RADIO & ELECTRONICS CONSTRUCTOR

MARCH 1976

35p

A VERY SIMPLE AND INEXPENSIVE DESIGN

LOW COST WOBBULATOR

STEREO I-C AMPLIFIER

ALSO FEATURED

CAPACITOR COMBINATION LOCK

160-80 METRE BAND RECEIVER


HOME
UNIT
INSURANCE
9 policies in ONE
1 Household contents and personal possessions up to £600
2 All Risks cover on personal belongings up to £60.
3 Personal accident insurance (road, rail and sea risks) – £3 per week
4 Loss of cash up to £20.
5 Household removal cover up to £600
6 All Risks cover on sports equipment up to £30.
7 Personal liability cover for the family up to £20,000.
8 Cover on Radio, Television etc., for damage in the home up to £60.
9 Holiday deposits cover up to £20.

RADIO & ELECTRONICS CONSTRUCTOR

MARCH 1976
Volume 29 No. 8

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Incorporating The Radio Amateur

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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.

Correspondence should be addressed to the Editor, Advertising Manager, Subscription Manager or the Publishers as appropriate.

Opinions expressed by contributors are not necessarily those of the Editor or proprietors.

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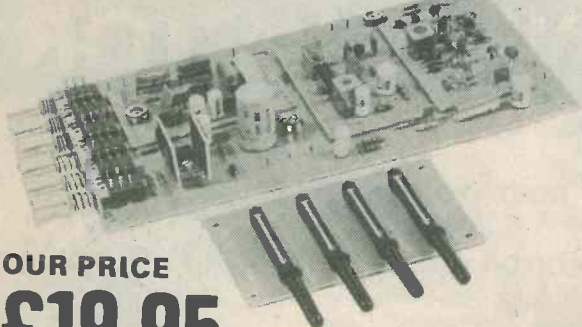
The *Radio & Electronics Constructor* is printed by Swale Press Ltd.

APRIL ISSUE WILL BE PUBLISHED ON 1st APRIL

BI-PAK High quality modules

NEW PUSH-BUTTON
STEREO FM TUNER
Fitted with Phase Lock-loop Decoder



☆ FET Input Stage
☆ VARI-CAP diode tuning
☆ Switched AFC
☆ Multi turn pre-sets
☆ LED Stereo Indicator

Typical Specification:
Sensitivity 3μ volts
Stereo separation 30db
Supply required 20-30v at 90 Ma max.

OUR PRICE
£19.95

The 450 Tuner provides instant program selection at the touch of a button ensuring accurate tuning of 4 pre-selected stations, any of which may be altered as often as you choose, by simply changing the settings of the pre-set controls.

Used with your existing audio equipment or with the BI-KITS **STEREO 30** or the **MK60** Kit etc. Alternatively the **PS12** can be used if no suitable supply is available, together with the Transformer **T461**.

The S450 is supplied fully built, tested and aligned. The unit is easily installed using the simple instructions supplied.

STEREO PRE-AMPLIFIER PA 100

A top quality stereo pre-amplifier and tone control unit. The six push-button selector switch provides a choice of inputs together with two really effective filters for high and low frequencies, plus tape output.

Frequency response + £dB 20Hz-20KHz
Sensitivity of inputs:
1. *Tape input 100mV into 100K ohms*
2. *Radio Tuner 100mV into 100K ohms*
3. *Magnetic P.U. 3mV into 50K ohms*

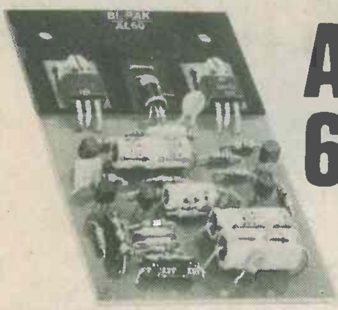
P.U. Input equalises to R1AA curve within 1dB from 20Hz to 20KHz. Supply – 20 – 35V at 20mA.
Dimensions:
299mm x 89mm x 35mm

£13.50
P.&P. 45p

MK60 AUDIO KIT: Comprising: 2 x AL60. 1 x SPM80. 1 x PA100. 1 front panel and knobs. 1 Kit of parts to include on/off switch, neon indicator, stereo headphone sockets plus instruction booklet. **COMPLETE PRICE £27.55 plus 62p postage.**

TEAK 60 AUDIO KIT: Comprising: Teak veneered cabinet size 16¾" x 11½" x 3¾", other parts include aluminium chassis, heatsink and front panel bracket plus back panel and appropriate sockets etc. **KIT PRICE £9.20 plus 62p postage.**

AL 60



VAT ADD 25%

25 Watts (RMS)

● Max Heat Sink temp 90C. ● Frequency response 20Hz to 100kHz ● Distortion better than 0.1 at 1kHz ● Supply voltage 15-50v. ● Thermal Feedback ● Latest Design Improvements ● Load – 3, 4, 5 or 16ohms. ● 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.

£3.95

STEREO 30 COMPLETE AUDIO CHASSIS

7+7 WATTS R.M.S.

The Stereo 30 comprises a complete stereo pre-amplifier, power amplifiers and power supply. This, with only the addition of a transformer or overwind will produce a high quality audio unit suitable for use with a wide range of inputs i.e. high quality ceramic pick-up, stereo tuner, stereo tape deck, etc. Simple to install, capable of producing really first class results, this unit is supplied with full instructions, black front panel, knobs, mains switch, fuse and fuse holder and universal mounting brackets enabling it to be installed in a record plinth, cabinets of your own construction or the cabinet available. Ideal for the beginner or the advanced constructor who requires Hi-Fi performance with a minimum of installation difficulty (can be installed in 30 minutes)

TRANSFORMER £2.45 plus 62p p&p
TEAK CASE £3.65 plus 62p p&p

£15.75
p. & p. 45p

Stabilised Power Supply Type SPM80

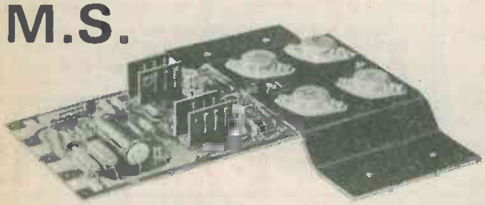
SPM80 is especially designed to power 2 of the AL60 Amplifiers, up to 15 watts (r.m.s.) per channel simultaneously. With the addition of the Mains Transformer **BMT80**, the unit will provide outputs of up to 1.5A at 35V. Size: 63mm. 105mm. 30mm. Incorporating short circuit protection.

Input Voltage: 33-40 V.A.C.
Output Voltage: 33V D.C. Nominal
Output Current: 10mA-1.5 amps
Overload Current: 1.7 amps approx.
Dimensions:
105mm x 63mm x 30mm
Transformer BMT80:
£2.60 + 62p postage

£3.00

for stereo, mono and other audio equipment

IT'S NEW!
IT'S POWERFUL
IT'S THE AL250
125 watts R.M.S.



POWER AMPLIFIER

Specially designed for use in: Disco Units, P.A. Systems, high power Hi-Fi, Sound reinforcement systems.

The module has a sensitivity of 450mV and a frequency response extending from 25Hz to 20KHz whilst distortion levels are typically below ·1%. The use of 4, 115w transistors in the output stage makes the unit extremely rugged while damage resulting from incorrect or short-circuit loads is prevented by a 4 transistor protection circuit.

SPECIFICATION:

Output Power 125watt R.M.S. Continuous.
Operating voltage 50-80.
Loads 4-16ohms.
Frequency response 25Hz-20kHz *Measured at 100 watts.*
Sensitivity for 100watts output at 1kHz. 450mV.
Input impedance 33kohms.

Total harmonic distortion 50 watts into 4ohms, 0.1%. 50 watts into 8ohms, 0.06%.
S/N radio better than 80dBs.
Damping factor, 8ohms, 65.
Semiconductor complement, 13 transistors, 5 diodes.
Overall size: Heatsink width 190mm, Length 205mm, Height 40mm.

ONLY £15.95 + 8% VAT

MPA 30

Enjoy the quality of a magnetic cartridge with your existing ceramic equipment using the new Bi-Pak M.P.A. 30 which is a high quality pre-amplifier enabling magnetic cartridges to be used where facilities exist for the use of ceramic cartridges only. Used in conjunction are 4 low noise, high gain silicon transistors. It is provided with a standard DIN input socket for ease of connection. Supplied with full, easy-to-follow instructions.

£2.65

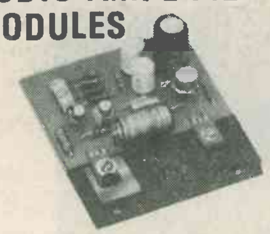
VAT ADD 25%

POSTAGE & PACKING

Postage and Packing add 25p unless otherwise shown. Add extra airmail minimum £1.00

AL10-20-30

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 home.
Harmonic Distortion Po=3 watts f 1KHz 0.25%
Load Impedance 8-16ohm.
Frequency response ± 3dB Po=2 watts 50Hz–25KHz
Sensitivity for Rated O/P – Vs=25V. RL=8ohm f=1KHz 75mV. RMS.
Size: 75mm x 63mm x 25mm

AL10 3w R.M.S. **£2.30** *AL20 5w R.M.S.* **£2.65** *AL30 10w R.M.S.* **£2.95**

NEW

PA12

£6.50

NEW PA12 Stereo Pre-Amplifier completely redesigned for use with AL10/20/30 Amplifier Modules. Features include on/off volume. Balance. Bass. Treble controls. Complete with tape output.
Frequency Response: 20Hz – 20KHz (–3db)
Bass and Treble range ± 12dB
Input Impedence 1 meg ohm
Input Sensitivity 300mV
Supply requirements 24V.5mA
Size 152mm x 84mm x 33mm

PS12

Power supply for **AL10/20/30, PA12, S450** etc Input voltage 15 – 20v A.C. Output voltage 22 – 30v D.C. Output Current 800 mA Max. Size 60mm x 43mm x 26mm.
Transformer T538 £2.30

£1.20

BI-PAK

PO BOX 6, WARE, HERTS.

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 suficient payment for registration (1st class letter post) or compensation fee (parcel post) included.

VALVE BASES

Printed circuit B9A – B7G 2p
Chassis B7 — 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**

VHF Radio Tuner Head Takes ECC 85 **80p**

TO3 or TO66 Mica Washer .. **2p**
18 volt 4 amp charger, bridge rectifier **50p**
GC10/4B **£3.00**

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

BOXES — Grey polystyrene 61 x 112 x 31mm, top secured by 4 self tapping screws **32½p**
Clear perspex sliding lid, 46 x 39 x 24mm **10p**
ABS, ribbed inside 5mm centres for P.C.B., brass corner inserts, screw down lid, 50 x 100 x 25mm orange **48p**; 80 x 150 x 50mm black **70p**; 109 x 185 x 60mm black **£1.04**

ALUMINIUM

3" x 2" x 1"	39p	4" x 2½" x 2"	45p	8" x 6" x 3"	99p
2¾" x 5¼" x 1½"	45p	4" x 5¼" x 1½"	54p	10" x 4½" x 3"	£1.02
4" x 4" x 1½"	45p	6" x 4" x 2"	65p	12" x 5" 3 3"	£1.20
4" x 2¾" x 1½"	45p	7" x 5" x 2½"	79p	10" x 7" x 3"	£1.22
				12" x 8" x 3"	£1.50

SWITCHES

Pole	Way	Type	
4	2	Sub. Min. Slide	18p
6	2	Slide	20p
4	2	Lever Slide	15p
2	2	Slide	12p
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	24p

Wafer Rotary, all types 30p
S.P.S.T. 10 amp 240v. white rocker switch with neon. 1" square flush panel fitting 30p

AUDIO LEADS

5 pin din plug 180° both ends ½ Mtr., 80p
3 pin din to open end, 1½yd twin screened 35p
Phono to Phono plug, 6ft. 35p

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** + **75p** post and packing
7lb for **£1.75** + **£1** post and packing

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

3" Tape Spools **8p**
1" Terry Clips **4p**
12 Volt Solenoid **30p**

KNOBS

SILVER METAL PUSH ON WITH POINTER, OR WHITE PLASTIC, GRUB SCREW WITH POINTER AND GOLD CENTRE **8p** EACH.
1" DIAM. WITH 1½" SKIRT SPUN ALUMINIUM GRUB SCREW FIXING, ¼" 30p EACH.

ZM1162A INDICATOR TUBE

0-9 Inline End View. Rectangular Envelope 170V 2·5M/A £1.50

RESETTABLE COUNTER

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

Ferric Chloride, Anhydrous mil. spec. 1lb. bag **50p**

RESISTORS

⅛–¼–½ watt .. 1p
1 watt 2p
Up to 5 watt wire 10p
10 watt wire wound 12p
15 watt 14p

Semiconductor Data Book 263 pages. Covers 2N21 through to 2N5558 plus some 3N's. Type / connector / perimeter details. **£1.50** No VAT

POTS

Log or Lin carbon 14p
Switched 25p
Dual Pots 38p
Dual & switch 50p
Lin wirewound 25p
Slider Pot 25p
Dual Slider 35p
1.5m Edgetype 8p

THERMISTORS

VA1008, VA1034, VA1039, VA1040, VA1055, VA1066, VA1082, VA1100 — 10p
VA1077, 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**
Mains or 12v d.p.c.o. heavy duty octal **60p**

Boxed GEC KT88 valve **£2**

JAP 4 gang min. sealed tuning condensers New **25p**
Ex-eqpt. 2 or 4 gang **15p**

ELECTROLYTICS MFD/VOLT. Many others in stock

MFD	Up to 10V	25V	50V	70–75V	100V	200–250V	300–350V	450–500V
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	25p	—
100	5p	6p	10p	12p	19p	20p	—	—
250	9p	10p	11p	17p	28p	—	85p	£1
500	10p	11p	17p	24p	45p	—	—	—
1000	13p	17p	40p	75p	—	£1.50	—	—
2000	23p	37p	45p	—	—	—	—	—

As total values are too numerous to list, use this price guide to work out your actual requirements
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**
50/50–385 .. .. .. **30p**
12,000/12, 32–32–50/300, 700/200 100–100–100–150–150/320 .. .. **50p each**
20–20–20/350 .. .. **40p each**

RS 100–0–100 micro amp null indicator Approx. 2" x ¾" x ¾" **£1.50**

INDICATORS

Bulgin D676 red, takes M.E.S. bulb 20p
12 volt or Mains neon, red pushfit 18p
R.S. Scale Print, pressure transfer sheet .10p

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, 5 x 50pF, 2 x 220pF, 50PF CERAMIC.

CONNECTOR STRIP

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

1¼ glass fuses 250 m/a or 3 amp (box of 12) 18p
Bulgin, 5mm Jack plug and switched socket (pair) 30p

1" or 1½" or 2" or ¾" CAN CLIPS 2p

MAINS DROPPERS

36+79 ohm 15p
66+66+158 ohm, 66+66+137 ohm
17+14+6 ohm, 266+14+193 ohm 20p
50+40+1k5 ohm
285+575+148+35 ohm
25+35+97+59+30 ohm } 30p

5¼" x 2¾" Speaker, ex-equipment 3 ohm 30p
2 Amp Suppression Choke 5p
PAXOLINE 3 x 2½ x 1/16" 2p
4⅝ x ½ x ⅛", ... 2 for 1p
PCV or metal clip on MES bulb Holder ..5p
VALVE RETAINER CLIP, adjustable 2p

OUTPUT TRANSFORMERS

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

12 volt 250M/A or 6 volt ½A Transformers **£1**
Whiteley Stentorian 3 ohm constant impedance volume control way below trade at **80p**
Drive Cord **1p** per yd.

