be extended by 1 in. only. Further extension will lower the frequency at which the system resonates. S.W.R. figures of less than 2:1 should be readily achieved.

With this type of aerial the usable bandwidth will be fairly narrow. Where the aerial is readily accessible, as when mobile, the telescopic top tube can be adjusted to that part of the band the operator wishes to use at a particular time. This may not be possible in a fixed station, and the author is working on a simple electronic switching arrangement whereby the working segment of the 160 metre band can be changed from inside the shack, and he hopes to publish details of this in a future issue.

Returning to the present design, sources of supply for the aluminium tubes consist of TV aerial erecting firms and aluminium stockists and merchants. A glance through the Yellow Pages may be helpful here. The plastic conduit tube is available from most electrical contractors. Since there could be discrepancies in wall thickness with some tubes, the constructor should verify for himself that the parts obtained will fit inside each other as described before purchasing. The tubing lengths are all relatively short, whereupon it may be possible to obtain all that is required from oddments stocks. For neatness, the Jubilee hose clips should be for the specific diameters at which they are positioned. ■

BACK NUMBERS

For the benefit of new readers we would draw attention to our back number service.

We retain past issues for a period of two years and we can, occasionally, supply copies more than two years old. The cost is the cover price stated on the issue, plus 8p postage.

Before undertaking any constructional project described in a back issue, it must be borne in mind that components readily available at the time of publication may no longer be so.

We regret that we are unable to supply photo copies of articles where an issue is not available.
Libraries and members of local radio clubs can often be very helpful where an issue is not available for sale.

THE 'SLIDE RULE' RECEIVER CUM CAPACITANCE METER

Part 1

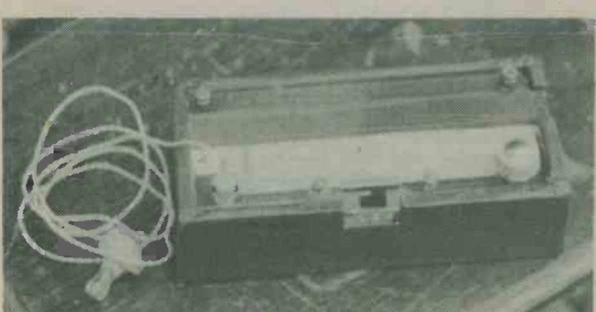
By Sir Douglas Hall, K.C.M.G.

This 2-part series describes an ingenious portable receiver covering 120 to 1,900 metres which can be built in either an earphone or a loudspeaker version. An unusual feature is that the receiver can also be employed as a sensitive capacitance meter capable of measuring capacitance values down to 1pF

See Aug. '75 p. 55

THIS IS A DESCRIPTION OF A SMALL PORTABLE RECEIVER which may be built either for use with an earphone only or to operate a speaker in addition, and which doubles up as an instrument to measure the values of capacitors from zero to about 5,000pF. The receiver coverage is from about 120 metres to the low frequency end of the medium waveband, together with sufficient of the long waveband to tune in Radio 2 and several other stations.

When used to measure capacitance, the principle of operation involves the use of a sharply tuned variable inductance and a receiving circuit with very little input capacitance, so that an increase of applied capacitance of as little as 1pF requires a noticeable change of inductance for the circuit to remain tuned to the same frequency. A trimmer is provided as a zero-set adjustment to compensate for an ageing battery or for changes in ambient temperature.



The completed 'Slide Rule' receiver when constructed as a personal earphone set

RECEIVER OPERATION

The unit will be considered first as a receiver and in the form designed for earphone use only. It will be found to give sensitive and, for a simple circuit, very selective results on the medium waveband. In addition, by using the position of the switch selected when the unit is being employed to measure capacitance, band-spreading of the higher frequency end of the medium waveband is provided, together with efficient coverage of the 'trawler band' and the 160 metre amateur band. Coverage down to about 120 metres is possible. From about 190 to 250 metres sensitivity is exceptionally high using this position of the switch, owing to the very high inductance-capacitance ratio obtaining. However, in these circumstances selectivity is not quite so good as on the normal medium waveband, where an extra 56pF tuning capacitance is in circuit. It might seem that theory would dictate that the exceptionally high inductance-capacitance ratio given when less than 15pF tuning capacitance is in circuit would result in the best possible selectivity. But self-capacitance in the inductor itself tends to modify the operation of the tuned circuit when the physical parallel capacitor has a very low value. In practice, the constructor has a choice of two switch positions for the part of the medium waveband lying between 190 and 250 metres, one offering the greater sensitivity and the other giving maximum selectivity.

As a capacitance meter the unit depends on reasonable reception of Radios 1, 2 and 3, although any station giving a good signal between 200 and 250 metres may substitute for Radio 1, and any station providing a reliable signal between 450 and 550 metres may be used instead of Radio 3. If the long wave Radio

2 is unobtainable, and no other station in the middle of that band can be received, then the unit will not measure capacitances above about 560pF unless a signal generator is pressed into service to substitute for Radio 2.

On the capacitance scales there is about ¼ in. spacing between the zero capacitance and 1pF points, and about 1 in. between the 1 pF and 10pF points, so the unit is easy to use for measuring very small capacitances. It should be remembered that there will be appreciable standing capacitance between any clips which might be used to hold the capacitor, and this standing capacitance should be measured first and subtracted from the final figure given when the capacitor being measured is connected. It may be found that capacitors with inefficient dielectric may not give a clear reading, owing to the consequent damping on the receiver tuned circuit.

CIRCUIT DIAGRAM

Let us now turn to the circuit diagram given in Fig. 1, looking at the unit as a receiver. It is similar to the author's '"S.A. Junior" Portable Receiver' which was described in the November 1972 issue of *Radio & Electronics Constructor*. There are, however, several modifications and the present design is more sensitive on medium waves than the earlier set.

For the time being, we shall ignore the a.f. section to the right of the broken line and will consider the circuit as an earphone receiver only. We shall introduce the a.f. section in the concluding article to appear next month.

The incoming signal picked up on coil L1 is applied to the base of TR1. This acts as an emitter follower at r.f. and the current amplified signal at its emitter is coupled to the base of TR2, which also functions as an emitter follower. L3 acts as an intermediate load, being damped slightly by R2 to prevent unwanted peaks which would otherwise cause instability at the higher signal frequencies. TR1 and TR2 function effectively as a Darlington pair, giving a considerable level of current gain and a high input impedance for r.f. at TR1 base. D1 is the detector and rectifies the signal, causing the detected a.f. to be applied back to TR2 emitter. This transistor operates as a common base amplifier at a.f. and an amplified a.f. signal appears at its collector. This is coupled to the base of TR1 via R4 and L1, whereupon TR1, acting this time in the common emitter configuration, provides further amplification. A small amount of negative feedback is given here by R1, which keeps the a.f. input impedance of TR1 high so that it more closely matches the output impedance at TR2 collector. The detected signal is thus finally built up across R6 and is coupled to the phone socket via C7. A crystal earphone

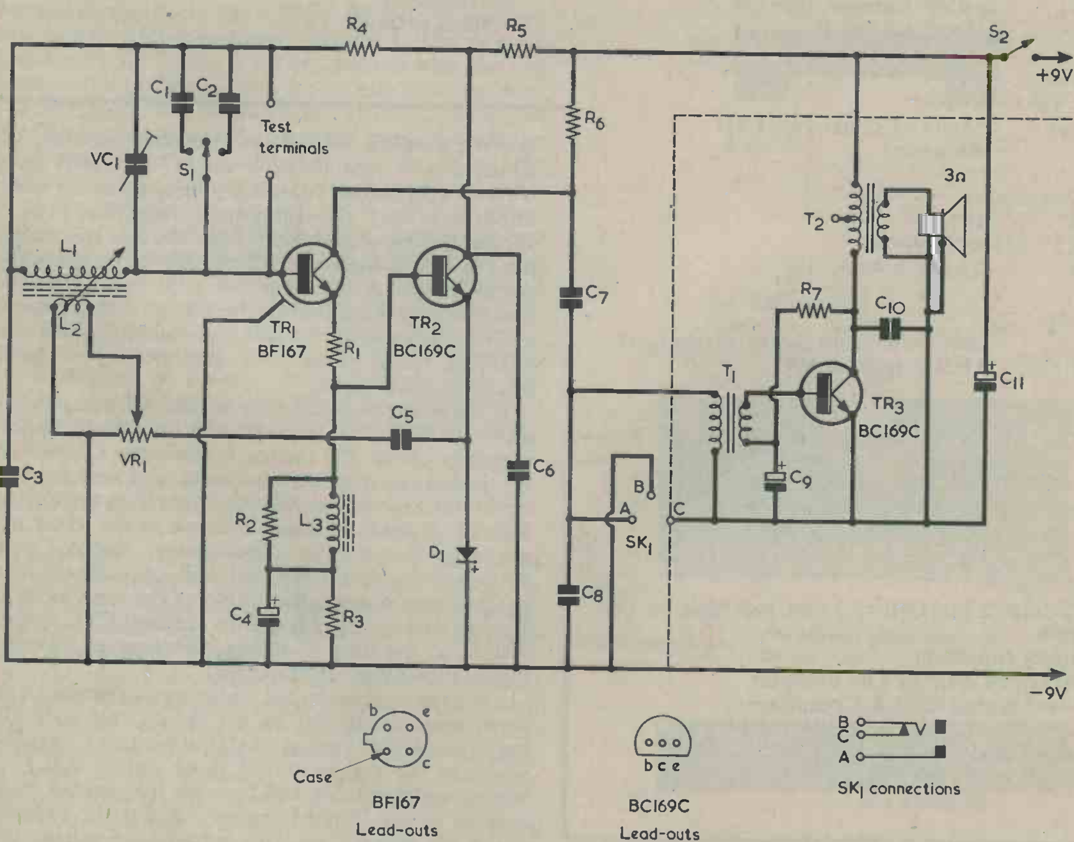


Fig. 1. The circuit of the 'Slide Rule' receiver. This will also measure the values of capacitors connected to the test terminals