THE RADIO SHACK

161 ST. JOHNS HILL, BATTERSEA, LONDON S.W.11
Open 10 a.m. till 7 p.m. Monday to Saturday – Also Sunday afternoons
Terms: Payment with order Telephone: 01-223 5016

SEMICONDUCTORS

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

AC107	12p
AC128	5p
AC176	9p
ACY28	18p
AD149	40p
AD161/2 matched pr.	69p
AF116	12p
AF124/6/7	20p
AF139/178/180/181	30p
AF239	20p
ASY27/73	25p
BC107A or B	9p
BC107/8/9	6p
BC108A/B/109B/C	10p
BC147/8/9	6p
BC147A/B	8p
BC148A/B/C, 9B/C/S	8p
BC157/8/9	6p
BC158A/B	11p
BC159B/C, 157A	11p
BC178/B/179B	10p
BC184C	9p
BC186/7	13p
BC213L/214B	9p
BC261B	10p
BC327/8	10p
BC337/8	11p
BC547/558A	7p
BC548/557	9p
BC548/A/557/559	9p
BCX32/36	12p
BCY40	60p
BCY70/1/2	9p
BD112/3/5/6	40p
BD131/2/3/5/7/9	30p
BD142	45p
BD201/2/3/4	£1.00
BD232/4/5	46p
BDX77	£1.40
BF115	10p
BF167/173	10p
BF178/9	20p
BF180/1/2/3	15p
BF184/5	15p
BF194/5/6/7	4p
BF194A/195C/200	10p
BF258/262/263	20p
BF336	25p
BFS28 Dual Mosfet	92p
BFW10/11 F.E.T.	26p
BFW30	£1.35
BFW57/58	20p
BFX12	20p
BFX29/30/84/88	16p
BFX89	35p
BFY50/1/2	12p
BFY90	50p
BR101 (Programmable Unj Junction)	30p
BRY39 (Programmable Unj Junction)	31p
BRY56 (Programmable Unj Junction)	34p
BSV64	40p
BSV79/80 F.E.T.s	£1
BSV81 Mosfet	90p
BSX20/21	13p
BSY40	28p
BSY95A	9p
BU105-01	93p
CV7042 (OC41 OC44, ASY63)	7p
GET111	40p
OC35	32½p
ON222	30p
TIP30	43p
TIP3055	50p
TIS88A FET	23p
ZTX300	5p
ZTX341	15p
2N393/MA393	30p
2N706	6p
2N929	14p
2N987	35p
2N1507/2219	14p
2N2401/2412/2483	25p
2N2904/5/6/7	10p
2N2907A	13p
2N3053	13p
2N3054/3055 (or equiv)	35p
2N3133	18p
2N3704	9p
2N4037	35p
2N5036	60p
2SA141/2/360	31p
2SB135/6/457	20p
40250	60p

OTHER DIODES

1N916	6p
1N4148	1.5p
BA145/148	11p
Centercel	10p
BZY61	10p
BB103/110 Varicap	18p
BB113 Triple Varicap	37p
BA182	18p
OA5/7/10	10p
BZY88 Up to 33 volt	6p
BZX61 11 volt	16p
BR100 Diac.	19p

INTEGRATED CIRCUITS

TAA700	£2.95
723 reg.	45p
741 8 pin d.i.l. op. Amp	18p
TAD100 AMRF	£1.00
CA3001 R. F. Amp	50p
TAA300 1wt Amp	£1.25
NE555v Timer	40p
TAA550 Y or G	31p
TAA263 Amp	62p
7400	8p
7402/4/10/20/30	10p
7414	45p
7438/74/86	25p
7483	80p
LM300, 2-20 volt	50p
74154	67p

BRIDGE RECTIFIERS

Amp	Volt		
½	1,600	BYX10	30p
1	140	OSH01-200	20p
1.4	42	BY164	28p
2	30	LT120 type	30p
0.6	110	EC433	15p
5	400	Texas	75p

RECTIFIERS

	Amp	Volt	
IN4004	1	400	3p
IN4005	1	600	4p
IN4006	1	800	4p
IN4007	1	1,000	4p
BY103	1	1,500	15p
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	£1.00
BYX46-400*	15	400	£1.50
BYX46-500*	15	500	£1.75
BYX46-600*	15	600	£2.00
BYX20-200	25	200	60p
BYX52-300	40	300	£1.75
BYX52-1200	40	1,200	£2.50

*Avalanche type

TRIACS

Amp	Volt		
6	800	Plastic RCA	90p
25	900	BTX94-900	£4.00
25	1200	BTX94-1200	£6.00

12-0-12 50M/A Min. Txfmr. 90p

RS 2mm Terminals Blue & Black .... 5 for 40p

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

DLI. Pal Delayline 50p

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, 4¼" dia. 10p

OPTO ELECTRONICS

BPX40	65p
BPX42	£1.00
BPY10 (VOLTIAC)	£1.00
BPY68, BPY69, BPY77 Diodes	£1.00

Photo transistor

BPX29	£1.00
OCP71	30p

BIG L.E.D. 0.2" 2v 50m/A max.

RED	13p
ORANGE, GREEN, YELLOW	15p
CLIP	2p

PHOTO SILICON CONTROLLED SWITCH BPX66 PNPN 10 amp £1.00

.3" red 7 segment L.E.D. 14 D.I.L. 0-9 + D.P. display 1.9v, 10m/a segment, common anode 65p

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

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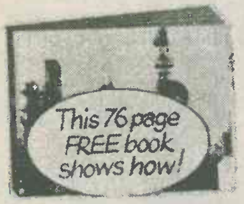

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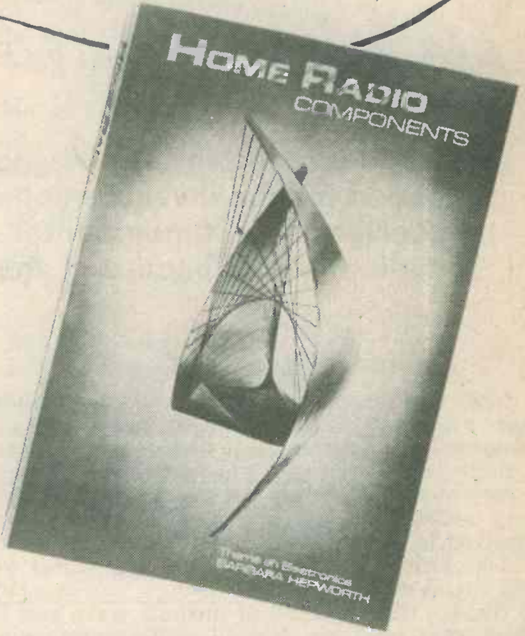

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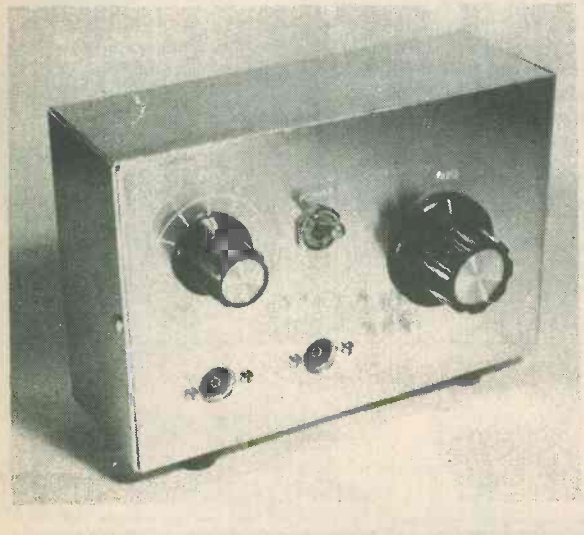
LOW COST WOBBULATOR

by P. R. Arthur

A very simple and inexpensive design which is primarily intended for the investigation of the r.f. and i.f. passbands of a.m. receivers. Its fundamental output may be tuned in on the medium wave band and the second harmonic on a short wave band.

Most electronics enthusiasts would probably consider a wobbulator to be something of a luxury and, admittedly, a comprehensive instrument is rather expensive. However, a basic wobbulator may be built for a very modest monetary outlay, and can prove to be very useful for anyone who has an oscilloscope and is involved in the building and alignment of receivers.

This article describes a simple wobbulator which will enable any oscilloscope having a timebase output to display the passband of medium wave and some short wave receivers. Not all oscilloscopes have the requisite timebase output facility but the wobbulator can still be employed with such oscilloscopes if an external timebase generator is employed. Details of a suitable generator which, like the wobbulator, is an inexpensive design, will be given in next month's issue.



Front view of the completed wobbulator unit

WOBBULATOR FUNCTION

The function of a wobbulator is to trace the passband of a receiver on an oscilloscope screen. This can be extremely helpful when testing and aligning complex i.f. filters, and can even be useful when aligning an ordinary medium wave broadcast superhet receiver. Here the i.f. transformers would normally be set up to the same frequency, resulting in a comparatively narrow and peaked response.

Improved audio quality can be achieved by slightly detuning one or more of the i.f. transformer coils, giving a slightly broader response towards the centre of the passband but without significantly increasing the overall bandwidth. This process can be very quickly and accurately carried out with the aid of an oscilloscope and wobbulator, but without these it becomes a matter of guesswork.

Fig. 1 illustrates the way in which a wobbulator functions. The timebase output of the oscilloscope is used to control a voltage controlled oscillator (v.c.o.) operating about the centre of the receiver's reception frequency. As the timebase signal sweeps the spot across the face of the oscilloscope tube, it also sweeps the v.c.o. frequency across the receiver's passband. The output of the v.c.o. is loosely coupled to the input of the receiver. The Y input of the oscilloscope is connected to the output of the receiver detector, and so the vertical deflection of the spot at any instant is proportional to the gain of the receiver at the particular frequency of the v.c.o. to which it corresponds.

As the spot is swept across the face of the tube it thus traces out the i.f. passband of the receiver, always providing of course that the basic v.c.o. frequency and level of sweep are correct.

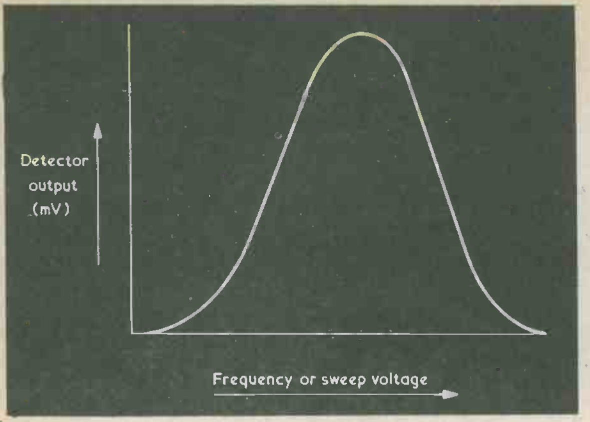


Fig. 1. Illustrating how a wobbulator and oscilloscope may display the response curve of a tuned amplifier

COMPONENTS

Resistors
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R2 100kΩ ¼ watt 5%
VR1 470kΩ potentiometer, linear

Capacitors
C1 0.1μF plastic foil, type C280 (Mullard)
C2 470pF ceramic or silvered mica
C3 680pF polystyrene or silvered mica
C4 0.47μF plastic foil, type C280 (Mullard)
VC1 100pF variable (see text)

Inductor
L1, 2 Miniature Transistor Tuning Coil, Yellow, Range 2T (Denco)

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THE CIRCUIT

The circuit diagram of the wobbulator appears in Fig. 2. As we have already seen, a wobbulator basically consists of a radio frequency v.c.o.

A simple feedback oscillator using TR1 as a common emitter amplifier forms the basis of the unit. L2 is the collector load for TR1 and L1 provides positive feedback to the transistor base via C2, which is a d.c. blocking capacitor. VC1 permits some variation in the operating frequency of the unit, and R1 is the base bias resistor.

The timebase input is coupled to VR1 by way of the input socket and C4. A controlled amount of the input is then fed by way of R2 to a pair of parallel connected variable capacitance diodes. As the timebase signal

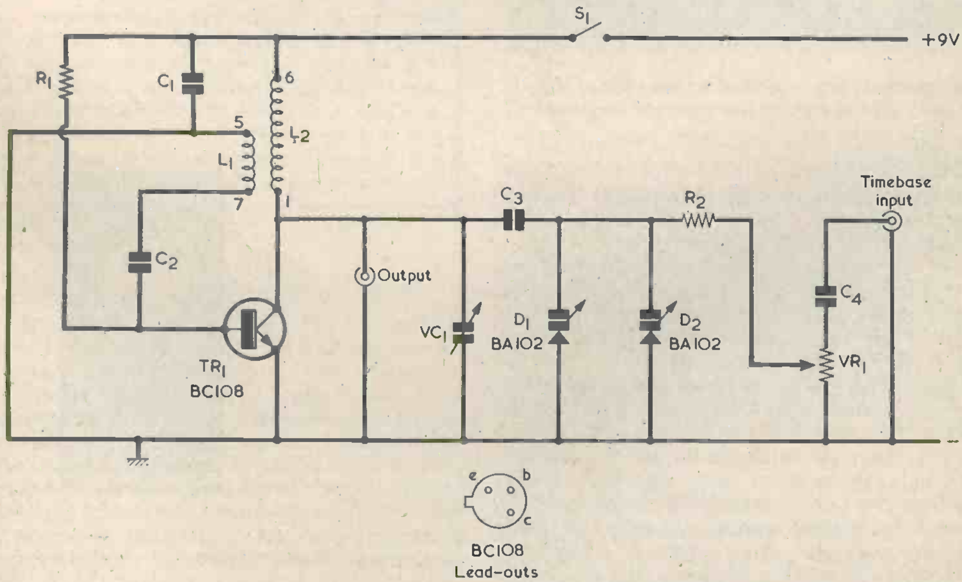


Fig. 2. The circuit of the low cost wobbulator. Despite its simplicity it offers a very useful frequency sweep

voltage increases, the reverse bias across the diodes rises and their depletion layer becomes larger. The depletion layer of a diode forms the dielectric for the capacitance it possesses so that, as the timebase signal voltage increases the diode capacitance reduces.

The two diodes are coupled via C3 to VC1 and L2, and their reducing capacit. nce causes a corresponding increase in the frequency of the oscillator. Two diodes are needed to provide an adequate capacitance swing.

VR1 controls the sweep level, and S1 is the on-off switch.

Ideally, there should be a linear relationship between frequency change and sweep voltage but this is not realised with the present simple arrangement, resulting in some distortion of the trace in this respect. Another factor when comparing the unit with more complex instruments is that it is not equipped with a calibrator to enable the graticule of the oscilloscope to be directly related to frequency. However, for a very small initial outlay the unit described here provides a reasonably accurate picture of a receiver's passband, and it has proved to be a very useful alignment aid in the author's workshop.

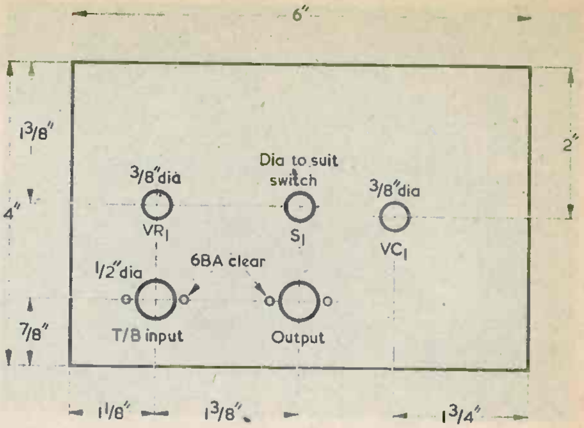
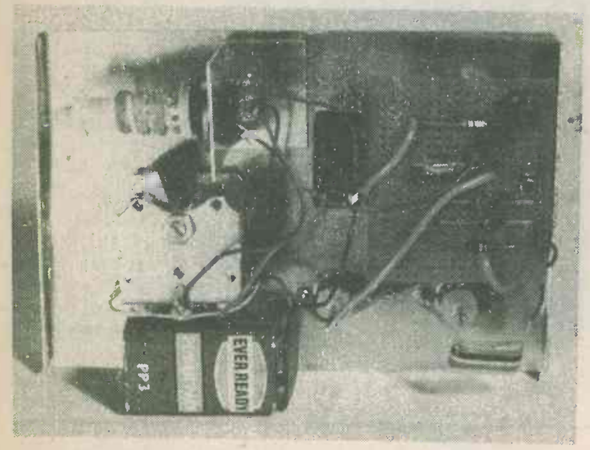


Fig. 3. Drilling details for the front panel



The components are mounted on the rear of the front panel. VR1 is behind the component panel

THE CASE

The prototype is housed in an aluminium box type AB13, which measures 6 by 4 by 2 in. The lid is employed as the front panel and, in the author's unit, was modified by having the flanges on the two long sides cut off. This modification is not really necessary, however, and other units may employ the lid in its original form. Four small cabinet feet are secured to the bottom 6 by 2in. side of the box.

Drilling details for the front panel are given in Fig. 3. A single hole is shown for VC1, but if this is of the Jackson '00' or '01' type it will also require three 4BA clear holes for short mounting bolts which pass into 4BA tapped holes in its front plate. Spacing washers are required on the bolts between the panel and the capacitor, and the bolt ends must not pass the inside surface of the capacitor front plate or they may damage its vanes. The value required in VC1 should be around 100pF, and the author employed the 176pF section of a Jackson type '00' 2-gang 208 + 176pF capacitor which was to hand at the time of construction. If a variable capacitor is to be obtained specifically for the project, a Jackson 100pF type C804 component would be a good choice, and this requires only a single bush-mounting hole.

The coil fits into a B9A valveholder, and the latter is mounted on the bracket shown in Fig. 4. The bracket is affixed to the rear of the front panel in the position shown in the accompanying photographs. The author secured the bracket in place with an epoxy adhesive but it can alternatively be mounted by means of two 6BA bolts and nuts, for which the requisite holes will need to be drilled.

The coil is fitted with an adjustable dust core, but this is not required and is removed. The coil has a second coupling winding, not used in the present circuit, which connects to its pins 8 and 9. This winding is not shown in Fig. 1 and no connections are made to its two pins.

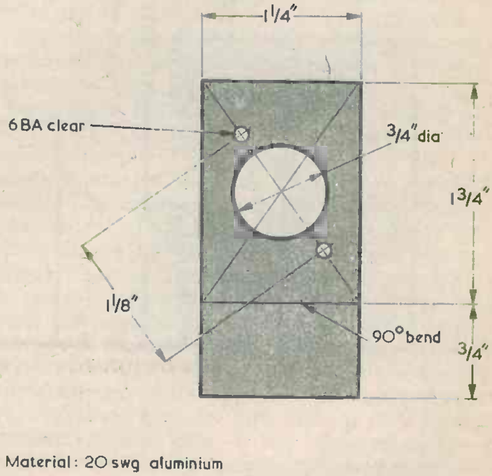


Fig. 4. The coil fits into a B9A valveholder mounted on the bracket shown here

COMPONENT PANEL

All the small components with the exception of C4 are wired up on a small plain perforated s.r.b.p. board having a matrix of 0.1in. This has 22 by 18 holes and the layout and underside wiring are shown in Fig. 5.

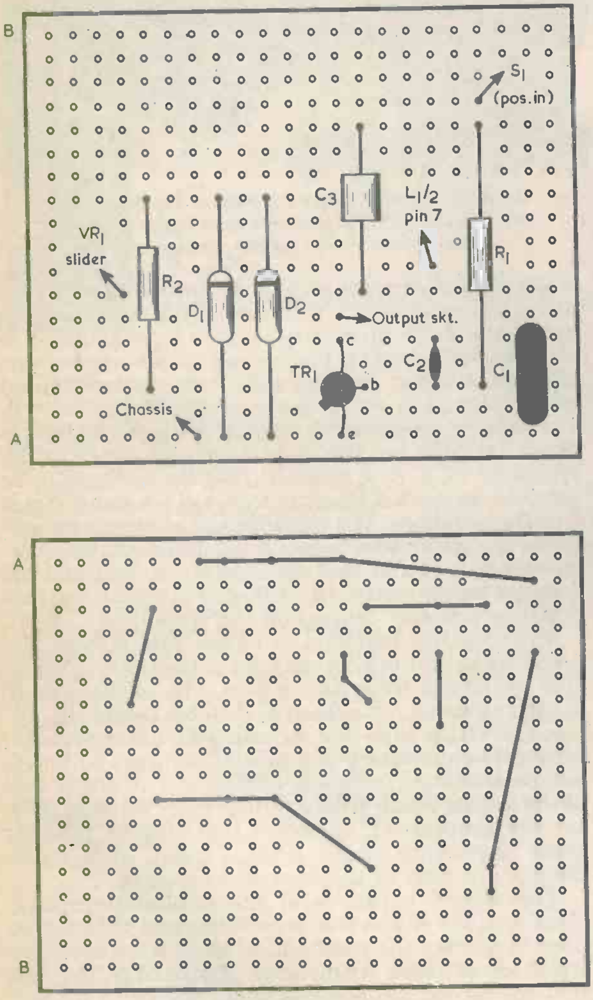
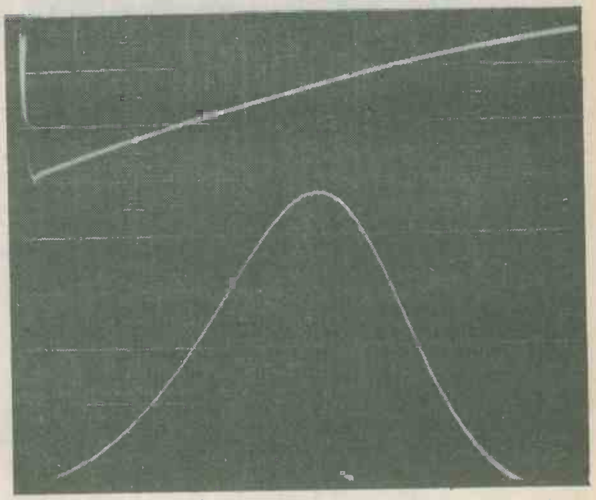


Fig. 5. Layout and wiring of the components on the perforated panel

Short insulated heavy gauge wires are used to connect the board to S1, the output socket and the slider of VR1. The board is positioned behind VR1 with C1 at top right as viewed from the rear of the front panel. As it is quite light, the three thick wires provide it with a perfectly adequate mounting. The board is fitted in place after connections have been made to the track tags of VR1.

Thinner wires pass from the board to pin 7 of the coil holder and to chassis. The chassis connection is given by a solder tag under one of the mounting nuts for the output socket. Also connected to this tag are the negative battery lead and the earthy end of VR1 track. The frame of VC1 is earthed to chassis via its mounting, and a lead travels from its moving vane tag to pin 5 of the coil. The output socket tag connects to the fixed vane tag of VC1 and then carries on to pin 1 of the coil. Pin 6 of the coil is connected to the same tag of S1 as is the thick wire from the board. The positive battery lead connects to the other tag of S1. C4 connects between the input socket and the remaining track tag of VR1.



Oscillogram obtained with a double beam oscilloscope. The lower trace shows an i.f. amplifier response obtained with the aid of the wobbulator. The upper trace is the output sweep of the timebase generator which will be described in next month's issue

The battery fits beneath VC1 and should be positioned so that it is firmly held lengthwise between the front and rear of the case when the panel is screwed into position.

Should it be found when the unit has been completed that TR1 does not oscillate, the effect of transposing the connections to pins 5 and 7 of the coil should be tried. The winding to which these pins connect is an inter-stage coupling winding which is not normally intended for oscillator feedback, and it may be connected to its pins with the alternate phase in some coils. The current consumption from the 9 volt battery will vary with different transistors, and is typically 4.5mA.

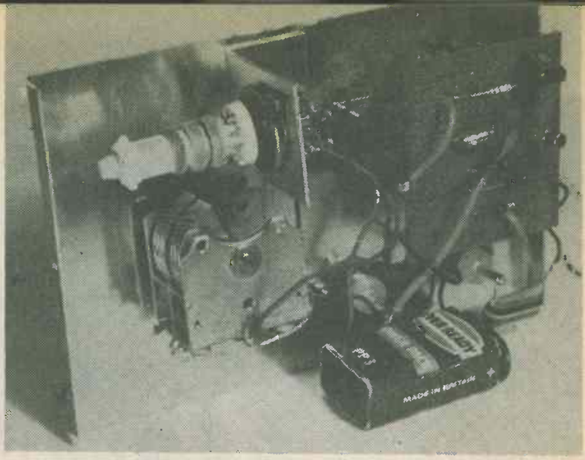
USING THE UNIT

If the oscilloscope has a timebase output which provides a positive-going sweep voltage with an amplitude of 4 volts peak-to-peak or more, this output is coupled to the input of the wobbulator. Should there be no timebase output, the separate timebase generator to be described next month will be needed.

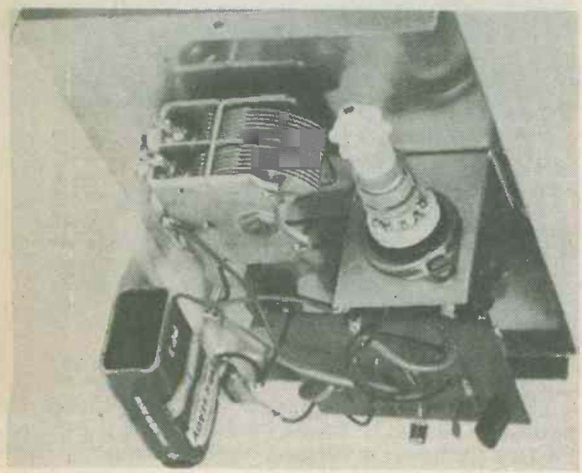
Some oscilloscopes incorporating valves have quite high timebase output voltages, these often being 50 volts peak-to-peak or more. If the wobbulator is employed with such an oscilloscope, VR1 must always be kept turned well back to avoid possible damage to the two variable capacitance diodes. These have a maximum reverse voltage rating of 20 volts. In cases where the wobbulator will always be employed with a particular oscilloscope having a high timebase output voltage a fixed resistor of appropriate value may be inserted in series between C4 and VR1 to ensure that the latter cannot be accidentally set to apply too high a voltage to the diodes.

It is normally quite a simple matter to connect the Y input of the oscilloscope to the receiver detector load, as this is usually the volume control. It is therefore merely necessary to connect the oscilloscope input across the receiver volume control.

A fairly low timebase frequency must be used or the set-up will not function satisfactorily. A frequency of 25 to 100Hz should be satisfactory. There should not be a tight coupling between the wobbulator and the receiver input as this can cause a.g.c. action in the receiver to give a flat top to what should be a rounded trace. The wobbulator output is high, at about 1 volt peak-to-peak. It is also at a high impedance since it connects directly to the oscillator tuned winding. The self-capacitance of a screened cable connected to the output socket is added to the capacitance tuning the winding; however, the self-capacitance of the 1 to 2ft. of coaxial cable which will normally be used will not cause any difficulties here. A very loose coupling to the receiver, given by positioning an unscreened section of the output lead near the receiver aerial input circuit should in many cases be sufficient.



Another view of the parts behind the front panel. The component panel is held in place by the three stout leads which connect to it



Looking at the rear of the front panel from its right hand end

The basic operating frequency of the wobbulator is about 1.4MHz, but this can be reduced somewhat by adjusting VC1. It is essential that the wobbulator be tunable, as it must be set to a part of the band that is free from stations. If a signal from a station is present inside the wobbulator sweep it will beat with the wobbulator output and modulate the trace. VC1 and the receiver tuning control are adjusted to produce a trace which is properly centred on the screen.

VR1 controls the level of sweep, and is normally adjusted so that the curved part of the trace virtually fills the screen from side to side. The oscilloscope Y gain is adjusted for a trace of suitable height. By advancing VR1 a little and adjusting VC1 it is possible to effectively magnify any part of the trace so that it can be examined in detail. Taking VC1 on either side of the setting which gives a central trace will also show up any spurious i.f. responses that may be present; these frequently occur when crystal or ceramic devices are used in the receiver i.f. stages.

The second harmonic of the wobbulator output gives a range of about 2 to 3 MHz, and this can be used to display the passband of short wave receivers which cover these frequencies. Apart from the fact that the second harmonic is being employed the set-up is essentially the same as with a medium wave receiver. ■

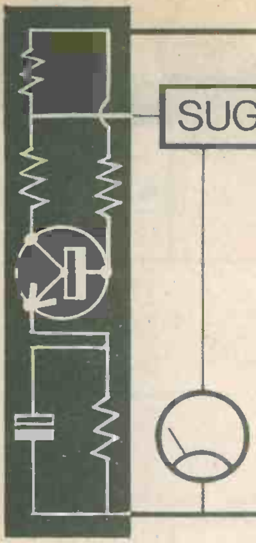
BACK NUMBERS

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 11p 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.



SUGGESTED CIRCUIT 304

Capacitor combination lock

By G. A. French

Combination locks which operate by electronic rather than mechanical processes offer an interesting field for design work. One possible method of making up such locks consists of providing a series of rotary switches which have to be adjusted to a precise combination of settings before the lock will open. Another way of presenting the combination is to make available a number of press-buttons arranged in a random pattern which have to be pushed in a certain order and manner to make the lock open. This is the method employed in the lock to be described in the present article. An attractive feature of the circuit is that it can accommodate any number of disabling buttons which, if pressed, bring the circuit back to the starting condition. The circuit is also sufficiently versatile to incorporate variations in operating routines. As with all locks of this natuie, an energising current is fed to a solenoid which operates a mechanical release latch when the combination has been correctly followed through.

BASIC CIRCUIT

The basic circuit of the combination lock is given in Fig. 1. In this diagram there are a number of press-buttons in addition to a standard on-off switch, all of which are mounted on a panel on the surface of the door or lid which is protected by the lock. The switch is included to ensure that there is no current flow at all from the 9 volt supply when it is opened. If the switch is closed and no buttons are pressed the current drain from the supply consists of a few microamps leakage current in the thyristor, TH1, which is in the non-conductive state.

The on-off switch is S1, and this has to be closed before any attempt can be made at opening the lock. The next operation consists of pushing S2, and this press-button has to be closed for a sufficiently long time to enable the electrolytic capacitor C1 to charge up to a voltage of around 6 volts or more. The time during which S2 must be maintained closed depends upon the value chosen for R1 and can range from around a second with R1 at 10kΩ to more than a hundred seconds with R1 at 1MΩ.

After S2 has been held depressed for the requisite time period the lock may be opened by pressing S3. This allows a pulse of current to flow from the charged capacitor via zener diode D1 and R2 to the gate of the thyristor which, in consequence, becomes conductive and allows an energising current to flow in the coil of the relay. The relay contacts close and the solenoid operates.

Thus, only two press-buttons have to be operated to open the lock (although, as we shall see shortly, further press-buttons can be brought into this opening sequence). First, S2 has to be pressed for a period of time, after which S3 is pressed. There are, however, many hazards for the would-be lock opener who is unaware of the simple sequence required. These are provided by the press-buttons S4 and S5 proceeding to Sn. If any of these buttons should happen to be pressed the electrolytic capacitor will be immediately discharged and any advantage obtained by initially pressing S2 will be completely lost. If more than one button is pressed in addition to S2 during the charging period the capacitor will either remain in the discharged state or will attain a voltage which is too low to fire the thyristor. This second circumstance is given if S3

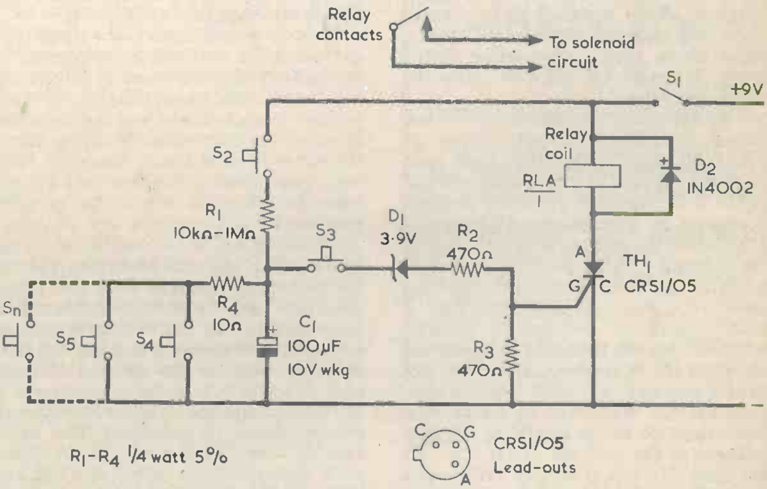


Fig. 1. The basic circuit of the capacitor combination lock

and S2 are both pressed together before the capacitor has charged to the trigger level. What happens then is that a potential divider is set up consisting of R1, the zener diode, R2 and R3. The voltage across the capacitor cannot increase above the level dictated by this potential divider. At the same time the voltage across R3 is too low to allow the thyristor to be triggered and become conductive. The capacitor will also become partly discharged if S2 is opened before it has reached the 6 volt charge level and S3 is then pressed.

As may be seen, the lock cannot be readily opened by anybody who does not know its principle of functioning. Of particular value here is the fact that R1 can be given a value which makes it necessary for S2 to be pressed for what is relatively a considerably long period.

There can be any number of press-buttons in the series from S4 to Sn; all of these being connected in parallel. The greater the number of press-buttons here the lower becomes the chance of the lock combination being broken.

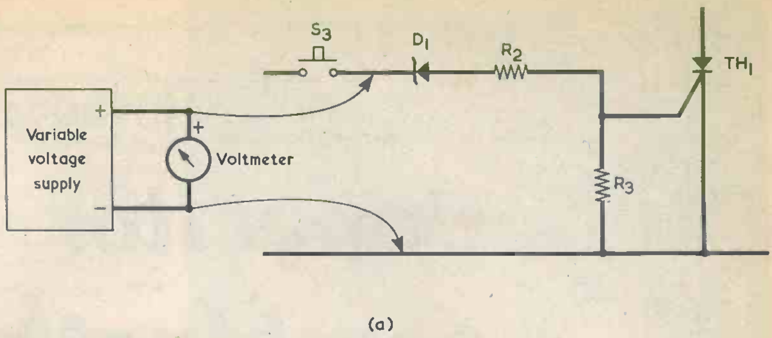
CIRCUIT DETAILS

Turning to more detailed aspects of the circuit, some of the components may next be discussed.

Resistor R4 is included to provide current limiting. If it were omitted and the press-buttons in the S4 to Sn sequence were connected directly across C1 there could be excessive discharge current surges from the capacitor together with sparking at the press-button contacts.

Resistor R3 is included in the gate circuit of TH1 to provide the potential divider effect just mentioned. If this resistor were omitted the thyristor could be fired by lower potentials across C1. Zener diode D1 contributes to the voltage delay in the firing of the thyristor, since the zener voltage appears across it when S3 is pressed and C1 is charged. Any small 3.9 volt zener diode with a dissipation rating from 250mW to 400mW may be employed here.