COMPONENTS

Basic Earphone Version

Resistors
(All fixed values ¼ watt 10%)

R1	100Ω
R2	18kΩ
R3	3.3kΩ
R4	10kΩ
R5	47kΩ
R6	22kΩ
VR1	5kΩ potentiometer, linear, with switch S2 (see text)

Capacitors

C1	56pF silvered mica or tubular ceramic
C2	820pF silvered mica (see text)
C3	1,000pF silvered mica or tubular ceramic
C4	10μF electrolytic, 2.5 V. Wkg.
C5	0.01μF polyester
C6	1,000pF silvered mica or tubular ceramic
C7	0.1μF polyester
C8	2,000pF silvered mica or tubular ceramic
VC1	2–25pF trimmer, type D7 (Henry's Radio)

Inductors

L1, L2	See text
L3	2.5mH r.f. choke type CH1 (Repanco)

Semiconductors

TR1	BF167
TR2	BC169C
D1	OA10

Switches

S1	Slide switch with centre off (see text)
S2	S.P.S.T. (part of VR1)

Socket

SK1	3.5 mm. jack socket with break contact

Battery
9 volt battery type PP3 (Ever Ready)

Miscellaneous
Crystal earphone with 3.5 mm. jack plug
Knob
Battery connector
Ferrite rod, 6 in. by ⅜ in. diameter
18-way tagboard, R.S. Components 'Standard' (see text)
6BA terminal nuts
¼ in. plywood, Perspex, s.r.b.p., Fablon or Contact, etc.

A.F. Output Stage

Resistor

R7	470kΩ ¼ watt 10%

Capacitors

C9	2.5μF electrolytic, 2.5 V. Wgk.
C10	0.047 or 0.05μF polyester
C11	1,000μF electrolytic, 10 V. Wkg.

Inductors

T1	Driver transformer type LT.44 (Eagle)
T2	Output transformer type LT.700 (Eagle)

Transistor

TR3	BC169C

Speaker
3Ω speaker, 5 by 3 in. (see text)

Battery
9 volt battery type PP6 (Ever Ready)

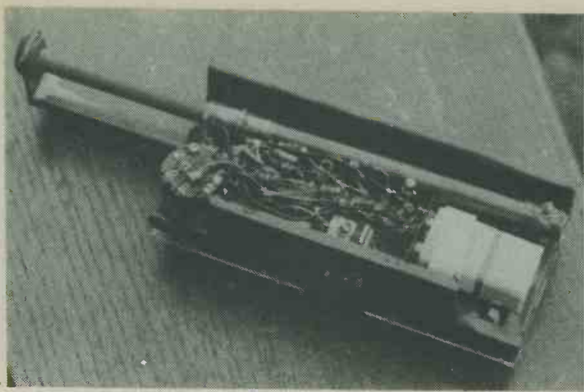
Miscellaneous
Speaker fabric

should be employed. If the output at the phone socket is to be fed to an a.f. amplifier the latter must have an input impedance of 20kΩ or more.

Tuning is effected by changing the inductance of L1, this being done by varying the insertion of a ferrite rod into the winding. With S1 in its central position, VC1 is adjusted such that Radio 1 on 247 metres is tuned in with the rod almost completely inserted in the coil. It is important that the minimum capacitance of VC1 should not be greater than 2pF, though the maximum need not be as high as the 25pF offered by the component specified. A maximum of 10pF would be ample. Sharp tuning is ensured by the high r.f. input impedance at TR1 base, and by the fact that reaction, controlled by VR1, is taken from TR2 emitter to the feedback coupling winding, L2.

If there is no capacitance across L1 other than that given by VC1, the receiver will tune from about 120 metres to about 250 metres. S1 switches C1 into circuit for the normal medium waveband, and switches C2 into circuit for long waves. Sensitivity on long waves is not as high as on medium waves because of the lower inductance-capacitance ratio. Nevertheless, Radio 2 and one or two Continental stations will be received in most parts of the country. Reception of the long wave Radio 2 signal will be improved if the value of C2 is reduced to 470pF, at the cost of losing reception at wavelengths higher than about 1550 metres.

Let us next consider the circuit as a capacitance meter. A pointer is coupled to the ferrite rod such that it traverses three tuning scales and three capacitance scales as the rod is moved in or out of coil L1. The tuning scales are marked up with frequencies or wavelengths in the normal manner, whilst the capacitance scales are marked up with capacitance values. On the lowest capacitance scale the pointer is at zero pF when S1 is in the central position and Radio 1 is tuned in. If a 1pF capacitor is now connected to the test terminals it will be necessary to withdraw the rod a little in order to keep Radio 1 tuned in, and the new position of the



A view inside the receiver with the ferrite rod partly out of its coil

pointer will be at the 1pF calibration point on the scale. This process can be repeated for any values of test capacitance up to about 56pF, at which capacitance the rod will have been removed some way from the coil The process cannot be repeated for test capacitances. much above 56pF as the Radio 1 signal then becomes rather faint due to the relatively small length of rod in the coil.

For test capacitances above 56pF, S1 is set to medium waves, bringing C1 into circuit across L1. The receiver will now pick up Radio 3 on 464 metres with the rod well inserted into the coil, and the pointer now indicates test capacitances on a second scale. If test capacitances up to 560pF are connected across the test terminals the rod will again have to be removed from the coil to tune in Radio 3, and the pointer will indicate the test capacitance on the second scale. For values of 560pF or more, Radio 2 on 1,500 metres can be tuned in with the rod well inserted, whereupon the pointer indicates the test capacitance on a third scale. In areas where Radio 2 provides a good signal it will be possible to tune it in with up to 5,000pF across the test terminals. If Radio 2 is received at lower level the limit of easy identification will be reached at around 3,000pF across the test terminals, at which value critical reaction is only just possible due to the unsatisfactory inductance-capacitance ratio.

CONSTRUCTION

We turn next to the construction of the receiver in its earphone-only version. As we shall see next month it is an easy matter to add the a.f. stage shown to the right of the broken line in Fig. 1 to this version, should loudspeaker reception be desired.

Two points concerning components need to be raised at this stage. The switch employed for S1 in the prototype was a slide switch having a centre off position. This type of switch is not currently advertised by the large mail order houses although readers who live near component retailers may be able to obtain one. If not, a satisfactory substitute is a small toggle switch having a centre off position. The toggle switch can be single pole or double pole; if the latter only one pole is used. The second part which requires mention is VR1/S2. This component should not be greater than 1 in. in diameter and it should not project back from the panel on which it is mounted by more than 1 in. The same depth restriction applies, incidentally, to S1 also.

The various pieces needed for the 'chassis' of the receiver are illustrated in Figs. 2, 3 and 4, whilst Fig. 5 shows how they fit together to form a complete assembly. First, cut out and drill three pieces of $\frac{1}{4}$ in. plywood as shown in Figs. 2(a), (b) and (c). The $\frac{7}{8}$ by $\frac{1}{2}$ in. cut-out in Fig. 2(b) is intended to take the body of the slide switch just mentioned. If a toggle switch is used this cut-out is not required, and a hole to take the switch bush is required instead. The toggle switch should take up approximately the same position as would the slide switch.

A clip to take the PP3 battery should be cut out from aluminium sheet or tinplate and screwed to the piece of Fig. 2(a) with a short woodscrew. The $\frac{3}{8}$ in. recess in this piece is to allow for the slide switch, and may need to be modified if a toggle switch is fitted. In Fig. 2(b) there are two $1\frac{1}{4}$ in. 6BA bolts with their heads on top, i.e. towards the reader, and these screws form part of the test terminals. They are cheese-head or round-head and each has a solder tag under the head. They are fitted with nuts and tightened up. So also is the remaining $1\frac{1}{4}$ in. 6BA bolt, which is countersunk and has its

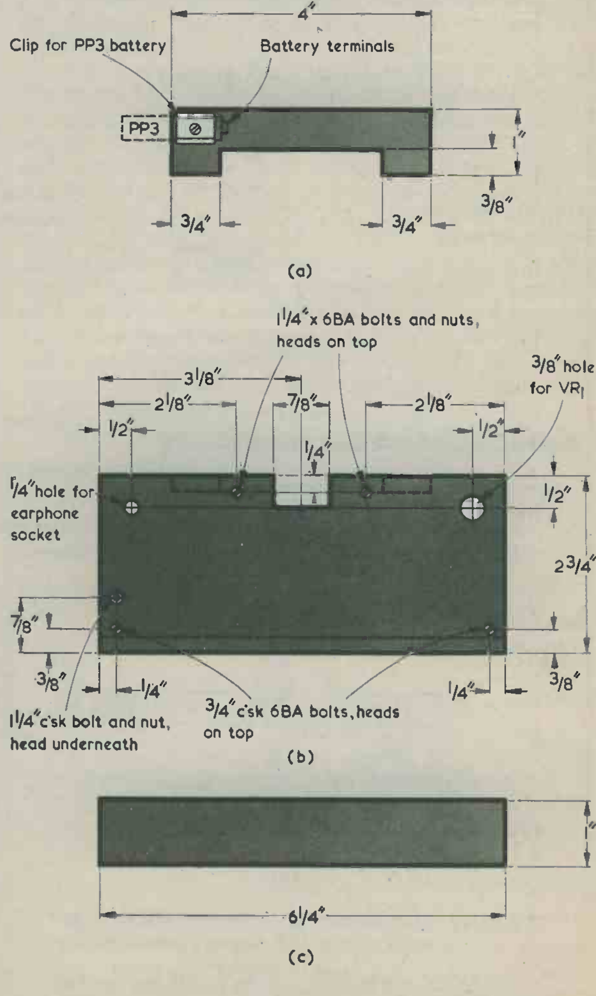


Fig. 2. The three basic parts of the receiver 'chassis'

head underneath the plywood piece, away from the reader. The two $\frac{3}{4}$ in. 6BA bolts are pushed into place but are not fitted with nuts. The three pieces are screwed together as indicated by the dashed lines, and the assembly is covered on the outside with Fablon or Contact.

Next cut out a piece of $\frac{1}{4}$ in. plywood as shown in Fig. 3(a), cover it with Fablon or Contact and glue a stiff wire into a $\frac{1}{16}$ in. hole as shown. This piece slides sideways with the ferrite rod, and the wire is the scale pointer. Cut out the piece in Fig. 3(b) from s.r.b.p. ('Paxolin') or Formica and cover it with Fablon or Contact. Fit a grommet with a $\frac{3}{8}$ in. centre to the $\frac{1}{2}$ in. hole, and screw the piece of Fig. 3(b) to that of Fig. 3(a). After the coils have been wound, the end of the ferrite rod will be fitted to the grommet, making up the assembly shown in Fig. 3(c).

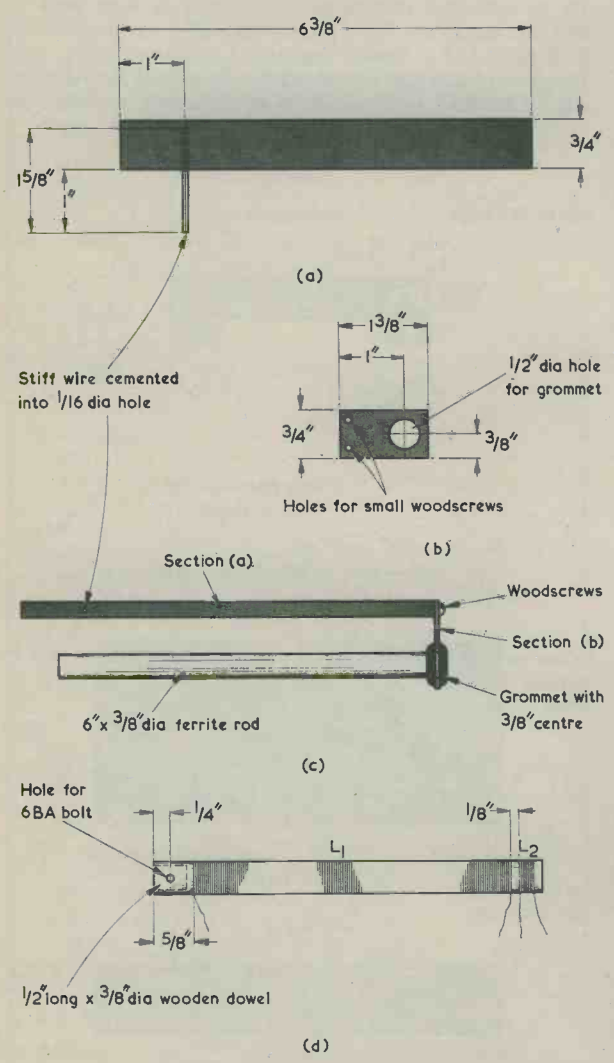


Fig. 3(a). This length of plywood slides sideways along the upper surface of the receiver
(b). S.R.B.P. item which holds one end of the ferrite rod
(c). The sliding ferrite rod assembly
(d). Details of coils L1 and L2

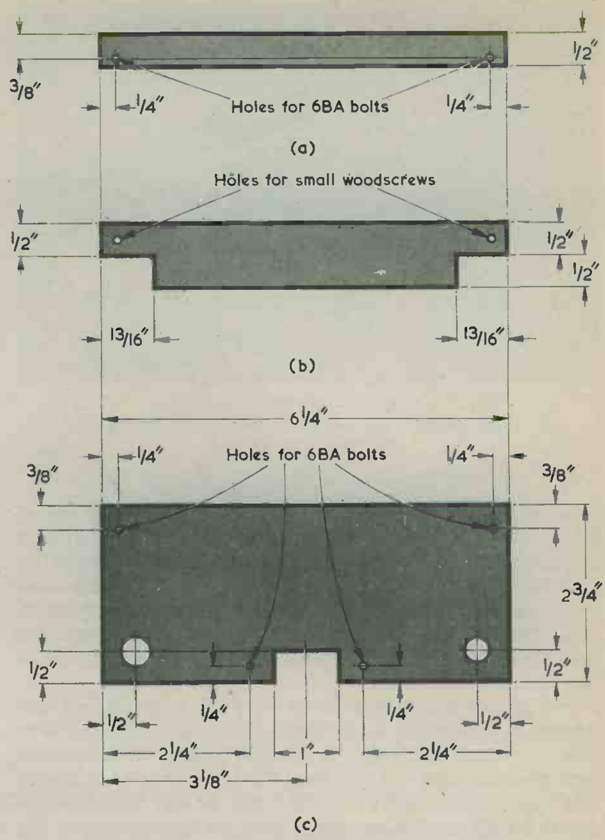
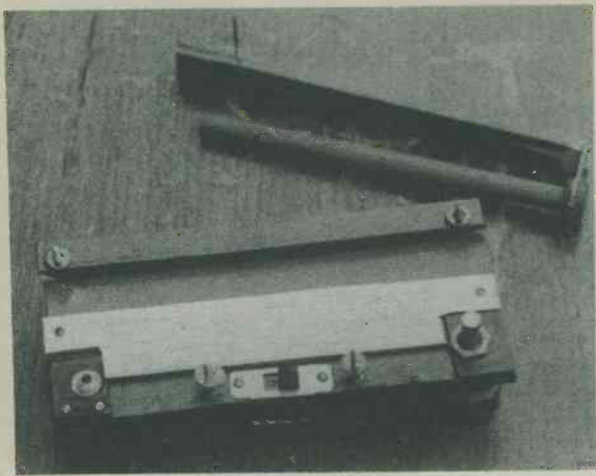


Fig. 4(a). Guide and spacer for the item of Fig. 3(a)
(b). Second guide for the item of Fig. 3(a). This also provides the backing for the tuning and capacitance scales
(c). The Perspex panel which is on top of all the pieces so far illustrated

COIL WINDING

Coils L1 and L2 should now be wound. Cut a piece of Fablon 6 in long by $1\frac{3}{4}$ in. wide, and remove a $\frac{1}{2}$ in. strip of backing paper from one 6 in. side. Wrap the Fablon around the ferrite rod with the $\frac{1}{2}$ in. exposed strip last so that this sticks to the layer of Fablon underneath, thereby making up a self-supporting tube. This tube should be a fairly tight fit but should still be removable from the rod. Cut a second piece of Fablon 6 in. by 6 in., and remove $\frac{1}{2}$ in. of backing paper from one edge. Wrap this round the ferrite rod and the first tube with the $\frac{1}{2}$ in. exposed strip last, thus making a second tube. Remove both tubes from the rod, then remove the first tube from the second and discard it. The second, thicker, tube is now the coil former and it will be found to be an easy, loose fit on the rod. Leave the rod inserted in the tube.

Fix the end of a length of 24 s.w.g. enamelled wire with Sellotape to the tube at a point $\frac{5}{8}$ in. from one end. Wind on 180 turns in a single layer, each turn touching the next, for L1. The end of the winding is then fixed with Sellotape.



Showing the ferrite rod assembly before it is inserted in position

There is a slight possibility that the ferrite rod obtained may be Blue grade, this being a low permeability grade which was marketed some years ago by R.S. Components and which has since been discontinued. Some stocks may still, however, be held by retailers, and ferrite rod of this type is readily distinguishable because of a blue coding mark at one end. If the ferrite rod is Blue grade, L1 requires 225 turns of 26 s.w.g. enamelled wire. Should the ferrite rod have any colour coding other than blue, or no coding at all, then L1 needs the 180 turns of 24 s.w.g. enamelled wire just mentioned. There is nothing magical in these grades of wire: they are chosen merely to ensure that L1 has as great a length as is practicable, thereby ensuring that the ferrite rod has a wide travel as it tunes the receiver. Either coil will be approximately $4\frac{1}{4}$ to $4\frac{1}{2}$ in. long.

L2 starts $\frac{1}{8}$ in. from the end of L1 and is also close-wound. It has 15 turns wound in the same direction as L1 and employs the same wire as was used for L1. It is held in place with Sellotape.