The thyristor specified for TH1 is listed in different catalogues as CRS1/05 and CRS1/05AF. Both type numbers apply to the same component. The author checked several thyristors in the circuit and these all fired when the voltage across C1 was of the order of 6 volts. There is, however, a slight risk that spread in triggering sensitivity may necessitate that a widely different voltage be present across C1 for the thyristor to be turned on when S3 is pressed, and this fact could upset circuit operaton. Constructors who wish to check this point may do so by applying varying voltages to the cathode of D1 with S3 left open. If a power supply with a continuously variable voltage output is available this may be coupled to the circuit in the manner shown in Fig. 2(a). The power supply voltage is slowly increased from a low value until the thyristor triggers, whereupon the appropriate voltage is indicated by the meter. Alternatively, check voltages may be obtained from a battery and several 1.5 volt cells, as in Fig. 2(b). If the thyristor triggers at the 6 volt or at the 7.5 volt level, and not at the 4.5 volt level, then all is well.



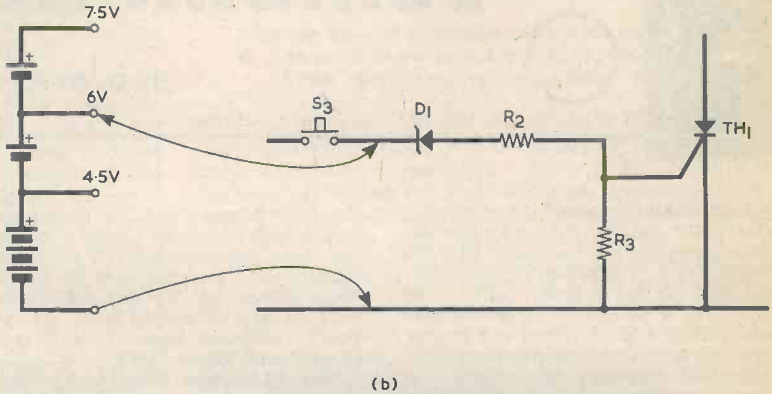


Fig. 2(a). Finding the voltage required at D1 cathode for the thyristor to be triggered
(b). An alternative method of finding the voltage if a variable voltage supply is not available

If it is found that the voltage required at D1 cathode for triggering is excessively high the value of R3 should be increased accordingly. If the voltage is excessively low the value of R3 may be decreased. Judging from the writer's experience, however, it is very probable that there will be no necessity to alter the value of this resistor.

The length of time needed for C1 to charge via R1 to around 6 volts is close to the time constant of these two components. Time constant defines the time needed for the voltage across a capacitor charging via a series resistor to reach 63% of the applied voltage and, in seconds, is equal to the product of the capacitance in microfarads and the resistance in megohms. The time constant for 100μF and 10kΩ is 1 second whilst that for 100μF and 1MΩ is 100 seconds. In the present circuit, it will in most instances be necessary to press S2 for a period somewhat longer than the time constant because the required voltage across C1 is a little higher than 63% of 9 volts and because, due to tolerances, the actual value of an electrolytic capacitor is on average higher than its nominal figure. Also, when R1 has a value above some 200kΩ or so leakage current in the capacitor becomes significant, with the result that a proportion of the current flowing in the resistor is capacitor leakage current whilst the remainder is charging current. This last effect will further lengthen the period required for C1 to charge up to the requisite voltage. The capacitor employed must be a modern component in good condition.

When initially checking out the circuit it is helpful to fit a 10kΩ resistor for R1 as there are then no undue delays in testing circuit operation. R1 may later be replaced by any value up to 1MΩ to give whatever time delay is required. As has just been discussed, the resistance required in practice will be somewhat lower than the calculated time constant value.

After TH1 has fired it will only remain conductive if an adequate holding current flows through it from its anode to its cathode. In general, this holding current should be 10mA or more whereupon, allowing for a small voltage drop in the conducting thyristor, the resistance of the relay

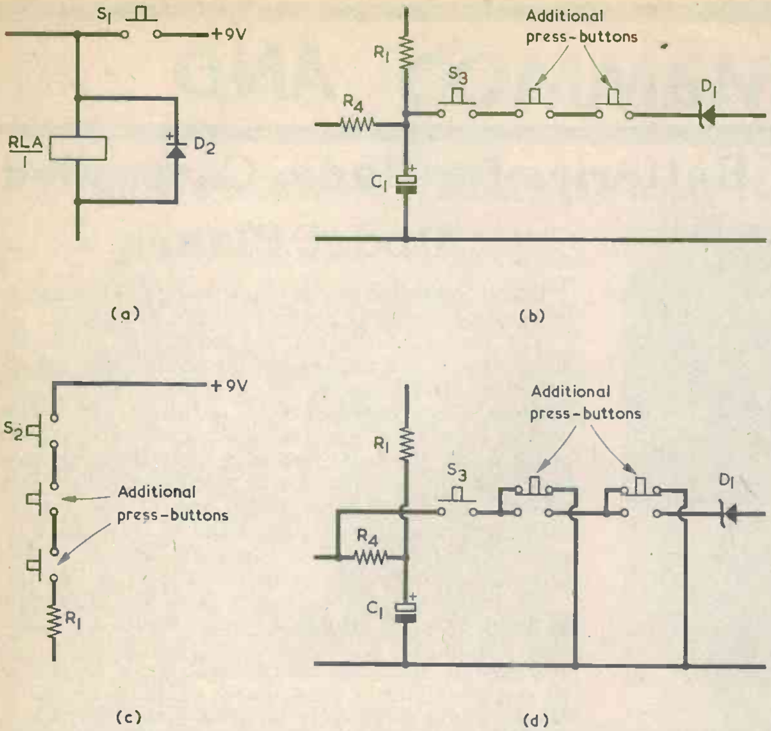


Fig. 3(a). Opening the lock is made more difficult if S1 is made a press-button
(b). Additional press-buttons may alternatively be added in series with S3
(c). Another variation, in which additional press-buttons are connected in series with S2
(d). With this circuit the lock is disabled if the three press-buttons are not pushed in the correct order

coil should not be greater than 800Ω. Minimum relay coil resistance is mainly dictated by the current which is drawn from the 9 volt supply when the relay energises and should preferably be of the order of 200Ω. In the prototype circuit the author employed a 'Miniature Open P.C. Relay' with a 410Ω coil, which is available from Doram Electronics. The relay coil could be replaced by the lock solenoid coil if the latter has a sufficiently high resistance. Diode D2 prevents the appearance of back-e.m.f. voltages across the relay (or solenoid) coil when the supply is turned off.

VARIATIONS

A number of alteratons to the basic circuit of Fig. 1 can be effected to make the lock more difficult to open.

A simple variation consists of replacing S1 with a press-button, as in Fig 3(a). With the circuit amended in this manner S1 has to be pressed continually whilst S2 and then S3 are operated.

An alternative scheme consists of inserting one or more press-buttons in series with S3. In Fig. 3(b) two more press-buttons are so connected. After S2 has been pressed for a sufficiently long time all the three buttons shown in the diagram have to be pressed simultaneously to trigger the thyristor. The same idea can be used in the S2 circuit by having one or more additional press-buttons in series with it, as in Fig. 3(c). All the push-buttons have to be pressed continually if the capacitor is to charge.

A further variation on the scheme in Fig. 3(b) is possible if the press-buttons have a double-throw switching action, and this is illustrated in Fig. 3(d). In this diagram S3 connects to the capacitor via R4 to obtain discharge current limiting. After the capacitor has charged, *both* the additional press-buttons in Fig. 3(d) have to be pressed before S3 is pressed. If this is not done, pressing S3 causes the capacitor to be discharged immediately.

Lock solenoids may be obtained from various sources or may be home-constructed. Two miniature solenoids are listed by Henry's Radio, one having a coil resistance of 55Ω and operating at 15 to 28 volts and the other having a coil resistance of 15Ω and operating at 4.5 to 9 volts. ■

NEWS . . . AND .

Nickel-cadmium Batteries for Radio Controlled Model Planes

Picture above shows typical plane using the Simprop remote control system powered by General Electric nickel-cadmium batteries. Below, the various elements of the RC system. In the centre: the portable ground unit. Left: the servos. Centre bottom: the receiver and the Simprop power pack using GE Power-Up 15 batteries

Radio controlled model plane flying has become an increasingly popular pastime in this decade.

The choice of the optimal battery to power the equipment is crucial. During the entire flight period, sufficient power must be available for the RC receiver, servo units and motor in the air, and for the control panel on the ground. A sudden drop in power could mean the total loss of a generally expensive "toy", usually assembled after months of painstaking efforts. After extensive tests, one of the leading manufacturers of model planes and RC systems, Simprop (Electronics), chose General Electric nickel-cadmium rechargeable batteries for their equipment.

GE batteries feature a longer than usual life span: as many as 1,000 discharge/charge cycles and a service life of up to 50,000 hours are possible. GE "Power-Up" batteries can be recharged in as little as 15 minutes. This is particularly valuable for model planes whose electrically powered motor draws substantially on the battery; with a 1,000 mA (19V) battery, expected flight time may reach 40 minutes, depending on propeller diameter, pitch and speed. After a short charging lapse, the plane can be in the air again.

According to Mr. Bosch, General Manager of Simprop Electronics, "the Simprop systems would never have been conceivable without General Electric's advanced technology in batteries, partly arising from space programmes. Investment in nickel-cadmium batteries," he added, "pays off in ruggedness, longer service life and higher power. The batteries have offered sportsmen substantial savings on operating costs and have made hobby flying more challenging."

A.C. Mains Connector-Filter

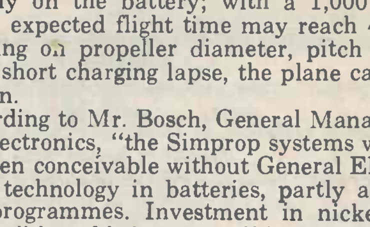
Roxburgh Electronics Limited announce the availability of a new combined a.c. mains connector and interference filter.

The SDP range of mains connector-filters combine, in a single panel-mounted assembly, a 3-pole connector and an a.c. mains interference filter. All the filtering components are enclosed in the integral steel case, which provides full electromagnetic screening, and the units are supplied with electroplated copper solder tags.

Three different versions of the SDP are available. These are rated at 1 amp, 3 amps and 5 amps at 250 volts r.m.s., and conform fully with existing and proposed U.K. and Continental specifications for a.c. mains filter units.

Typical applications include the protection of digital equipment from the effects of transient interference on their a.c. mains supplies, and the prevention of damage to semiconductor circuits by high energy voltage transients. They can also be used to prevent excessive interference due to electromechanical systems, relays, etc., being fed back into the a.c. mains power supply.

The address of the manufacturer is Roxburgh Electronics Limited, 22 Winchelsea Road, Rye, Sussex.



The Roxburgh Electronics combined a.c. mains connector and interference filter. This protects supplied equipment from transient interference on the a.c. mains supply.

. . . COMMENT

1976 'Scotch' Wildlife Sound Recording Contest

Prizes worth more than £1,000 are to be awarded in the 1976 'Scotch' Wildlife Sound Recording Contest.

Top award for the overall winner of the contest, which is open only to British amateur tape recordists, is a Sennheiser MKH 815T transistorised condenser gun microphone, together with power pack and accessories, donated by Hayden Laboratories. New to the competition are special awards for cassette recordings and stereo entries: a Wollensak 4766E hi-fi cassette deck with Dolby noise reduction circuitry (recommended price £288) goes to the entrant submitting the best entry made on a cassette machine, and a pair of Monitor MA5 Series II speakers will go to the recordist entering the best stereophonic recording.

In addition, a Grampian parabolic reflector with DP6 microphone, and a pair of Rotel stereo headphones will be awarded for the most original recording, and specially commissioned watercolours featuring the subjects of their recordings will go to the six class winners.

Subject categories are: birds, mammals and insects, and outdoor habitat. Scotch Classic recording tape or cassettes will be bonus prizes for all winners and runners-up, and all entrants will be invited to the prizegiving luncheon in London.

There is no entry fee, and copies of the rules and entry forms — together with hints on wildlife recording by lecturer, author and international recording contest winner Richard Margoschis — are available from Bill Bowles, Public Relations Executive, 3M United Kingdom Ltd., 380 Harrow Road, London W9 2HU. Closing date for receipt of entries is March 31, 1976.

Pictured above are some of the prizes for 3M's 'Scotch' Wildlife Sound Recording Contest

Laskys claim first solar energy watch

Laskys, Europe's largest hi-fi retailer, have specially imported what is believed to be the world's first digital watch, incorporating a wrist-based calculator and powered by solar energy.

It is called the Uranus Time Computer and represents "the State of the Art" in digital integrated circuit technology. This was first demonstrated in England recently on the BBC TV's "Tomorrow's World" programme.

The watch function displays on command, hours, minutes, day of the month and seconds.

The calculator is a four-function, +, ×, ÷, —, machine with an 8-digit display full floating decimal and automatic stand.

The Time Computer contains a solar cell which draws its power from sunlight, daylight or artificial light. The batteries, therefore, never need replacing.

The heart of the Time Computer is a tiny encapsulated "chip" of silicone containing many thousands of transistors and other active electronic devices.

The Uranus Time Computer is on special display at 481 Oxford Street, Laskys' major store.

It is available to special order for £295 including VAT.

The 'Drachma' S.W. and V.H.F. Portable

The author of this article, which appeared in the last December and January issues, has advised us of several points arising from experience with the receiver. Should VR1 become noisy when adjusted, C8 may be increased to 80μF 10 V. Wkg. If hand capacitance effects appear on parts of the short wave bands, they can be cleared by connecting a 3ft. length of flex to the negative supply rail. This hangs down below the receiver and forms a counterpoise earth. Also, VC1 may be employed, if desired, as a Vernier reaction control.

"Don't worry Sergeant — with the aid of this new issue wireless set I'll get help through in next to no time!"

160-80 METRE BAND

by
A. P. Roberts

In this novel receiver design signal pick-up is achieved by a combination of telescopic and ferrite aerials. Coverage is from 1.6 to 5MHz and a particularly attractive feature is an extremely low battery current consumption.

Considering the large aerials and high receiver gains normally employed for reception on the 160 and 80 metre amateur bands, it might at first seem a little over-optimistic to design a self-contained t.r.f. receiver for operation on these bands. Nevertheless, it is possible to receive many amateur transmissions with a simple receiver of this type, and with good propagation conditions it is even possible to pick up stations as far away as Italy and Yugoslavia.

The circuit utilises three transistors including one field-effect type, together with a detector diode and a variable capacitance diode. The output is intended for high impedance 4,000Ω headphones, and could also be connected to an a.f. amplifier having a medium or high impedance input.

THE CIRCUIT

The receiver circuit is given in Fig. 1 and incorporates an f.e.t. r.f. amplifier, a diode detector and a 2-stage audio amplifier.

L2 is the tuned winding of the ferrite aerial and is coupled direct to the gate of the f.e.t., TR1. The coil also maintains the gate at the same d.c. potential as the negative rail, whereupon source bias is developed across R3 which is bypassed by C4. An f.e.t. has an extremely high input impedance and this ensures a very low level of loading on the tuned circuit with consequent good selectivity. TR1 functions in the common source mode of operation.