A $\frac{1}{2}$ in. length of $\frac{3}{8}$ in. wood dowelling has a few turns of Sellotape wound on it to ensure a good fit and is then inserted in the end of the Fablon tube, as shown in Fig. 3(d). The ferrite rod is now removed from the tube and fitted to the grommet, as in Fig. 3(c). A 6BA clear hole is next drilled through the Fablon and the dowelling, as indicated. Take up the assembly of Fig. 2 and position it so that the head of the $1\frac{1}{4}$ in. countersunk 6BA bolt is underneath. Fit a nut and then a washer to this bolt, then fit the Fablon tube and the dowelling over this, with the bolt passing through the 6BA clear hole just drilled. Fit another washer and another 6BA nut. Do not tighten the nuts yet. Next turn the Fig. 2 assembly over so that the head of the $1\frac{1}{4}$ in. countersunk 6BA bolt is on top and slide the rod assembly of Fig. 3(c) into position so that the rod enters the coil and the plywood piece of Fig. 3(a) lies on top of the Fig. 2 assembly. Adjust the nuts holding the coil former so that the latter is parallel with the underside of the Fig. 2(b) piece, and then finally tighten them.

Next cut out and drill the three items shown in Fig. 4. That in Fig. 4(a) is made of $\frac{1}{4}$ in. plywood, that in Fig. 4(b) of s.r.b.p. or Formica, and that in Fig. 4(c) of $\frac{1}{8}$ in. Perspex. It will be helpful at this stage to refer also to Fig. 5 from time to time to gain an idea of the complete construction. The piece of Fig. 4(a) is covered with Fablon or Contact and it passes over the $\frac{3}{4}$ in. bolts in the Fig. 2 assembly. The Fig. 4(b) item is fitted to the top of the Fig. 2 assembly with small woodscrews, and is positioned so that it lies under the pointer and is close enough to the piece of Fig. 3(a) to allow the latter to slide smoothly and without wobble as it takes the ferrite rod in and out of the coil. A piece of white card is cut to the same dimensions as Fig. 4(b) and will later be marked up with the scales and fitted over this item. It should have two small holes matching those in Fig. 4(b). The Perspex piece of Fig. 4(c) passes over the same two 6BA bolts which pass through Fig. 4(a) and it passes also over the $1\frac{1}{4}$ in. test terminal bolts. The two large holes in this piece should have diameters which will, respectively, accommodate the bush of VR1 and allow the earphone plug to pass into its socket.

Before fitting the Perspex panel place thin washers

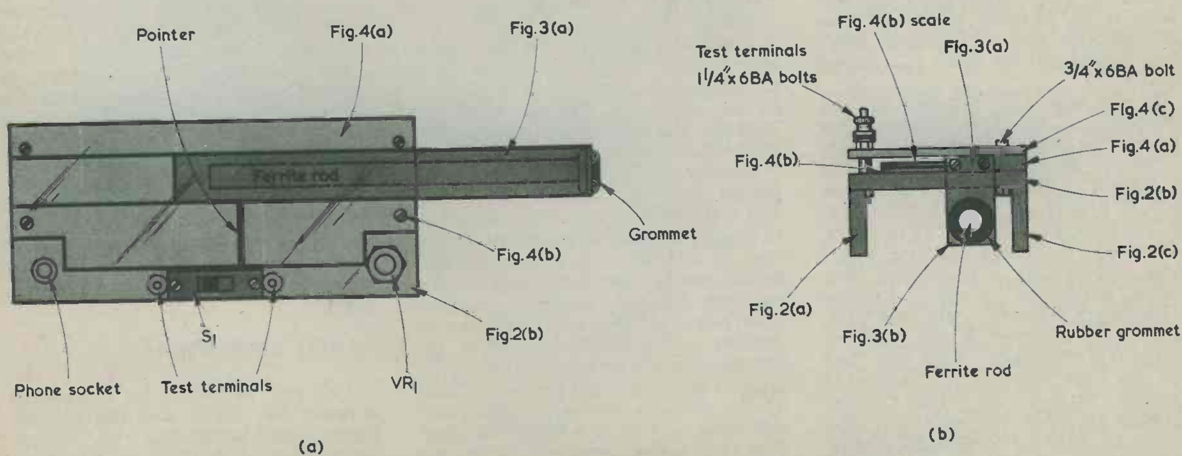


Fig. 5(a). View from above of the previous items when assembled together (b). Side view of the complete assembly

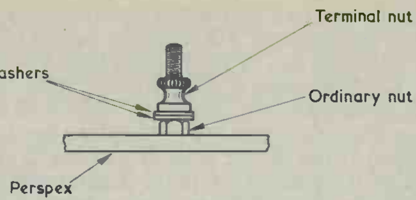


Fig. 6. How the terminals are made up above the Perspex panel

over the $\frac{3}{4}$ in. bolts passing through the Fig. 4(a) part, and fit spacing washers over the test terminal bolts which will space off the Perspex panel from the top of the Fig. 2 assembly by slightly more than $\frac{1}{4}$ in. Ordinary nuts may be used to secure the Perspex at the $\frac{3}{4}$ in. bolts, although dome nuts or terminal nuts will look better.

Nuts, washers and terminal nuts are passed over the test terminal bolts, as illustrated in Fig. 6.

Since the Perspex piece is spaced off by slightly more than $\frac{1}{4}$ in., the ferrite rod assembly should be free to slide in and out smoothly.

NEXT MONTH

Next month's concluding article will give details of wiring and will also describe how the a.f. stage and loudspeaker may be added.

A complete Components List is given this month and lthis includes the parts required for the a.f. section. If it is intended to build the 3-transistor version from the start, then the PP3 battery will not be required. The textual references to the speaker and tagboard will be dealt with in the next article.

(*To be concluded*)

Radio Topics

★ ★ ★ By Recorder ★ ★ ★

NUMBERS ARE FASCINATING THINGS and I can well understand mathematicians who become completely immersed in them, regardless of their connection with the physical world in which they fit. For those of us who like to play around with numbers at a simpler level there are, also, many intriguing features to discover about them.

THINK OF A NUMBER

Think of any number less than 10. Multiply 37 by that number, then multiply the answer by 3. Say we chose the figure 2. 37 multiplied by 2 comes to 74, and that number multiplied by 3 gives 222. Try it with any other number. There is an obvious reason for the answers you get, but please don't write in and tell me when you realise it!

If we take the squares of the numbers, 1, 2, 3, 4, 5, 6 . . . in order we find that we have the series, 1, 4, 9, 16, 25, 36 . . . Should we then take what are known as the 'first differences', we get 3, 5, 7, 9, 11 . . . The 3 is 4 minus 1, the 5 is 9 minus 4, the 7 is 16 minus 9, and so on. Note that the first differences increase by 2 each time. The 'second differences', given by 5 minus 3, 7 minus 5, 9 minus 7, etc., are all 2. This is an example of the 'Law of Constant Differences'. You may feel that this little gimmick is a matter of academic interest only, but Charles Babbage used it as the basis of operation in his ill-fated 'difference engine' of the 1820's. The 'difference engine' was a mechanical calculating machine, but the engineering skills of the day were not sufficient for the manufacture of the precisely dimensioned gears which the machine required, and the 'difference engine' as conceived by Charles Babbage never became a practical proposition. It was to be followed by work on his 'analytical engine' which, in theory, was a mechanical forerunner of the modern computer. The tragedy for Charles Babbage was that the mechanical equipment available to him could not match up to the brilliance of his ideas. Ironically, a Swedish-made 'difference engine', based partly on Babbage's design, did appear during his lifetime and functioned satisfactorily.

FURTHER NUMBERS

Returning again to numbers themselves, there is a little trick of which advantage was taken by G. A. French in his Suggested Circuit, '"Magic" Number Indicator'. This appeared in the March 1972 issue of this journal.

Since more than two years have passed since G. A. French's article was published, I think it's reasonable to quickly repeat the numerical artifice that he described. Take any number having two or more digits. It could, for instance, be your telephone number. Then rearrange the digits to give a new number which is different from the first number and subtract the smaller of the two numbers from the larger. Add up the digits in the remainder. These will come to 9 or to a higher number. If it is a higher number add up the digits again and, if necessary, repeat. The final result will always be 9.

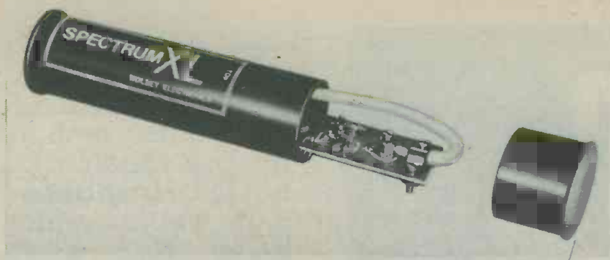
To take an example, let's say that our first number is 3,017. We can rearrange this to 1,703. If we subtract 1,703 from 3,017, we get 1,314, the digits of which add up to 9. We could have rearranged 3,017 to become 7,013, whereupon 7,013 minus 3,017 is 3,996. The digits in 3,996 add up to 27. A second addition then produces 9 again. Try it with numbers of any size having two digits or more.