VC1 is the main tuning capacitor, with the varicap diode D1 coupled across it via C3. The capacitance

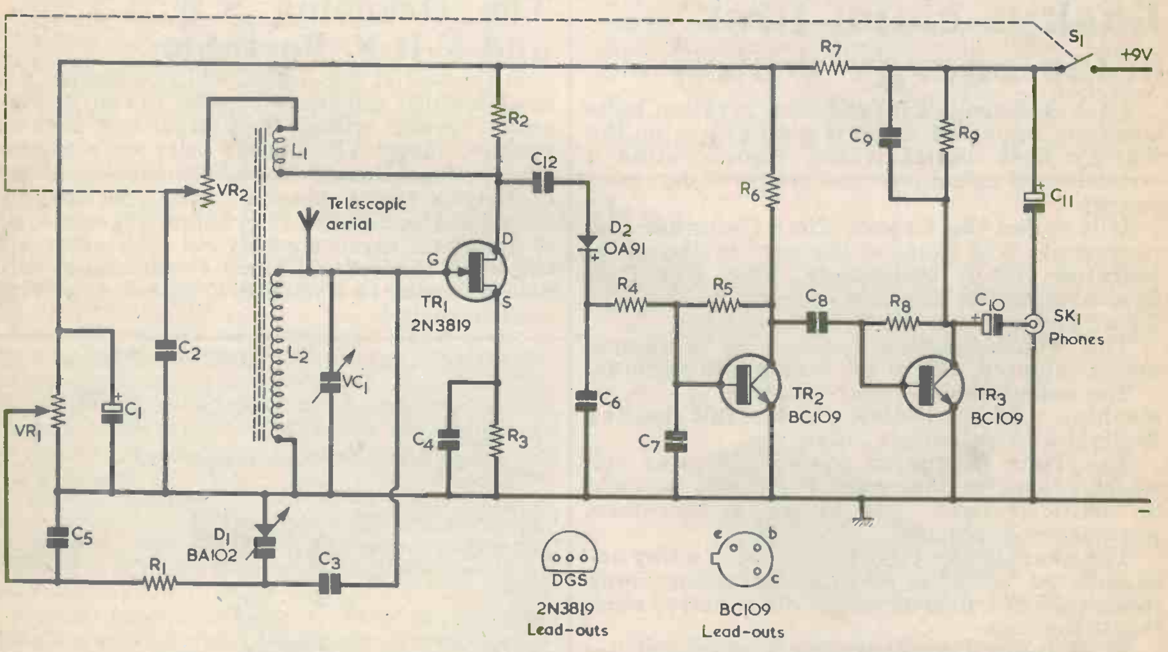
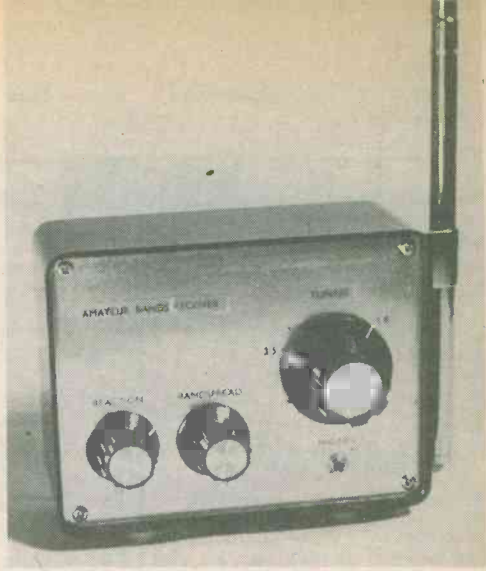


Fig. 1. The circuit of the 160-80 metre band receiver. This covers the 160 and 80 metre amateur bands as well as the "Trawler Band". The chassis connection shown here is to the metal front panel

RECEIVER



COMPONENTS

Resistors
(All fixed values $\frac{1}{4}$ watt 5%)
- R1 8.2MΩ
- R2 4.7kΩ
- R3 3.3kΩ
- R4 680Ω
- R5 2.2MΩ
- R6 8.2kΩ
- R7 680Ω
- R8 1.2MΩ
- R9 3.9kΩ
- VR1 500kΩ potentiometer, linear
- VR2 5kΩ potentiometer, linear, with switch S1

Capacitors
- C1 125μF electrolytic, 10 V. Wkg.
- C2 1,000pF polystyrene
- C3 47pF polystyrene
- C4 0.022μF type C280 (Mullard)
- C5 0.22μF type C280 (Mullard)
- C6 0.022μF type C280 (Mullard)
- C7 0.01μF type C280 (Mullard)
- C8 0.22μF type C280 (Mullard)
- C9 0.01μF type C280 (Mullard)
- C10 10μF electrolytic, 10 V. Wkg.
- C11 125μF electrolytic, 10 V. Wkg.
- C12 0.022μF type C280 (Mullard)
- VC1 365pF variable, type 01 (Jackson)

Inductors
- L1, L2 see text

Semiconductors
- TR1 2N3819
- TR2 BC109
- TR3 BC109
- D1 BA102
- D2 OA91

Switch
- S1 s.p.s.t. toggle, part of VR2

Socket
- SK1 3.5mm. jack socket

Miscellaneous
- Case, 130 x 100 x 50mm., A.B.S. type M3 (Doram)
- 9 volt battery type PP3 (Ever Ready)
- Battery connector
- Telescopic aerial type E171 (Henry's Radio)
- Ferrite rod, 4-4$\frac{1}{2}$ x $\frac{3}{8}$in. diameter
- 24 s.w.g. enamelled copper wire
- Plain perforated s.r.b.p. panel, 0.1in. matrix
- Large control knob
- 2 small control knobs
- 4 small cabinet feet
- Headphones, 4,000Ω

offered by D1 is varied by VR1, which functions in consequence as a bandspread control. This circuit is more complex than would be given by a simple low value variable capacitor connected directly across VC1 but, with the current high cost of variable capacitors, it actually proves to be less expensive.

In order to provide an efficient signal transfer the telescopic aerial is connected direct to L2 instead of being coupled to it by way of a coupling winding on the ferrite rod.

Regeneration, from TR1 drain via L1, is incorporated to increase the level of r.f. amplification and selectivity. The level of regeneration is controlled by VR2, and if it is taken just beyond the oscillation point it is possible to resolve s.s.b. and c.w. signals. C2 provides d.c. blocking in the regeneration circuit.

C12 couples the drain of TR1 to the germanium diode D2, which in turn connects to the r.f. filter given by C6, R4 and C7. Despite the fact that there is no d.c. path across the diode, the overall circuit functions satisfactorily in practice. Indeed, there were problems of pick-up of mains hum and l.f. interference by way of the ferrite rod when attempts were made to employ TR1 as a regenerative detector on its own, and the present arrangement gives a much improved signal-to-noise ratio.

TR2 and TR3 form the 2-stage audio amplifier with both transistors in the common emitter mode. The two base bias resistors are R5 and R8 respectively, with C8 providing inter-stage coupling. C10 gives d.c. blocking at the output.

S1 is the on-off switch and is ganged with the regeneration control, VR2. C11, R7 and C1 are supply decoupling components. Power is obtained from a 9 volt PP3 battery. This has a very long life as the current consumption of the receiver is only about 2.25mA.

FERRITE AERIAL

The ferrite aerial rod should have a diameter of $\frac{3}{8}$in. and a length of 4 to 4$\frac{1}{2}$in. It may be broken from a longer rod by filing a deep V-cut all round at the appropriate point and rapping the rod against a bench edge. Alternatively, a 4in. rod of the required diameter may be purchased and used as it is. A suitable rod, listed as 101mm. long and 9.5mm. in diameter, is available from Henry's Radio, Ltd.

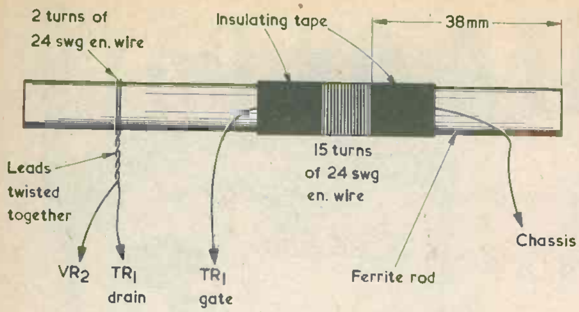
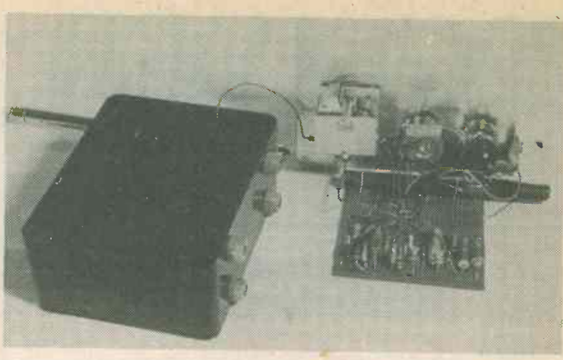


Fig. 2. Details of the ferite rod aerial windings



The component board and the front panel assembly wired together before installation of the board in the case

L2 consists of 15 turns of 24 s.w.g. enamelled wire close-wound direct on the rod. The winding starts 38mm. from one end of the rod as shown in Fig. 2. Plastic insulating tape anchors the winding ends and prevents the coil from springing apart.

L1 simply consists of 2 turns of the same wire. The lead-outs are twisted together close to the winding so that it fits fairly tightly around the rod.

COMPONENT PANEL

Apart from C2 and C5, all the small components are assembled on a plain s.r.b.p. perforated panel of 0.1in. matrix having 30 by 33 holes. This also provides a mounting for the ferrite aerial rod. Full details of the component layout and the underside wiring on this panel are given in Fig. 3.

First start by cutting out the panel with a hacksaw. The cutting must be carried out very carefully as the material tends to be brittle. Next drill out the two 6BA clear holes. Then mount the components in the positions indicated in the diagram. Their lead-outs are bent over at right angles under the panel and connected up as shown.

The ferrite aerial is tied to the panel by two lengths of twine or similar. It must not be secured by pieces of wire as these would constitute shorted turns and would upset aerial performance. When the receiver has been checked out after completion the ferrite rod may be held more securely by a generous "blob" of a good adhesive. However, for the time being the two pieces of twine will suffice as it may be necessary to move L1 along the rod. It may also be necessary to transpose the connections of L1 during checking in case it is wired with incorrect phase.

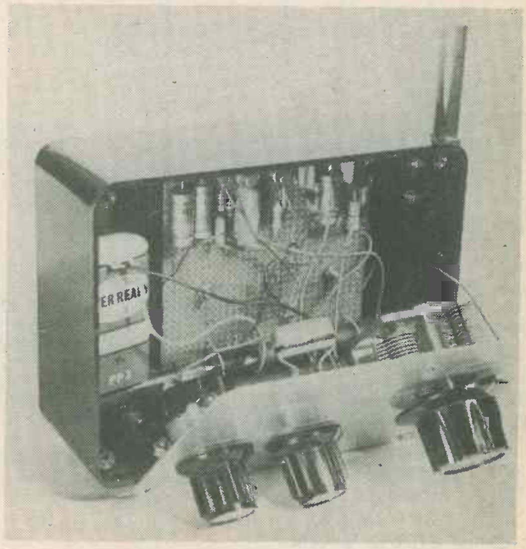
FRONT PANEL

The prototype is housed in an "A.B.S. Case" type M3 which is available from Doram Electronics, Ltd. This has nominal dimensions of 130 by 100 by 50mm. and consists of a plastic body with a metal front panel. Any other case of similar dimensions having an insulated body and a metal front panel could also be used.

Details of the drilling required in the front panel are given in Fig. 4. A 6mm. diameter hole is shown for the 3.5mm. jack socket SK1, and this will be correct for most sockets of this type. However, a few 3.5mm. jack sockets require a slightly larger hole and this point should be checked before the hole is drilled out.

VC1 is mounted by three 4BA countersunk bolts which pass through the 4BA clear holes in the panel into tapped holes in the capacitor front plate. The panel holes may be marked out with the aid of a paper template prepared in the following manner. Cut a $\frac{1}{4}$in. diameter hole in the centre of a small piece of paper and pass this over the spindle of the capacitor. Then mark on the paper the centres of the three holes in the capacitor front plate. Remove the paper and place it on the receiver front panel with the $\frac{1}{4}$in. hole central in the 10mm. hole. Mark up the panel at the three marks in the paper and then drill the three holes.

When fitted, the ends of the three 4BA bolts must not pass more than fractionally beyond the rear surface of the capacitor front plate as they may then damage the capacitor vanes. In consequence, the bolts have to be short. Also, thin spacing washers are fitted on the bolts between the receiver front panel and the capacitor front plate to give clearance for the capacitor ball race housing.



Here the component board is in position and the front panel has only to be screwed in place

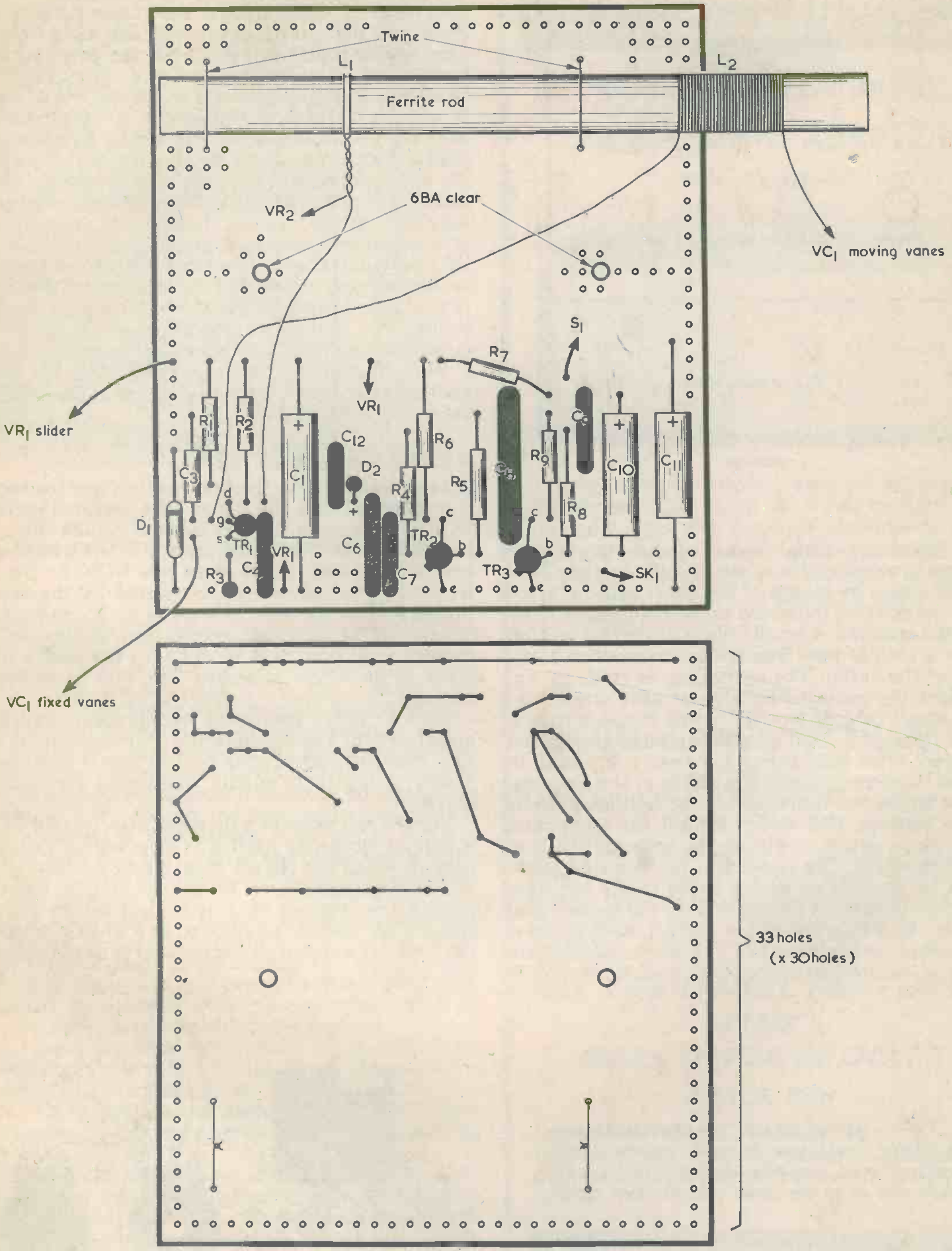


Fig. 3. The two sides of the perforated components panel. The lead to VR1 from the bottom row of holes in the upper view picks up the negative supply rail connection at the front panel

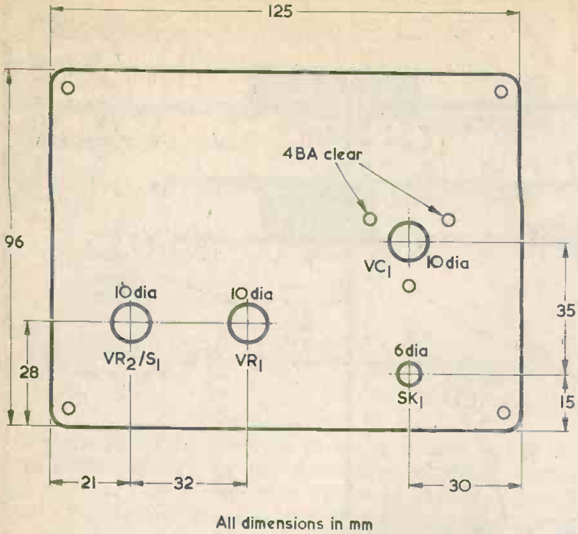


Fig. 4. Drilling details for the front panel of the receiver

The telescopic aerial specified has an integral mounting bracket and it is secured to the right hand side of the case by means of two short 6BA bolts and nuts in the position indicated in the photograph of the completed receiver. A small hole is drilled lower down to allow a lead to pass through for connection to the bottom of the aerial. The connection is made by way of a solder tag mounted by a short 4BA screw.

Four small cabinet feet are bolted to the bottom of the case. The perforated s.r.p.b. component panel will be secured, after final wiring has been completed, by two 6BA bolts and nuts to the inside of the case rear with the ferrite rod horizontal at the bottom. Spacing washers between the case rear and the component panel prevent undue strain on the latter as the bolts are tightened up. The panel will be mounted to the right so as to leave sufficient space on its left hand side for the battery. A simple clip for the battery may be devised or it may be held in position with pieces of foam rubber or plastic when the front panel of the receiver is secured in place. The battery should be spaced away from the ferrite aerial rod by some 12mm.

The final wiring operation consists of first fitting the controls and output socket to the receiver front panel and of then making the connections between these and the component panel. The wiring required here is illustrated in Fig. 5. All the interconnecting leads must, of course, be insulated. They should also be kept reasonably neat and short, but not so short as to make it difficult, or impossible, to bolt the component panel in place after the wiring has been completed. The connections to SK1 illustrated in Fig. 5 are applicable to most standard jack sockets of open construction, but if any doubt exists the socket tags may be identified by visual inspection or with the aid of a continuity tester or ohmmeter. The lead from VC1 moving vanes connects to the tag corresponding to the jack plug sleeve and the lead from C10 connects to the tag corresponding to the jack plug tip. Incorrect connections to the socket could result in the receiver output being short-circuited via the metal front panel.

When the wiring has been completed, the component panel is bolted to the inside rear of the case in the manner just described.

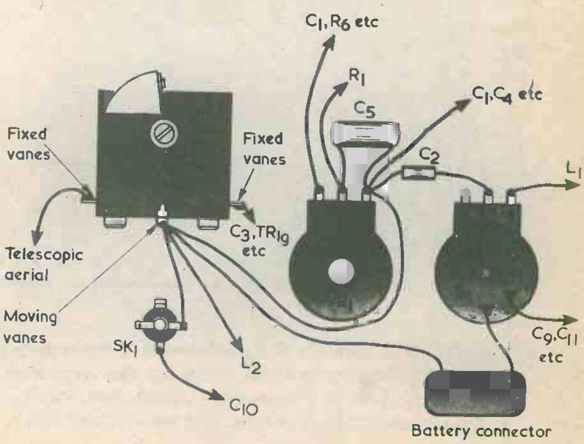
USING THE RECEIVER

In order to obtain the best results from the receiver it is essential that the controls be operated correctly. VC1 is the main tuning control, whilst VR1 is a bandspread or fine tuning control. It has a much more restricted tuning range than has VC1. At the high frequency end of the range covered by the receiver tuning is difficult with VC1 alone, as a small rotation of this control can pass over dozens of stations. The correct approach is to set VC1 to the centre of the band to be tuned and then use VR1 to search for signals.

VR2-S1 is the combined regeneration control and on-off switch. The regeneration control is not the same as a conventional volume control and it must be adjusted critically to obtain maximum receiver sensitivity.

For the reception of a.m. signals the spindle of VR2 is turned clockwise until it is at a setting just below that at which the circuit breaks into oscillation. The nearer regeneration is to the oscillation point the greater the receiver sensitivity and selectivity. The onset of oscillation is indicated as a whistle of varying pitch which is heard as the receiver is tuned across an a.m. signal.

Fig. 5. Final wiring details. The chassis connection to the front panel is made via the tuning capacitor frame, and also via the output socket when this is of the open construction type



Taking another look at the completed receiver

C.W. (morse) and s.s.b. (single sideband) signals can be received by setting VR2 just on to the point of oscillation. VR1 is then adjusted to give an audio signal of the desired pitch for a c.w. signal, or to resolve the modulation with an s.s.b. transmission.

VR2 should not normally, in these instances, be advanced further than is necessary to just obtain oscillation since the receiver sensitivity then commences to fall. The only occasion when it might be advantageous to advance VR2 beyond the just-oscillating point is when receiving a very strong s.s.b. signal. Such a signal may swamp the receiver and cause heavy audio distortion, whereupon increasing the level of regeneration will eliminate this.

If it is not possible to obtain oscillation by adjusting VR1 it may be necessary to slide L1 along the ferrite rod to bring it closer to L2. Should this not allow oscillation to occur it is very probable that L1 has been connected into circuit with incorrect phase and its lead-out connections should be transposed.

The receiver covers the whole of the "Trawler Band" from about 5 to 1.6MHz. Many marine and a few broadcast stations can be received, but the 160 metre (1.8 to 2MHz) and 80 metre (3.5 to 3.8MHz) amateur bands will probably be of most interest to the short wave listener.

Since the 160 metre band is used mainly for local contacts it is likely to offer relatively few amateur transmissions; indeed, in some areas such transmissions may be completely absent. 80 metres, on the other hand, will usually provide numerous signals, particularly during the evenings and at week-ends. The signals will almost certainly all be of U.K. origin, although a few more distant ones may be heard as well at times. The best time for picking up distant stations on this band is late at night. ■

SHORT WAVE NEWS
FOR DX LISTENERS

By Frank A. Baldwin

Times = GMT *Frequencies* = kHz

As reported elsewhere in this article, Radio Pathet Lao ceased functioning way back last November and so from the short wave scene passed one of the most exciting of the so-called clandestine transmitters. Transmissions from Vientiane now occupy the former Pathet Lao channels.

Liberation Radio operating from Hanoi is no longer termed in that manner. Now that North and South Vietnam are as one country, Hanoi operates two networks radiating programmes specifically designed, and directed to, the former South Vietnam.

The First Network has been logged by us on a measured **6449** at 1640 when a programme of local music and songs was being radiated. Sign-off was at 1657 after identification, without any National Anthem. This channel has also been heard at 2216.

Another First Network channel is that of a measured **7374** at 1506 with a programme similar to that above and a further frequency in this Network is that of 10060, logged by us at 1525, this signing-off at 1715.

The Second Network to the former South Vietnam may be heard on **4995** where we logged it at 1542, the programme content being largely as described above.

Other Second Network channels heard have been on a measured **6426** with a parallel channel on **10010** at 1530.

All programmes are, of course, in Vietnamese. The former Saigon (now renamed Ho Chi Min City) transmitter on **4877** has ceased to function.

CURRENT SCHEDULES

● GREECE

The "Voice of Greece", Athens, radiates programmes in English (newcasts) to Europe from 0715 to 0730 on **5960** and from 1920 to 1930 on the same channel.

● LAOS

An External Service from Vientiane is presented on **7145** from 0400 to 0630; 1100 to 1400 and from 2300 to 0130. Programmes in English, for South East Asia, are radiated from 0600 to 0630; 1330 to 1400 and from 0100 to 0130.

The Domestic Service, in Laotian, is from 2300 to 0030 on **5160** and **6130**; from 0030 to 0200 sign-off on **4245, 5160, 6130, 6200, 6210** and **7310**; from sign-on at 0400 through to 0600 sign-off, programmes are radiated on **4245, 5160, 6130, 6200, 6210, 7310, 7480** and on **8630.**

Some of the frequencies being used by the "National Radio Broadcasting Station", Vientiane, were formerly those of the clandestine "Radio Pathet Lao", which latter transmitter ceased operations in November last, all this information according to the BBC Monitoring Service.

● SWEDEN

"Radio Sweden", Stockholm, has an External Service in English to Europe as follows — from 1100 to 1130 on **9630** and **21690** (also directed to Africa); from 1600 to 1630 on **6065, 9665** and on **11735** (also to the Middle East); from 1830 to 1900 on **6065, 9625** and on **11780** (also to Africa); from 2030 to 2100 on **6065, 9605** and on **9685** and from 2300 to 2330 on **6035, 6045** and on **9605** (also to North America).

● CHINA

The P.L.A. Fukien Front Station broadcasts programmes, mainly in Standard Chinese, to Taiwan and other offshore islands as follows — Network One from 1000 to 1902 on **2600, 3300** and on **3900**; from **3000**; from 1159 to 2240 on **3535** and **3640**; from 1000 to 0530 on **4045**; from 1000 to 0030 on **4330**; from 2240 to 0530 on **5240** and **5265**; from 2315 to 0530 on **5900**; from 0001 to 0530 on **6765** and from 0030 to 0530 on **7850.**

Network Two operates from 1159 to 1902 on **2430**; from 1000 to 1902 on **2600, 3300** and on **3900**; from 0930 to 1902 on **3200, 3400** and on **4140**; from 0230 to 1902 on **4380** and on **4840**; from 0230 to 1127 on **5170**; from 0230 to 1000 on **6000, 6400, 7025** and on **7960** and from 0230 to 0930 on **5770, 7280** and on **8195**, all according to the BBC Monitoring Service.

"Radio Peking" radiates in English to Europe from 2030 to 2130 on **6270, 6410, 6860** and on **7590** and from 2130 to 2230 on **6270, 6960** and on **9030.**

● CUBA

"Radio Havana" directs its External Service programme in English to Europe from 2010 to 2040 on **11715.**

● U.S.S.R.

Programmes in English to the U.K. from "Radio Moscow" may be heard from 1130 to 1230 on **9450, 11705, 11745, 11830** and on **15190**; from 1900 to 1930 on **5920, 5980, 6010, 6020, 6175, 7280** and on **7360**; from 2000 to 2030 on **5920, 5950, 5970, 5980, 6010, 6020, 6175, 7280** and on **7360**; from 2100 to 2200 on **5920, 5970, 6010, 6175, 7280, 7300** and on **7360**; from 2200 to 2230 on **5920, 5970, 6010, 7300** and on **7360.**

● SYRIA

The external Service from Damascus features programmes in English for Europe from 0700 to 0730 on **7105** and from 2030 to 2200 on **9655.**

AROUND THE DIAL

● CHINA

Radio Peking on **4800** at 2103, OM with a talk in Chinese followed by some typical local music with a vocal by a young lady having a most charming voice. This is the Home Service 1 during the scheduled 2000 to 0100 period of transmission.

Radio Peking on **3920** at 2003, programme of local music, orchestral style in the Home Service 1st Programme, schedule as above.

Lanchow on **4865** at 1515, womens chorus in a drama production — very stirring stuff — the chorus, not the women! This transmitter is scheduled from 0950 to 1600 and from 2120 to 0600.

The PLA (People's Liberation Army) Fukien Front station on the not-so-often reported frequencies of **2430, 3535, 4330** and **4380** all logged around 1430, programmes of usual format, lots of talk and some music in between.

● INDIA

AIR (All India Radio) Delhi on **3365** at 1532, long discussion in Hindi. Afternoon schedule is from 1230 to 1735, the power is 10kW and the news in English should have been at 1530 — wonder what went wrong?

AIR Kurseong on **3355** at 1508, OM and YL in local dialect The schedule of this one is from 1130 to 1700 with newscasts in English at 1230 and 1530, the power is 10kW.

AIR Hyderabad on **4800** at 1825, programme of local music with songs both by solo and choral artistes. Schedule is from 1130 to 1830 and there is an English newscast at 1530, the power is 10kW.

AIR Lucknow on **3205** at 1605, YL with songs, local-style music. Schedule is from 0025 to 0215 and from 1130 to 1830 with an English newscast at 1530, power is 10kW. For insomniacs, Lucknow often puts a good signal into the U.K., around 0130 or so; I'm not one of those — I just stay up late!

AIR Gahauti on **3235** at 1445, with a programme of rather suprising content — no less than a piano rendition of "Beautiful Dreamer Awake Unto Me" — well I never! Gahauti is on the air from 1300 to 1800 and from 0100 to 0200 with English newscasts scheduled for 1232 and 1530, power is 10kW.

AIR Bombay on **4840** at 1510, usual local programme format of songs and music. This regional transmitter operates from 1200 to 1830 and from 0215 to 0400 and the power is 10kW.

● PAKISTAN

Rawalpindi on **3400** at 1502, a discussion in Urdu and then into a local-style music programme. This is the West Pakistan Service being carried on this channel from 1415 to 1620 from November through to February and in addition from 1700 to 1810 from November through to April, the power is 10kW.

Islamabad on **3395** at 0255, YL with songs in a musical programme for local consumption. The schedule of this one is not known at present and yes, I did stay up late for this logging!

Peshewar on a measured **3328** at 1516, OM with a talk in dialect then into a programme of local music and songs. Listed on **3330,** the afternoon schedule is from 1415 to 1810 but has been reported closing as late as 1900.

A word of warning about Pakistan transmitters. The frequencies on which these stations operate are liable to vary literally from day to day, on one recent occasion Rawalpindi being measured on **3403.5.** Confusion can reign if you abdicate care!

● MALAGASY REPUBLIC

Tananarive on **3232** at 1820, OM with announcements in French then African orchestra in typical drum-beat style. This programme was part of the Home Service 2 in French which is scheduled from 0300 to 0500 and from 1600 to 1900, the Foreign Service programme in English being from 1500 to 1600. The power is 10kW and the channel is a difficult one owing to the commercial interference which abounds on the band.

● LIBERIA

Monrovia on **3227** at 1815, the throbbing beat of African drums intertwined with chords of local music from equally local instruments must be heard to be appreciated — and this I certainly did! Schedule is from 0610 to 0800 and from 1805 to 2220 and the power is 10kW.

● CAMEROON

Garoua on **5010** at 2135, African drums, local-style orchestral music complete with YL's in a thrilling trilling chorus — which alwasy reminds me of Arabic women with their high-pitched cries when their menfolk set out for battle, Lawrence knew the sound very well. The schedule of this 30kW transmitter is from 0500 to 0700 and from 1700 to 2200 with the English programme scheduled from 1830 to 1845.

I must confess to a "soft-spot" for this particular station, often listening to their programmes whilst attending to other matters in the shack. An endearing habit of this transmitter is the closing ceremony, after the National Anthem one can hear the interval signal on a flute and tam-tam repeated. I know of no other station having this charming trait.

● MALI

Bamako on **4786** at 0635, music from a locally made stringed instrument, song by YL. The schedule is from 0600 to 0800 and from 1800 to 0000 (Fridays to Sundays from 1830) and the power is 18kW. The frequency of this one is likely to vary at times.

● ECUADOR

Radio Iris, Esmeraldas, on a measured **3381** at 0249, a very excited OM with an exciting sports commentary in Spanish. Schedule is from 1100 to 0500 although the closing time is variable and has been reported closing at various times between 0430 to 0530 — perhaps they get excited about this as well!

● INDONESIA

Yogyakarta on **5047** at 1550, gongs, chimes, the slow deliberate beat of South East Asian music, soothing and exotic at one and the same time. The schedule is from 2200 to 0230 and from 1000 to 1600, the power is 20kW.

STEREO I.C. AM

By R. A.

Incorporating a popular a.f. stereo amplifier has switched i ceramic or crystal cartridge. The c bass and treble cut and boost co simpler design, one of the prin employed on its own to give a

An integrated circuit a.f. amplifier which is becoming increasingly popular with constructors is the Texas Instruments SN76023N. This is typically capable of providing 5 watts r.m.s. in an 8Ω load when using a 24 volt supply, and requires only a small quantity of external components when employed without tone controls.

This article describes a stereo amplifier incorporating two of these i.c.'s together with a comprehensive tone control network. As an introduction to the circuit an individual amplifier employing the SN76023N will be described, and readers who wish to do so may make this up on its own as a mono amplifier. The main part of the article will then be devoted to a stereo version incorporating two of the amplifiers.

MONO AMPLIFIER

The circuit of the mono amplifier is given in Fig. 1. The bias for the i.c. non-inverting input at pin 1 is given, via R3 and R2, from an internal voltage reference at pin 2. This reference voltage is bypassed by C2 to ensure that any noise on the positive supply rail is not applied to the non-inverting input. C5 and C6 are included in the interests of stability, whilst R4 and C7 compensate for increase in speaker impedance with rising frequency. C8 is a d.c. blocking capacitor between the i.c. output and the speaker.

Negative feedback, both at d.c. and a.c., from the output to the inverting input at pin 16 is provided by way of the network comprising R5 to R12, VR2, VR3, C3 and C11 to C16. These include the tone control components which appear in a quite conventional circuit offering both bass and treble cut and boost. VR2 is the bass control and VR3 the treble control, and they provide approximately 10dB of boost and cut at 100Hz and 10kHz with respect to 1kHz.

A series resistor, R1, is included in series with the input to volume control VR1. It increases the input impedance of the circuit to give a good match to a crystal or ceramic pick-up, and it also ensures that there is a relatively low variation of input impedance with alteration of the volume control setting. This is helpful since the frequency response of crystal and ceramic cartridges is largely dependent on load impedance, especially at bass frequencies. The signal tapped off by the slider of VR1 is passed to the non-inverting input of the i.c. via C1.

When used with the power supply to be described later, the amplifier requires an input of about 70mV for an output of 5 watts r.m.s. into an 8Ω speaker.

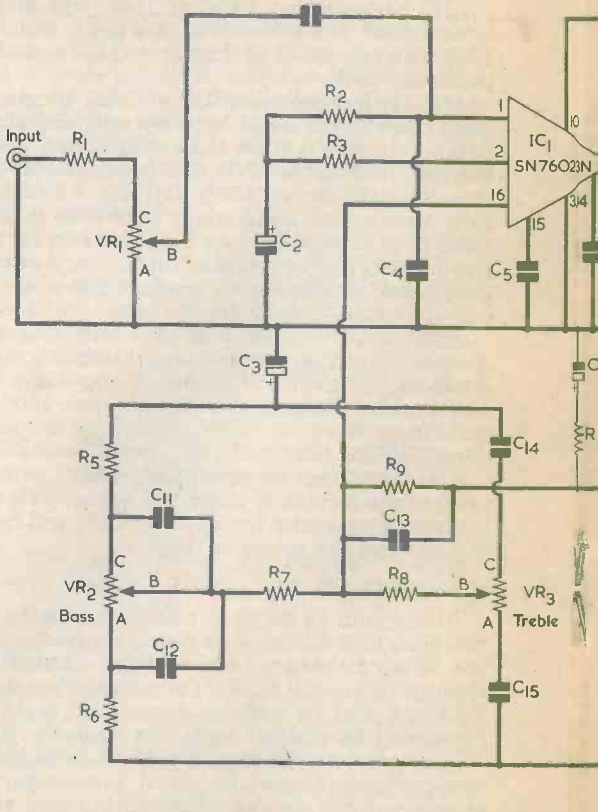


Fig. 1. The circuit of the mono amplifier. This is also amplifi

I. C. AMPLIFIER

By R. A. Penfold

Incorporating a popular a.f. power integrated circuit, this stereo amplifier has switched inputs for radio tuner or for ceramic or crystal cartridge. The design features comprehensive bass and treble cut and boost controls. For those who prefer a simpler design, one of the printed circuit modules may be employed on its own to give a 5 watt mono a.f. amplifier.