The reason for this phenomenon is that the digits in any multiple of 9 always add up to 9 or to a multiple of 9. This fact is self-evident from the 9-times table where we have the series 18, 27, 36, 45, and so on. Any number greater than 9 must be a multiple of 9 or a multiple of 9 plus a remainder from 1 to 8. The number we chose, 3,017, is a multiple of 9 plus the remainder 2, because the digits in the number add up to 11. If we rearrange 3,017 in any way, its digits still add up to 11, and the number is still a multiple of 9 plus the remainder 2. When we subtracted 1,703 from 3,017 we were subtracting a multiple of 9 plus 2 from another multiple of 9 plus 2. The two 2's disappeared during the subtraction whereupon the result was a multiple of 9 minus another multiple of 9, The answer must then itself be a multiple of 9.

AERIAL AMPLIFIERS

Two new amplifiers for connection between the aerial and the receiver have been introduced by Wolsey Electronics, a division of AB Electronic Components Ltd.

The first of these is the 'Clearsound' Signal Booster, which is designed for



The Wolsey Electronics 'Spectrum XL' Masthead Amplifier. This boosts television signals in the u.h.f. Bands IV and V

the amplification of v.h.f. f.m. signals. Wolsey Electronic state that the minimum signal level for good stereo radio reception must be 8 to 10 times (18 to 20 bB) greater than that required for mono reception. In areas where signal strength is poor and the stereo decoder cannot be locked in properly the 'Clearsound' amplifier can raise the incoming signal comfortably over the stereo threshold.

The 'Clearsound' booster incorporates a low noise silicon transistor and has a frequency range of 87.5 to 100MHz with a minimum gain of 20 dB. Ideally, it should be fitted to the aerial mast close to the aerial but it can be located nearer the f.m. receiver if masthead mounting is difficult.

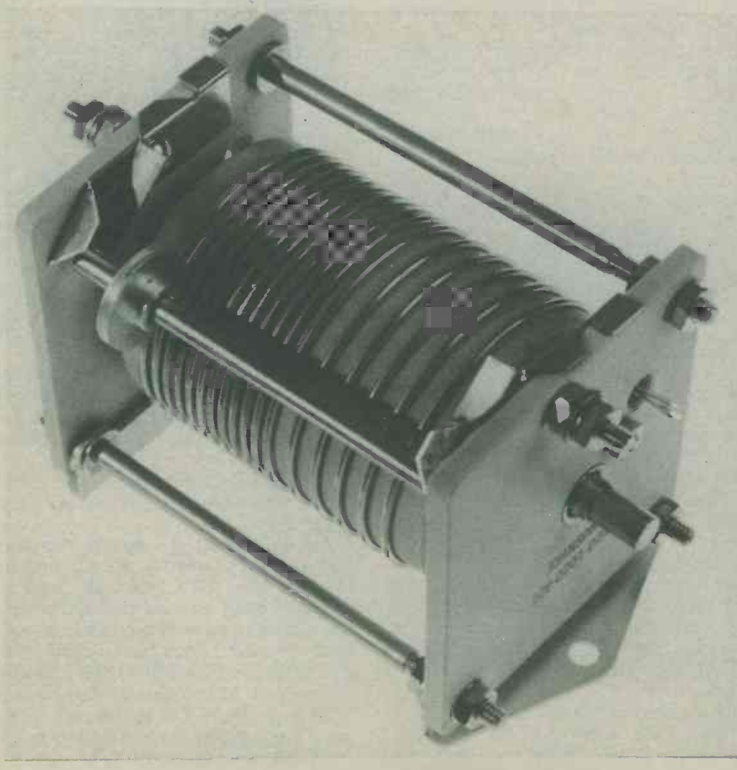
The second signal booster from Wolsey Electronics is the 'Spectrum XL' Masthead Amplifier. This is also fitted with a low noise silicon transistor and it is intended for u.h.f. colour or monochrome television reception. The amplifier is completely weatherproof and is positioned close to the u.h.f. aerial. Two amplifiers can be wired up in cascade, if desired. Typical minimum gain is 10 dB with a noise figure of between 2.5 and 3.5 dB. Three models of the 'spectrum XL' are available, these covering Group A (Channels 21 to 34), Group B (Channels 39 to 51) or Group D (Channels 49 to 68). The amplifier can be seen in the accompanying photograph.

Further details on these amplifiers can be obtained from Wolsey Electronics, Cymmer Road, Porth, Rhondda, Glamorgan, CF39 9BT.

VARIABLE INDUCTOR

My second photograph illustrates a variable inductor intended for transmitting work. The whole coil former is capable of being rotated by means of the shaft projecting from the centre of the assembly end-plate, whereupon the pulley rides along the spiral which constitutes the coil. Connection is made to the pulley by way of the rod on which it turns.

This particular unit is one of a range of special inductors now being handled by Vero Electronics Limited, Industrial Estate, Chandler's Ford, Eastleigh, Hants. The range includes fixed and variable inductors incorporating copper wire, ribbon or tubing, and non-standard inductors can be made to special order. These products are manufactured by the American firm, E. F. Johnson Company, and some are already in use in U.K. broadcasting stations.



A variable inductor from the range now being marketed by Vero Electronics Limited

DOWN WITH NANOFARADS!

You can call me a square old reactionary if you like, but I can't for the life of me see any point in making changes where changes are not required.

I have just been looking at a rather poorly reproduced circuit diagram, and spent some time wondering why an r.f. bypass capacitor was given the unusual value of 2μF, when I suddenly realised that the capacitor wasn't 2μF at all. The smudgy character after the figure '2' wasn't 'μ' for 'microfarad' but was 'n' for 'nanofarad'. As you know, nanofarads come between microfarads and picofarads, and 1 nanofarad is equal to 1,000 picofarads. So that r.f. bypass capacitor I was looking at had the eminently reasonable value of 2,000pF. (Or, as Dick of 'In Your Workshop' fame would have put it some years ago, it had a 'puffage' of 2,000).

For more than twenty years now we have been pressing on quite contentedly with just the two units of capacitance: microfarads and picofarads. They have met our requirements perfectly adequately and there can surely be no reason at all in complicating matters by introducing nanofarads. In many circuit diagrams these days the letter 'F' is omitted from capacitance values, whereupon these values may be shown as, say, '10μ' or '50p'. There is little risk of confusion between the symbols 'μ' and 'p', and in most instances the actual value in figures and the function of a capacitor indicate with little room for doubt what the capacitance unit is. But such is not the case when values in nanofarads are allowed to creep in.

It would be interesting to find how many errors due to the use of the nanofarad as a unit have arisen in manufacturers' research and development work; in which, say, drawing office personnel have mistaken the symbols for capacitance in engineers' sketched circuits. Enough, I would guess, to make the letter 'n' stand strictly for 'nuisance value' rather than for an unnecessarily introduced unit of capacitance. ■

In your workshop

This month Dick and Smithy embark on the repair of a small imported a.m. radio which does not even boast a manufacturer's name. The Serviceman demonstrates some simple servicing techniques which can be carried out on receivers of this type.

"HOORAY," SAID SMITHY JUBILANTLY, "that's my last job for today cleared up."

He carried the television receiver he had repaired over to the racks then returned to his bench. Contentedly, he tidied up his tools and test equipment, picked up a small brush and swept the day's debris of solder blobs and wire ends into his rubbish bin. Glancing over at Dick's bench, he saw that his assistant was engrossed in a small object in front of him. Smithy walked over to Dick's side.

"Still busy, eh?" he said chattily. "That's what I like to see!"

Dick looked up.

"I've just this minute started on this job," he remarked. "It's a little imported a.m. radio, and so far I can't get a thing out of it."

NO-NAME RADIO

Smithy leaned over and looked at the set on Dick's bench. It still had the back on and he picked it up to examine it more closely. It was a small pocket radio having two controls only, one being a rim operated volume control and on-off switch at the side and the other a tuning knob on the front. As Smithy turned the latter, figures from "6" to "16" appeared hopefully in a small window. He examined the case carefully and searched unsuccessfully for a manufacturer's name. The little set did, however, possess some identity, and this was proclaimed by a paper rectangle, peeling at one corner, which stated bravely: "Dreadnought".

"This is peculiar," grunted Smithy, frowning. "We don't usually accept these cheap little radios for servicing. The cost of fixing them is often more than the original cost when they were bought new. Still, we've cleared out all the other sets that are in for repair today so we might as well have a stab at this one before we finally pack in. I don't want to be too late tonight, by the way; I've got a fairly full evening on down at my club."

"I've got a fairly full evening in front of me, too," said Dick morosely. "But I can't say I'm looking forward to it."

"Why not?"

"I've been press-ganged into doing a job for one of my aunts," explained Dick unhappily. "I'm going to have a really hilarious time."

Even Smithy would have conceded that Dick had more than his fair share of aunts. The Serviceman clicked his tongue sympathetically.

"Oh well," he said comfortingly. "Perhaps it won't be too bad."

"Let's hope not," stated Dick. "Incidentally, what do those tuning numbers stand for?"

"What tuning numbers?"

"The ones from 6 to 16 on the tuning dial of that set."

"Oh, those," replied Smithy, bringing his thoughts back to more immediate matters. "Why, they're probably intended to be hundreds of kHz. As there's no wavechange switching this is almost certainly a medium wave only job, so the range will be from about 600 to 1,600kHz."

"It seems funny," remarked Dick, "to think of a medium wave band which is marked out in frequency instead of wavelength."

"Not really," replied Smithy. "Other countries have an a.m. broadcast band equivalent to our medium waves, but they identify the stations in it by frequency. It's us who are probably behind the times sticking to wavelengths."