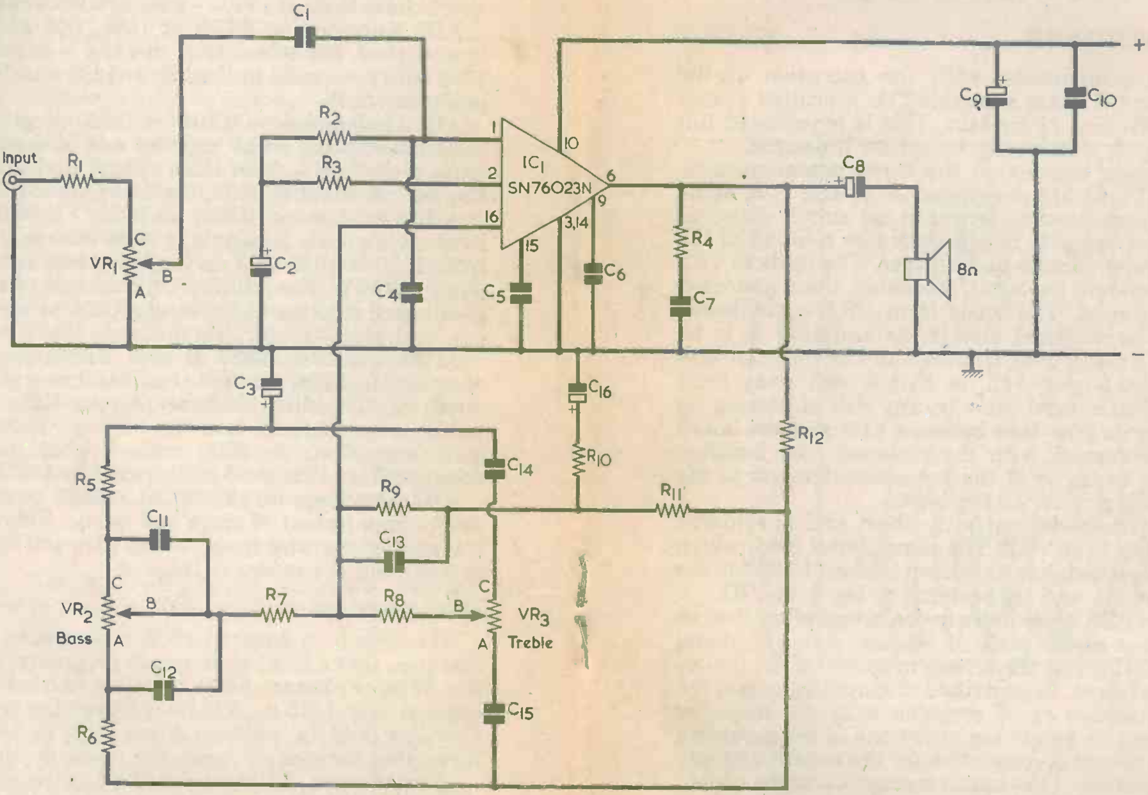
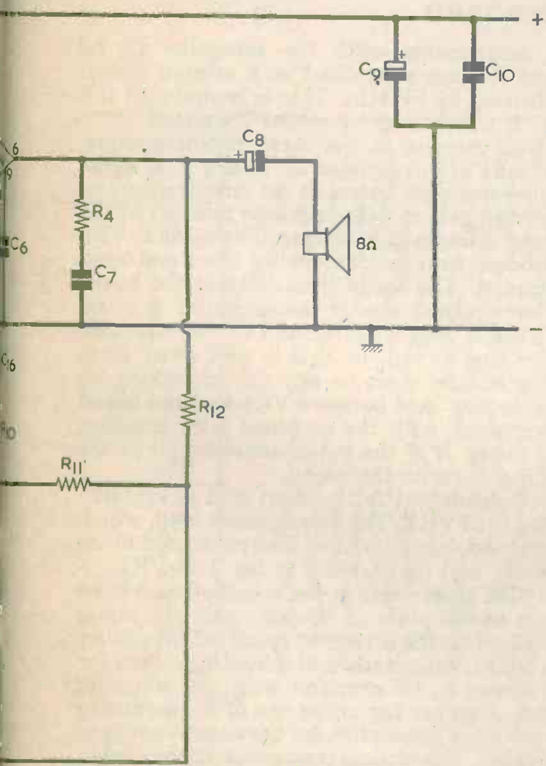


Fig. 1. The circuit of the mono amplifier. This is also the basic circuit for one channel of the stereo amplifier

PLIFIER

. Penfold

power integrated circuit, this inputs for radio tuner or for design features comprehensive ntrols. For those who prefer a nted circuit modules may be 5 watt mono a.f. amplifier.



o the basic circuit for one channel of the stereo ier

COMPONENTS

MONO AMPLIFIER

Resistors

(All fixed values ¼ watt 5%)

R1 560k Ω
R2 560k Ω
R3 100k Ω
R4 15 Ω
R5 390 Ω
R6 3.9k Ω
R7 10k Ω
R8 10k Ω
R9 100k Ω
R10 100 Ω
R11 820 Ω
R12 27k Ω
VR1 1M Ω potentiometer, log
VR2 50k Ω potentiometer, linear
VR3 50k Ω potentiometer, linear

Capacitors

C1 0.1μF type C280 (Mullard)
C2 4μF electrolytic, 16V Wkg.
C3 10μF electrolytic, 16V Wkg.
C4 330pF ceramic plate or silvered mica
C5 0.0015μF plastic foil
C6 0.001μF plastic foil
C7 0.01μF disc ceramic
C8 1,000μF electrolytic, 16V Wkg.
C9 100μF electrolytic, 30V Wkg.
C10 0.068μF type C280 (Mullard)
C11 0.47μF type C280 (Mullard)
C12 0.047μF type C280 (Mullard)
C13 470pF ceramic plate or silvered mica
C14 0.0022μF plastic foil
C15 0.022μF type C280 (Mullard)
C16 100μF electrolytic, 16V Wkg.

Integrated Circuit

IC1 SN76023N (d.i.l.)

Miscellaneous

3 knobs
8 Ω speaker
Materials for printed circuit board

COMPONENTS

STEREO AMPLIFIER

Resistors

(All fixed values ¼ watt 5% unless otherwise stated)
R1, R1(a) to R12, R12(a) As R1 to R12 of mono amplifier
R13, R13(a) 56kΩ
R14, R14(a) 47kΩ
R15 0.5Ω 5 watts wire-wound
VR1, VR1(a) 1MΩ+1MΩ dual-gang potentiometer, log
VR2, VR2(a) 50kΩ+50kΩ dual-gang potentiometer, linear
VR3, VR3(a) 50kΩ+50kΩ dual-gang potentiometer, linear
VR4 2MΩ potentiometer, linear

Capacitors

C1 C1(a) to C16, C16(a) As C1 to C16 of mono amplifier
C17 1,500μF electrolytic, 30V Wkg.
C18 1,500μF electrolytic, 30V Wkg.

Transformer

T1 Mains transformer. Secondary 9-0-9V at 1A, Osmabet type MT9V (see text)

Semiconductors

IC1, IC1(a) SN76023N (d.i.l.)
D1-D4 silicon bridge rectifier, 1A 100P.I.V.

Switches

S1, S1(a) d.p.d.t. slide
S2 d.p.d.t. toggle

Indicator

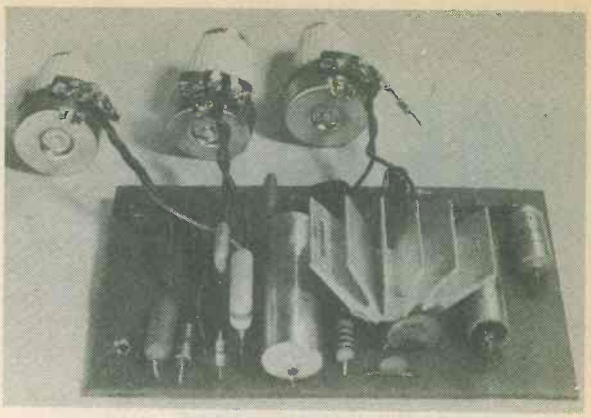
NE1 240V neon indicator with integral resistor

Sockets

Dual phono socket
5-way DIN socket
2-off 2-way DIN speaker sockets

Miscellaneous

7-way tagstrip (see text)
4-off control knobs, aluminium 22mm. dia. (Doram)
Aluminium chassis, 16 s.w.g., 9 x 7 x 2in. with baseplate (see text)
Chipboard (see text)
2-off 8Ω speakers
Materials for printed circuit boards
3-core mains lead and plug



One of the stereo amplifier boards may be employed on its own to give a simple mono amplifier

Speakers with impedances lower than 8Ω must not be employed, although speakers with a higher impedance can be used with an attendant loss of output power. The input impedance of the amplifier is of the order of 1MΩ, and the input sensitivity makes it suitable for any crystal or ceramic cartridge.

The SN76023N is in a 16 way d.i.l. package, with pins 4, 5, 12 and 13 missing.

PRINTED BOARD

All the components, with the exception of the controls and R1, are assembled on a printed circuit board measuring 2¾ by 4½in. This is reproduced full size in Fig. 2, which may be traced if desired.

Short leads connect to the three potentiometers, and these leads are designated A, B and C to agree with the corresponding letters in the circuit diagram. Point C corresponds to full clockwise rotation of the potentiometer spindle in each case. The leads to VR2 and VR3 should be kept reasonably short and need not be screened. The leads from VR1 to the board need not be screened also if the amplifier is to be housed in a metal case, which should be common with the negative supply rail, or if it is well away from mains fields. Should there be any risk of picking up hum, however, the lead between VR1 and the board must be screened, with the screened wire braiding connecting to tag A of the potentiometer and to the corresponding point on the board.

R1 has its leads cut fairly short and is soldered direct to tag C of VR1. The signal input lead, which must be screened, has its central lead connected to the free end of R1 and its braiding to tag A of VR1.

The two 6BA clear holes in the board allow it to be secured to a metal plate or chassis, with ¼in. metal spacing washers on the screws to space off the underside of the board. This method of mounting causes the mounting screws to be common with the amplifier negative rail. A solder tag under one of the mounting nuts then provides connection for the negative supply and the speaker. The chassis connection to the copper on the printed board is improved if shake-proof washers are fitted at the top of the spacing washers immediately under the copper.

The speaker employed with the amplifier should be capable of handling at least 5 watts.

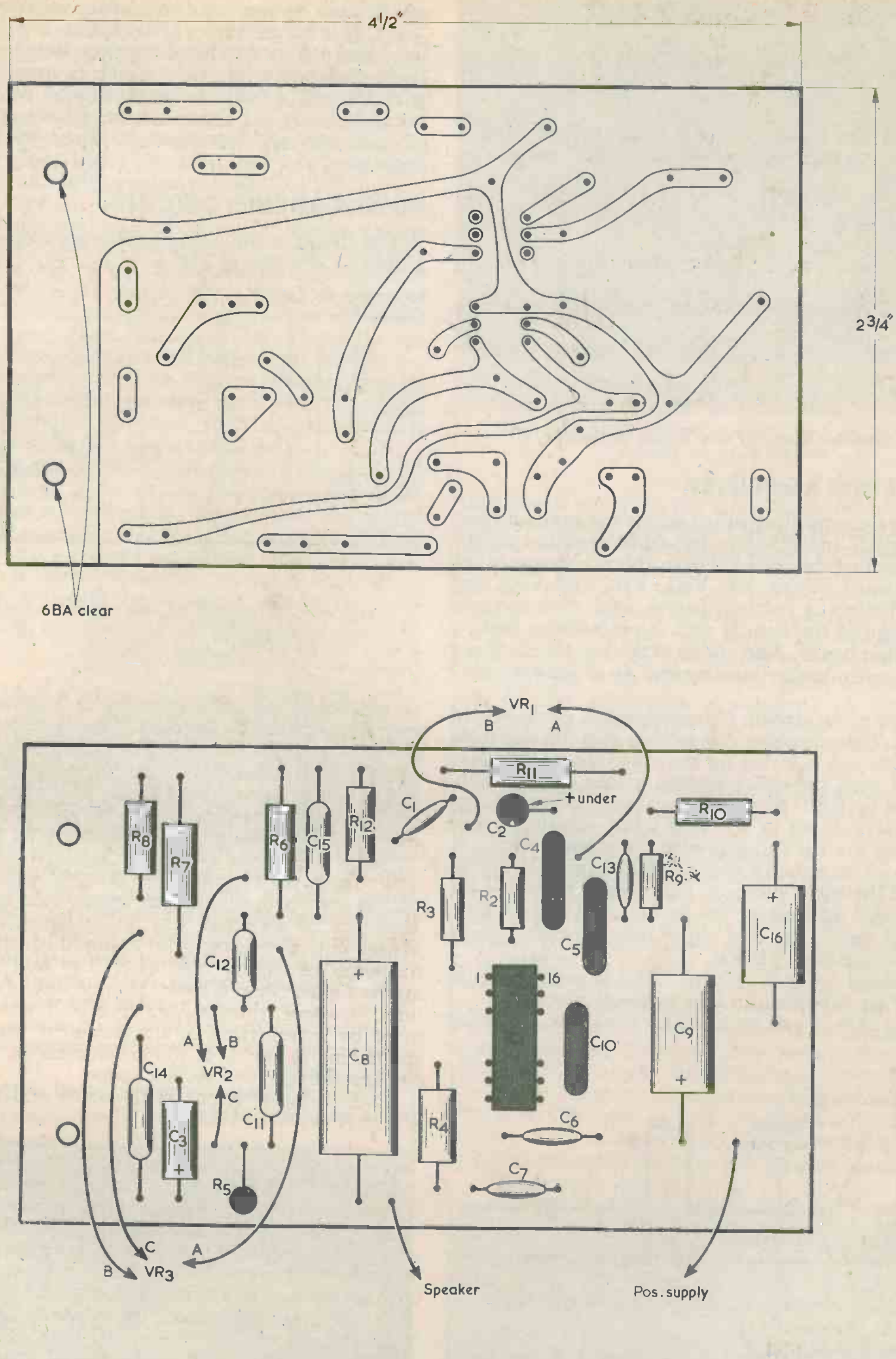
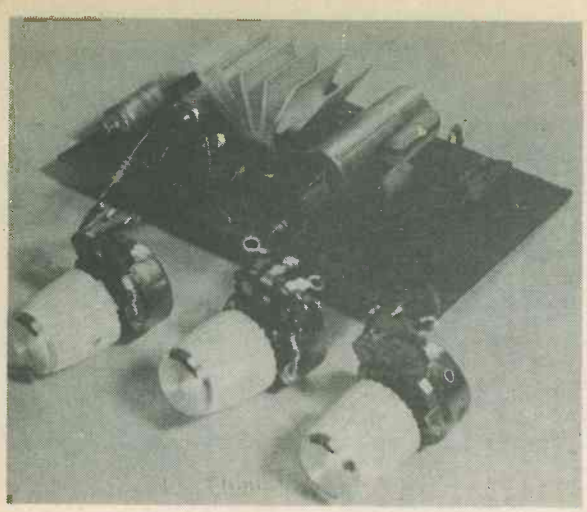


Fig. 2. The copper and component sides of the printed board. The board is reproduced full size for tracing. Two boards are employed in the stereo amplifier



Another view of the mono amplifier

THE STEREO AMPLIFIER

The stereo amplifier which forms the main subject of this article incorporates two of the printed circuit assemblies just described. There are no changes to the printed board design, but VR1, VR2 and VR3 now become dual-gang potentiometers, each with one section for one of the boards and the remaining section for the other board. Also added at the input circuit is a balance control potentiometer and an input switching circuit.

The new input circuit, for one channel, is illustrated in Fig. 3. This employs one section of a d.p.d.t. slide switch. The input wiring for the other channel is identical and uses the other section of the slide switch. When the switch is set to select ceramic cartridge, the input passes direct to R1, and input sensitivity and impedance are the same as with the mono design, i.e. 70mV at an impedance of the order of 1mΩ. With the switch in the tuner position, the input is passed to R1 via a simple attenuator consisting of R13 and R14. The input sensitivity and impedance are then 155mV into approximately 100kΩ.

The added balance control, VR4, is also shown in Fig. 3. This functions in conventional manner.