He glanced at his watch.

"Well," he went on, handing back the set to Dick, "we've got half an hour to fix this set, so let's get down to it right now. Routine checks to start off with!"

"Fair enough", replied Dick epuably, taking the set from Smithy. "I'll get the back off first."

He soon found the manner in which the back was secured, and he removed this with a click to reveal a tiny printed circuit board on which were packed four diminutive square metal cans, two a.f. transformers and a minor forest of other components. A small ferrite slab aerial was fixed to one end of the board. At the other end was a black plastic battery holder in which two 1.5 volt cells were visible. Dick looked quickly for obvious faults but could find none. There were two small tags on the battery holder, to which were connected two wires from the board. He pulled his testmeter towards him, selected a low voltage range and applied its prods to the two tags. The meter needle rose to around 4 volts on its scale. Dick switched on the receiver, wereupon the voltage reading dropped to less than 2.5 volts. He switched the set off again.

"The battery's had it," he remarked, removing the cells from the battery holder and examining them. "Could you get me four U7 cells please, Smithy?"

"Okeydoke," replied Smithy obligingly. "Incidentally, they're HP7 cells these days."

He walked to the spares cupboard and returned with a plastic package holding four HP7 cells. He split the package open and handed the cells to his assistant who fitted them into the battery holder. Dick next picked up the testmeter prods and once more checked the voltage at the battery holder tags.

"That's funny," he remarked, frowning. "I should be getting 6 volts here."

"What are you getting?"

"3 volts."

Smithy sighed.

"I should have known better than to help you on this job," he stated irritably. "I've been in a good humour all day, and now you've started spoiling it."

"Well, there's no need to get all uptight about it," said Dick defensively. "These new cells must be duffy."

"What is infinitely more likely," snorted Smithy, "is that you've put one of them in wrong way round." (Fig. 1.)

Dick looked down at the battery holder.

"Gosh, you're right, too," he said. "Well, I'll soon put that right."

Quickly, he removed one of the cells, turned it round and refitted it. The voltmeter now gave a reading of 6 volts.

"That's more like it," said Smithy, mollified. "Let's see how the set works."

He leaned over, turned the receiver volume up and adjusted the tuning knob. He soon found a signal giving adequate volume at the high frequency end of the scale. It had an unpleasantly distorted quality. Smithy turned down the volume and the distortion increased very noticeably.

"I would guess," he remarked judiciously, "that we've probably got a case of crossover distortion in the Class B output transistors here. You heard that there was quite good volume and that the distortion increased when the volume went down. This makes crossover distortion a reasonable possibility because the signal range over which this distortion takes place occupies a larger proposition of the overall signal at lower volume levels." (Fig. 2.)

"Yes, I think I can follow your reasoning there," remarked Dick. "But what could be causing the crossover distortion?"

"The output transistors," replied Smithy, "won't be getting sufficient quiescent bias. I hardly need to tell you that Class B output stages are given a bias which allows them to pass a few milliamps when no signal is present."

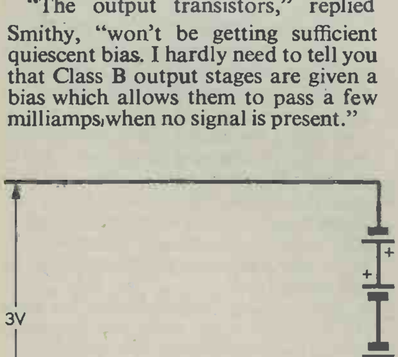


Fig. 1. How four 1.5 volt cells, with one inserted incorrectly in a battery holder, produced a total voltage of 3 volts

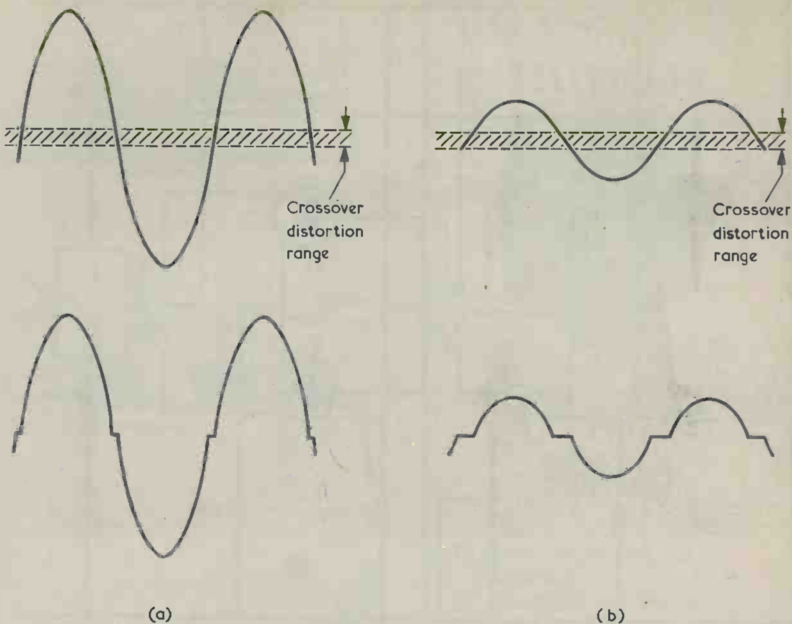


Fig. 2(a). If a Class B output stage is operated without quiescent bias the central part of the signal is not amplified and crossover distortion results. The input waveform is shown at the top and the distorted waveform below
(b). If the input waveform has a low amplitude the effect of crossover distortion is relatively higher

Dick gazed down at the crowded printed circuit board of the receiver.

"That's all very well," he said helplessly, "but where the heck do we start looking for bias faults in this little lot? It isn't as if we had a service manual, even."

"The fault shouldn't be too hard to trace," said Smithy. "As you can see, there are two a.f. transformers on that printed board. These are bound to be an a.f. driver and an a.f. output transformer. A.F. circuits incorporating a driver and an output transformer are virtually the same in nearly all these small sets. Look, I'll show you."

OUTPUT CIRCUIT

Glancing over Dick's bench he spotted his assistant's note-pad and pulled it over towards him. He took out his pen and quickly sketched out a circuit. (Fig. 3).

"Here you are," he said "This is the sort of thing you get in the driver and Class B output stage when these use transformers. I've shown p.n.p. transistors because driver and output transformer are more liable to appear in older receivers, but the circuit could equally well employ n.p.n. transistors with the supply polarity reversed. If you look at the secondary of the driver transformer you'll see that its outer ends go to the bases of the output transistors whilst its centre-tap has one resistor going to the negative supply rail and the other going to chassis."

"Do these resistors provide the quiescent bias?"

"They do," said Smithy. "If the output transistors are germanium types, the upper resistor can have a value of around 4.7kΩ and the lower one a value of around 100Ω. More often the lower resistor will be replaced by a thermistor, or by a thermistor and resistor in parallel."

"What does the thermistor do?"

"It prevents distortion due to changes in ambient temperature," said Smithy. "If the temperature goes up the output transistors try to pass more current. But the increased temperature also causes the resistance of the thermistor to reduce, whereupon the bias voltage for the output transistors goes down and couteracts their tendency to pass increased current."

"There's another resistor in that circuit of yours. The one between the output emitters and chassis."

"Ah yes," said Smithy. "Well, that resistor is a low value job and is usually in the region of 2 to 4 ohms It's to guard against thermal runaway in the output transistors. If these pass a heavy current, the voltage across that resistor rises and causes the base-emitter bias voltage to reduce. Another point I should mention is that there's normally a negative feedback circuit coupling back from the output trans-

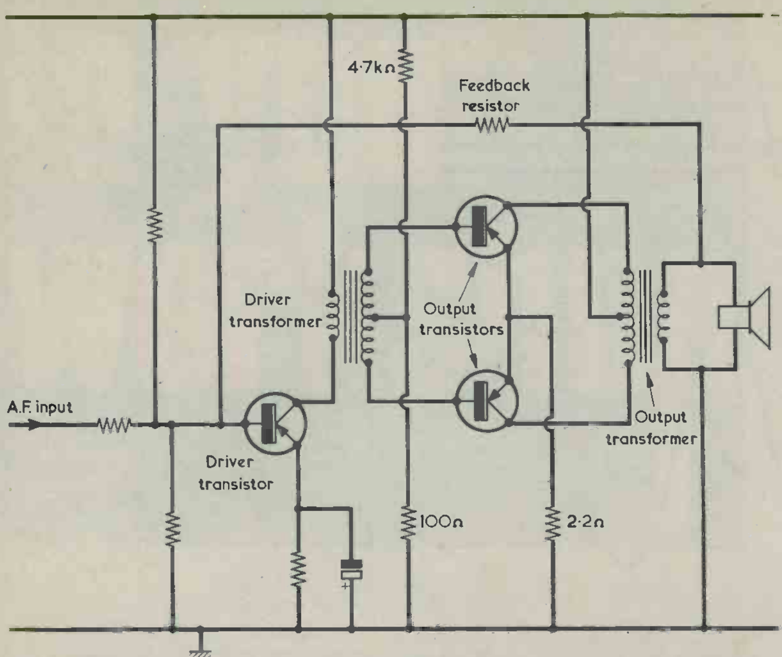


Fig. 3. Nearly all small transistor radios incorporating a driver and a.f. output transformer employ this output transistor bias circuit. The component values shown here are representative

former secondary to the base or emitter of the driver transistor. In my diagram I've shown it coupling back to the base of the driver transistor but you'll find variations on this in most sets. However, the remaining part of the circuit including the quiescent bias supply arrangement is pretty standard for all sets."

"Isn't this business of using transformers rather old-fashioned?"

"Oh, definitely," agreed Smithy. "There are much more effective a.f. driver output circuits available these days which don't require transformers at all. What I find surprising is that quite recent transistor radios, both those made here and those imported, still incorporate transformers. I suppose the transformer circuit has the advantage of simplicity and that the transformers can be produced pretty cheaply. So far as servicing is concerned, you and I will be seeing transistor radios with a.f. transformers in them for a few more years yet. But you're quite right in calling the use of transformers old-fashioned."

A thought suddenly crossed Dick's mind and his face took on an expression of gloom.

"Talking of things being old-fashioned," he grumbled, "has reminded me that I've got to do that dratted job for my aunt tonight. She's so old-fashioned it just isn't true."

"Which aunt is it?"

"Aunt Effie."

"Is she the one who puts ruffles on the piano legs?"

"That's the one. The family all call her Effie the Ineffable and what I can't understand is that they then all fall about laughing over it. Another thing I don't understand is that they're all queueing up to do jobs for her. Or rather," he added darkly, "getting me to do jobs for her."

"Perhaps," said Smithy consolingly, "they have their reasons. Anyway, let's get back to this set and our assumption that it's suffering from crossover distortion. If this is the case, there's a strong likelihood that the resistor coupling the upper supply rail to the centre-tap of the driver transformer secondary has gone open. You shouldn't have much difficulty tracing that resistor on the board because it connects to the driver transformer centre-tap."

"Fair enough," commented Dick. "Hey, wait a minute! How will I know which transformer is the driver one?"

"The other one," said Smithy sweetly, "connects to the speaker."

"Blimey, of course. I'll get the printed circuit out then."

"Righty-ho," remarked Smithy. "Be careful with it. Some of these little sets have pretty tricky fastening arrangements."

But Dick was in luck. The tuning knob pulled off without any difficulty and, after removing three small screws, the circuit board came free complete with the speaker. It was only necessary to unsolder the two leads at the battery holder tags. And Smithy was lucky, too. After a little searching Dick located the upper bias feed resistor and found that it had, indeed, become open-circuit. It was colour-coded 3.9kΩ, and Dick soon fitted another of this value in its place. He replaced the board in the cabinet and resoldered the two wires at the battery holder. He then fitted the tuning knob and switched on. He returned to the station previously selected by Smithy and adjusted the volume control. The quality of the reproduction offered by the little receiver was now quite adequate for one of its ilk.

POOR TRACKING

"Job done," he announced joyfully. "You certainly pin-pointed that snag, Smithy."

An outside observer might have noted that Dick's pleasure at the successful repair was considerably higher than the situation would apparently warrant.

"I wish all the faults we dealt with were as easy," remarked the Serviceman. "Let's see how the set handles now."

Smithy leaned over and checked the performance of the receiver at different tuning positions. He frowned.

"It doesn't," he remarked, "seem to be tracking very well. It's quite sensitive at the high frequency end of its scale but it's not so hot at the low frequency end. Let's see if the ferrite aerial coil needs a little adjustment."

He switched off the receiver, turned it over and placed an exploratory finger on the aerial coil mounted on its ferrite slab. .

"Darn it," he said irritably. "This blasted coil's immovable."

"How do you mean?"

"Well," said Smithy, "the ferrite slab is held at its extreme ends by two brackets and the aerial coil takes up nearly all the space between these brackets. So I can't move the ferrite slab and I can't move the coil!"

"That's a funny set-up, isn't it?"

"It's a very annoying one," stated Smithy. "I bumped into a similar situation in another little imported set some years ago and I cursed that one too. Anyway, before going any further, let's see if the coil *does* need to be moved. In other words, lets see if it needs a little more or a little less inductance at the low frequency end of the scale for its resonant frequency to be at the signal frequency selected by the oscillator."

"You mean," asked Dick, "to see if it's resonant at the oscillator frequency minus the intermediate frequency?"

"That's right," said Smithy. "The oscillator frequency selects the signal which is to go into the highly selective i.f. amplifier. It's the function of the aerial tuned circuit to bring that signal up to its optimum level. With these little sets it's particularly important for the aerial coil to be at the correct frequency and give maximum signal boost."

"How," asked Dick, "are you going to see if the aerial coil needs more or less inductance if you can't move it along the ferrite slab?"

"I have a trick up my sleeve here," stated Smithy. "Have you ever heard of a tuning wand?"

"A tuning wand? No, that's a new one on me."

"Well," said Smithy, "it's an insulated rod which has a piece of iron-dust core material at one end and a brass slug at the other." (Fig. 4.)

"What do you use it for?"

"We used to use it, in the days before ferrite aerials, to check signal tuned circuits in which the coils did not have iron-dust cores. If we wanted to check whether a signal frequency coil needed more inductance we put the iron dust core end of the wand into the coil. This increased its inductance and if, say, signal strength increased as a result then we knew that the coil required more inductance. If signal strength decreased, then we at least knew that the coil didn't need any more inductance. We then put the brass slug end of the rod into the coil. This decreased its inductance, and if the process caused signal strength to increase, then we knew that the coil needed less inductance."

"I get it," said Dick brightly. "Following from this, I suppose that if signal strength decreased both when the iron-dust end was inserted and when the brass end was inserted then the coil inductance was spot on."

"That's the idea."

"How does that apply to this receiver here? You can't poke a tuning wand into its ferrite aerial coil."

"But we can do a very similar thing," said Smithy. "Hang on a bit whilst I have a dig in my junk box."

He walked over to his bench, pulled a cardboard box towards him and rummaged around in its contents. With a grunt of satisfaction he picked out a small object, then returned to Dick.

"What," asked Dick, "have you got there?"

"A four inch length of ferrite rod," replied Smithy. "Now let's see if we can find a station near the low frequency end of this receiver's range."

He switched the receiver on again and tuned in a weak station at the low frequency end of its scale. He then picked up the ferrite rod and, holding it parallel with the ferrite slab in the receiver, brought it up to the slab. When the ferrite rod was about an inch away from the slab the signal commenced to decrease in strength. It grew weaker and weaker and had almost completely disappeared when Smithy had the ferrite rod as close to the slab as was possible. (Fig. 5 (a).)

"What," asked Dick, "does that tell us?"

"It tells us that the aerial coil doesn't need more inductance. Bringing that ferrite rod up to the coil increased its inductance."

"How can you set about decreasing its inductance?"

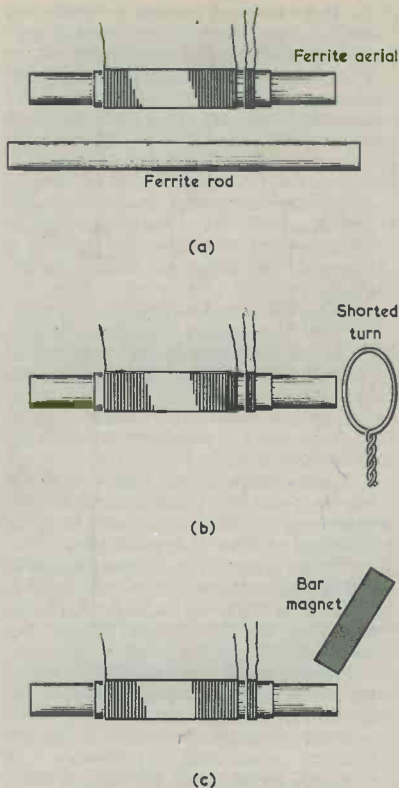


Fig. 5(a). Bringing a ferrite rod close to a receiver ferrite aerial increases the inductance of the latter. This can provide a simple check to determine whether a ferrite aerial coil requires increased inductance for accurate tracking
(b). The inductance of a ferrite aerial coil may be reduced by bringing a shorted turn up to and, if necessary, over one end of its ferrite rod
(c). The ferrite aerial coil inductance may also be reduced if one pole of a bar magnet is brought close to one end of the ferrite rod. This approach is not as effective as that employing the shorted turn, but can still be helpful if the ends of the ferrite aerial rod are inaccessible

Fig. 4. A tuning wand. This can be made up from scrap materials and a suitable length is of the order of 6 inches

"If it were an ordinary ferrite rod with its ends free of any mounting," replied Smithy, "I could do it by bringing a shorted turn up to the end of the rod which is nearer the coil under investigation. As the shorted turn approaches the rod it causes coil inductance to decrease in just the same way as the brass slug in the old tuning wand used to do. The shorted turn can just be an odd bit of bare wire with its ends twisted together and having a diameter of about an inch or so." (Fig. 5 (b).)

"Can't you try that here?"

"Not very easily," replied Smithy. "The way that ferrite slab is mounted it's difficult to bring a shorted turn up to it in the required manner. However, I've got another little dodge to fall back on here. Let's have another dig in my junk box."

Smithy once more walked over to his bench. After the sound of further searching in his cardboard box, he returned with another small object.

"What is it this time?" queried Dick.

"A bar magnet," replied Smithy. "Now lets see what happens if I bring one pole of this magnet up to the ferrite slab."

Slowly, Smithy brought the magnet up to one end of the ferrite slab. When it was very close to the ferrite slab the volume level of the signal from the receiver increased noticeably in strength. Smithy took the magnet away again. (Fig. 5 (c).)

"Hell's teeth," said Dick, supremely impressed by this manifestation. "What happened there?"

"Bringing the magnet up to the ferrite slab," explained Smithy, "reduced its incremental permeability and caused the aerial coil to have less inductance. The magnet isn't as effective as the shorted turn, but it does give an indication when the aerial coil has just a little too much inductance."

"Is there any risk of permanently magnetising the ferrite slab?"

"Not to my knowledge. I've tried this magnet scheme on quite a few rods and slabs, and it's caused no trouble even when the magnet actually touched the ferrite material. If you wanted to play safe you could just ensure that the magnet and rod don't come into contact although as I say, I've never had any trouble on this score myself. The magnet needs to be a pretty strong one. The one I've got here is primarily intended for operating dry reed relay switches."

OSCILLATOR ALIGNMENT

"What do we do next?" asked Dick. "We can't just send this set out with a magnet stuck to the ferrite slab, can we?"

"Not really," chuckled Smithy. "Since we can't change the aerial coil inductance to agree with the oscillator tuning, we'll have to do the next best thing and change the oscillator tuning to agree with the aerial coil inductance. This means that stations from the middle to the low frequency end of the band will be shifted to slightly different places on the tuning scale, but this doesn't matter if we get increased sensitivity as a result."

"What about the trimming capacitors? Will we have to adjust these?"

"Probably not," replied Smithy. "As you know, part of the general alignment procedure for a set of this nature is to trim, by adjusting the trimming capacitance, at the high frequency end of the band. After that we pad, by adjusting the inductance of the oscillator coil and where possible that of the aerial coil at the low frequency end of the band." (Fig. 6.)

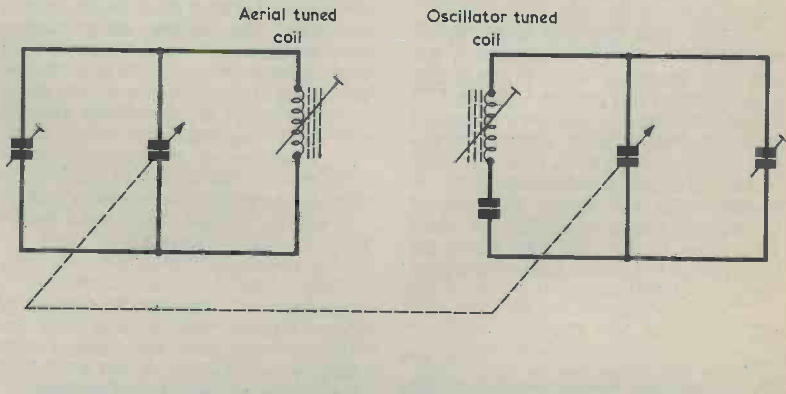


Fig. 6. In a single band superhet r.f. alignment normally consists of adjusting the trimmers at the high frequency end of the band and adjusting coil inductance (padding) at the low frequency end

Smithy looked inside the receiver.

"The trimming situation raises no problem," he went on. "There are two trimmers integral with the 2-gang tuning capacitor, and one of these will obviously be the oscillator trimmer and the other the aerial trimmer."

Smithy picked up the receiver and adjusted its tuning control near the high frequency end of the scale. He readily picked up a loud transmission.

"Isn't that Radio One?" asked Dick.

"It is," confirmed Smithy. "Now, Radio One is on 1,214kHz, and it's turning up just above the '12' marking on this scale. This would indicate that the oscillator trimmer is set fairly accurately. Let's tune up a little higher."

He adjusted the receiver for a higher frequency and was able to tune in a weak signal near the high frequency end of the scale. He picked up a small screwdriver.

"What, asked Dick, "are you going to do now?"

"Adjust the aerial trimmer."

"But how do you know which one is the aerial trimmer?"

"I don't," replied Smithy. "But I'll soon find out after I've checked what each one does."

Carefully, Smithy adjusted one of the trimmers very slightly. The signal disappeared, then reappeared as Smithy brought the trimmer back to its original setting.

"Adjusting that trimmer," announced Smithy, "gave the same effect as tuning the whole receiver. So that will be the oscillator trimmer, and the other one will be the aerial trimmer."

He applied his screwdriver to the remaining trimmer, and was able to increase the strength of the received signal by a very small amount.

"Not much improvement there," remarked Dick.

"Indeed not," returned Smithy. "Anyway, now that we've checked that the trimming at the high frequency end of the band is all right, we can turn our attention to the low frequency end."

Smithy retuned the receiver to the weak signal at the low frequency end of the scale.

"What come's next?" asked Dick.

"I'm going to readjust the oscillator core so that this signal comes in at maximum strength."

"But," protested Dick, "if you adjust the oscillator core you'll tune the set off the signal."

"No, I won't," replied Smithy, "because whilst I'm adjusting the oscillator core I shall also continually rock the receiver tuning back and forth through the signal. As the tuning scale position of the signal changes I'll be able to keep up with it."

Dick looked at the four screening cans on the printed circuit board.

"The oscillator coil," he remarked, "is certain to be in one of these cans. Do you know which one it is?"

"I'll have to make a guess at it," replied Smithy. "The oscillator coil can is bound to be near the tuning capacitor and is most likely to be that closest to it. There's one can here which meets that description, so I'll try that first."

Smithy picked up an insulated trimming tool and carefully adjusted the core in the can he had selected. He found that he could tune the signal in and out by adjustment of the core in much the same way as with the oscillator trimmer.

"This is the one," he grinned. "If it had been an i.f. transformer the signal would just have gone down a little in strength without the detuning effect. Right, now I'll finish the job."

Smithy rocked the receiver tuning control across the signal and slowly adjusted the oscillator core setting. He found that as he screwed the core in the signal increased in strength. He very soon reached a setting where the received signal was at its strongest.

"There we are," he said, pleased. "That oscillator core only needed three-quarters of a turn or so. Let's check the trimming again."

The Serviceman retuned to the high frequency end of the band, to find that the aerial trimming had not been noticeably affected by the oscillator core adjustment. He then tuned over the whole range of the receiver. It was now patently more sensitive over the middle and lower frequencies.

FINAL STEPS

Dick listened with an expression of unmitigated joy.

"That's really something," he remarked, happily. "That oscillator adjustment has improved the set no end."

He picked up the receiver, switched it off and started to refit the back.

"It *is* better, isn't it?" replied Smithy, pleased. "I think I should mention that the little bit of alignment I did there should only be attempted with sets having simple trimming and padding arrangements. If the set has a long wave band it's best to leave the trimming and padding alone if the service sheet isn't available. That's because adjustments on medium waves can mess up adjustments on long waves if the alignment isn't carried out as laid down by the maker of the set."

He looked down at his watch.

"Ah good," he remarked, "It's right on packing-up time. Now I must go home and get ready for my evening at the club. I'll be thinking of you while you're working at your aunt's."

"You needn't," returned Dick, grinning. "It looks as though I'll have my evening free after all."

"Free? But you've been moaning no end about this job you had to do for her."

"Not now I'm not."

"Why's that?"

"Because," replied Dick, as he slipped the little radio into his pocket and made hastily for the door, "you've just done it for me!"

■

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(Continued on page 637)

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(Continued from page 635)

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(Continued on page 638)

SMALL ADVERTISEMENTS

(Continued from page 637)

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(Continued on page 639)

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(Continued from page 638)

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COMMON MUSICAL TERMS II

The Table gives generally accepted definitions of common musical terms, and completes the list started in Data Sheet No. 97.

Meno	less
Mezzo-forte (mf)	half loud
Mezzo-piano (mp)	half soft
Minuet	graceful slow dance
Moderato	in moderate time
Molto	much, extremely
Molto fortissimo (fff)	same as fortississimo
Molto pianissimo (ppp)	same as pianississimo
Mosso	moved
Motet	sacred cantata
Moto	motion
Non	not
Obbligato	musical accompaniment of independent importance
Pastorale	idyllic opera or cantata
Pianissimo (pp)	very soft
Pianississimo (ppp)	as soft as possible
Piano (p)	soft
Piu	more
Pizzicato	strings plucked
Plain-song	recitative choral music
Poco	little, small
Polka	Bohemian dance
Polonaise	Polish dance
Prelude	introductory movement, prefatory piece
Prestissimo	as quick as possible
Presto	quick, quicker than allegro
Prima	first
Prima-donna	leading female singer
Rallentando	with decreasing speed
Reprise	repeat of a passage
Requiem	Mass for the dead
Ritardando (rit.)	slower
Ritenuto (riten.)	held back
Rondeau	form of poem
Rondo	movement, musical setting for a rondeau
Rubato	in irregular rhythm
Saraband	slow Spanish dance
Scherzo	lively, playful passage
Scordato	out of tune
Scordatura	stringed instruments intentionally detuned
Secco	plain, unaccompanied
Sforzando (sfz)	sudden emphasis on chord or note
Sostenuto	sustained
Spirito	spirit, energy
Staccato	abrupt, disconnected
Stringendo	accelerating the tempo
Tarantella	Neapolitan dance
Tempo	time, rhythm
Tremolo	continual variation of amplitude
Troppo	too much
Tutti	all
Vibrato	continual variation of pitch
Vivace	lively, vivacious
Vivacissimo	very lively