Details of the parts required for the stereo amplifier are given in the accompanying Components List. Where there are two components of the same value, one in each channel, the second one is given the suffix "(a)". It is immaterial which channel is employed for left hand or for right hand reproduction, and an arbitrary choice can be made which causes components with the suffix "(a)" to be associated with the right hand channel. The Components List also gives details of hardware and the parts required for the power supply.

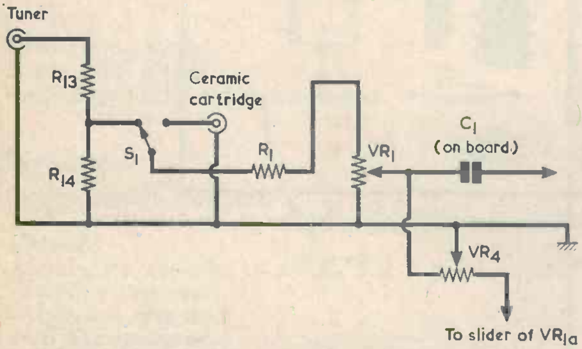


Fig. 3. The input circuit for one channel of the stereo amplifier. S1 is one half of the double pole slide switch. The input circuit for the other channel is identical

POWER SUPPLY CIRCUIT

The circuit of the power supply section of the stereo amplifier is given in Fig. 4.

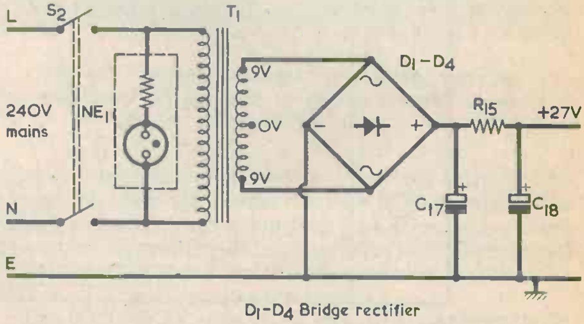


Fig. 4. The circuit of the power supply. This may alternatively be employed to power the mono amplifier

The SN76023N does not require a highly smoothed or well stabilized supply, and so the simple unregulated design in Fig. 4 is quite adequate. It is important that the maximum supply voltage rating for the SN76023N of 28 volts is not exceeded under quiescent conditions, and use of the mains transformer specified ensures that this requirement is met. The whole of the 9-0-9 volt secondary of the transformer is applied to the silicon bridge rectifier, no connection being made to the secondary centre-tap. The rectified voltage appears across reservoir capacitor C17, whilst R15 and C18 provide further smoothing.

The quiescent voltage measured across C18 is 27 volts. The neon indicator, NE1, must be a type having its own integral series resistor and which is intended for connection to the 240 volt a.c. mains. The mains transformer used is available from Home Radio (Components) Ltd.

This supply can also be employed for powering the mono amplifier of Fig. 1.

The rear of the stereo amplifier, showing the input and output sockets, together with the input selector switch

CONSTRUCTION

The stereo amplifier and its power supply are assembled in a metal case consisting of a 16 s.w.g. aluminium chassis measuring 9 by 7 by 2in. and complete with baseplate. This can be obtained from H. L. Smith and Co. Ltd., 287 Edgware Road, London, W.2. The baseplate is employed as the lid, the chassis being, in effect, used upside-down. The lid may be secured in place when the amplifier has been completed by small self-tapping screws.

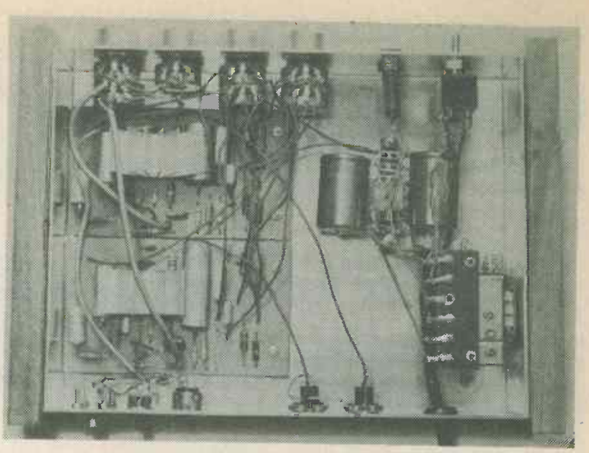
The two 9 by 2in. sides of the chassis form the front and rear panels, and drilling details for these are given in Fig. 5. The holes for switch S2 and neon indicator NE1 are cut out to suit the particular components employed. The slide switch, S1, is fitted on the rear panel and has a double phono socket on one side and a 5-way DIN socket on the other side. Holes for the switch and phono socket are also cut out to suit the actual components used. The two loudspeaker sockets are 2-way DIN style to take a plug with one round and one flat connector. The hole for the mains lead is fitted with a grommet of suitable size.

The case is completed by affixing two pieces of ½in. chipboard, 7½ by 2½in., to the two short sides of the chassis to give a "book-ends" appearance. The pieces of chipboard are covered, apart from a central area on one side, with a self-adhesive plastic material such as Contact or Fablon. Material having a wood-grain pattern was used with the prototype, and this gives an attractive finish. The two chipboard pieces are then secured to the chassis sides by means of an epoxy adhesive, such as Araldite, applied to the uncovered areas.

The positioning of the two amplifier boards can be seen in the photograph of the case interior. It is important that the amplifier boards are mounted as far to the right as possible, looking at the amplifier from the front, and the mains transformer as far to the left as possible. If this is not done the magnetic field from the transformer may introduce a noticeable hum level in the amplifier channels. The two mounting holes of each board are towards the centre of the case.

The amplifier boards are mounted by means of 6BA screws and nuts, the screw heads being under the case. The boards are spaced off by ½in. metal spacers passed over the screws with shake-proof washers at the top of the spacers to ensure good electrical contact between the metal case and the earthed copper sections on the boards. There is no need to fit a solder tag under any of the 6BA nuts, as the negative supply and speaker connections are carried by the metal case. If it is felt that, even with the ½in. spacing, there is any risk of the underside connections of the boards touching the case, strips of p.v.c. insulating tape may be affixed to the case surface under the boards before these are mounted.

Before mounting the boards it is also necessary to connect the various leads which will pass to the potentiometers, speaker sockets and positive supply. At this stage it should not be difficult to judge the approximate lengths these leads will require; they can be cut slightly on the long side and then shortened as necessary when the boards have been mounted in position. With regard to the dual-gang potentiometers, it is helpful to connect the forward board to the forward potentiometer sections, and the rear board to the rear potentiometer sections. The two leads to VR1/VR1(a) are screened, with their braiding earthed at the boards. The two earthy ends of the tracks of VR1 and VR1(a) are connected together and provide the chassis connection for the braiding of the screened wire from the input switch circuit. As with the mono version, R1 is soldered direct to VR1, and R1(a) direct to VR1(a). For convenience the forward board may be



Looking directly down into the stereo amplifier case. The use of printed circuit modules for the two channels allows a neat and uncluttered layout to be adopted

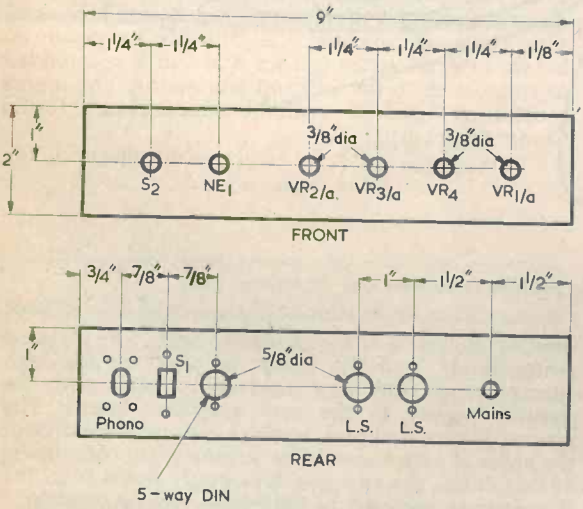


Fig. 5. Drilling details for the front and rear panels of the stereo amplifier case

A view, from the rear, at the controls mounted on the front panel

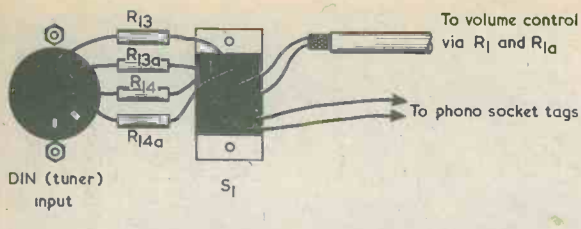


Fig. 6. Wiring diagram illustrating the input connections to the slide switch

looked upon as being in the left hand channel and the rear board as being in the right hand channel.

A solder tag is secured on the inside of the case under one of the mounting nuts for the speaker sockets. This provides the chassis connection for the two speaker sockets.

Details of the input wiring around S1 are given in Fig. 6. It will be seen here that the two tuner inputs are applied to the 5-way DIN socket, and the two pick-up inputs to the phono sockets. The phono sockets obtain their chassis connection by way of their mounting. The lead from S1 to R1 and R1(a) on the dual-gang volume control is twin screened wire with, as already mentioned, the braiding earthed at the volume control.

The balance control, VR4, is wired to the dual-gang volume control in the manner shown in Fig. 3. Screened leads need not be employed here provided the wiring is kept short and direct.

alongside. The position of the tagstrip is shown in the photograph of the case interior, the earthed tag being to the rear. The two positive supply leads from the amplifier boards are not soldered to the tagstrip at this stage.

The live and neutral wires of the 3-way mains lead connect to S2, whilst the earth wire connects to the earthed tag on the tagstrip. Leads from S2 then connect to the transformer primary and to the neon indicator. The transformer secondary connects to the tagstrip as indicated. There is limited clearance between the top of the mains transformer and the inside surface of the lid. Since the transformer tags are at the top, they should be covered with insulating tape to ensure that there is no risk of their short-circuiting to the lid. The underside of the lid should also have insulating tape affixed to it over the area above the transformer tags.

If the sockets at the rear of the case, or their mounting nuts, prevent the lid from sliding fully into position, the rear flange of the lid may be filed down slightly at the appropriate point or points.

After completion, all wiring must be checked very carefully before applying the mains and switching on, as a mistake can easily result in damage to components. A testmeter, switched initially to a high current range for safety, is then inserted in series with the positive supply to the forward board and the mains supply switched on. If the initial reading shows that it is safe to proceed further, the mains is switched off, the meter set to a lower current range and the mains switched on again. The quiescent current reading should be of the order of 12mA. The mains is switched off, and the meter is re-set to the high current range and then inserted in series with the positive supply to the rear amplifier board. The process is repeated and, again, a quiescent reading of the order of 12mA should be obtained. On completion of this check the two positive supply leads from the boards may soldered to the power supply tagstrip.

The amplifier is now complete and ready for use. ■

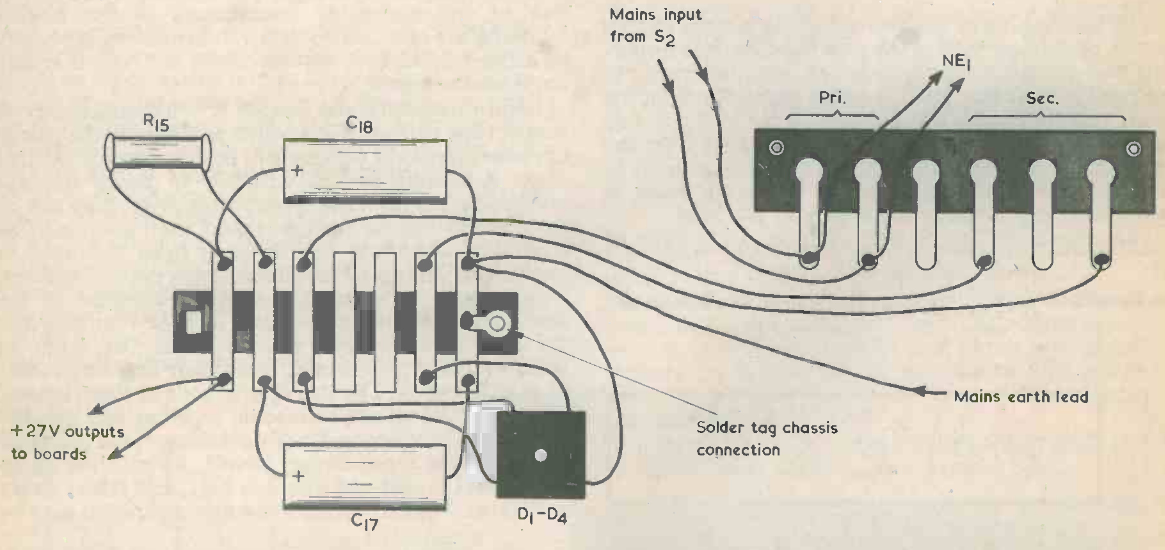
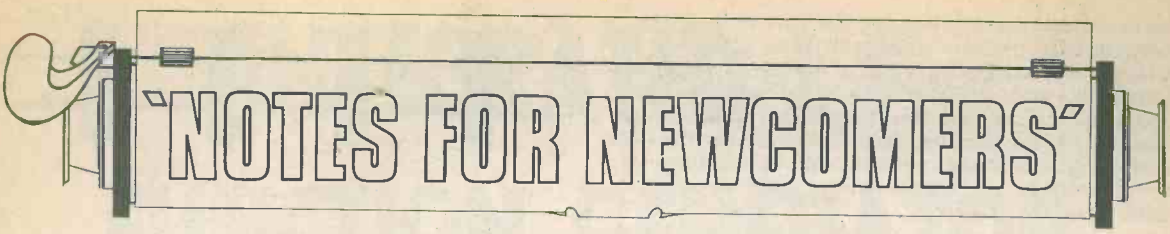


Fig. 7. The wiring in the power supply section is carried out as shown here

POWER SUPPLY WIRING

The power supply components are assembled on a 7-way tagstrip as illustrated in Fig. 7. This tagstrip is cut from a 28-way tagstrip "Type B", available from Doram Electronics, Ltd. After the four components have been wired to it, the tagstrip is mounted with 6BA screws and nuts, being spaced off from the case bottom by ½in. spacers. Note that a solder tag under one of the securing nuts is soldered to the end tag



Basic details on the winding of coils by the home-constructor.

by C. F. Edwards

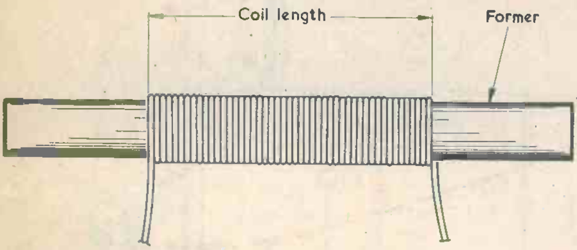
A wide range of ready-wound inductive components is available on the electronics retail market, these including transformers, tuned coils and chokes. Nevertheless, it is frequently desirable for the home-constructor to wind some of his own coils, in most instances either because a commercial coil of the required type cannot be obtained or because the coil is of a relatively simple nature which involves little expertise or tedium in its winding.

VARIOUS WINDINGS

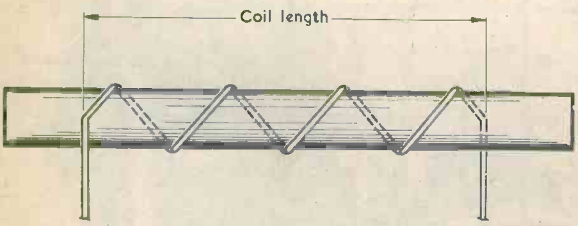
A common form of coil, as wound by a home-constructor, is shown in Fig. 1(a), and it consists of a single layer of wire with each turn touching the next so that the overall length of the coil is the product of the wire diameter and the number of turns. Coils of this nature are referred to as 'single-layer,' 'close-wound' or as being wound with turns 'side-by-side.' Once the start of the coil has been anchored to the former on which the coil is being wound it is normally quite a simple matter to wind on the wire by hand. Coils of this nature are used, typically, in medium and short wave tuned circuits.

An alternative type of coil is shown in Fig. 1(b). Here the wire is spaced evenly along the former and the winding instructions will state the number of turns required and the overall length of the coil. Such coils are most commonly encountered in very high frequency (v.h.f.) tuned circuits and require a small number of turns only.

A common type of winding, illustrated in Fig. 2(a), is known as a 'wave-winding.' This coil is produced by a factory winding machine in which a wire guide continually oscillates across the coil surface as the

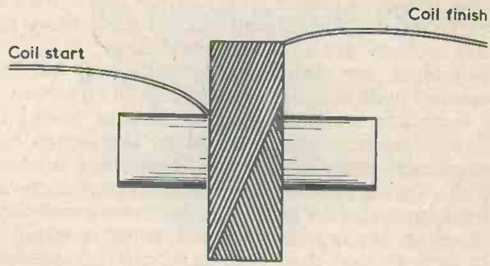


(a)

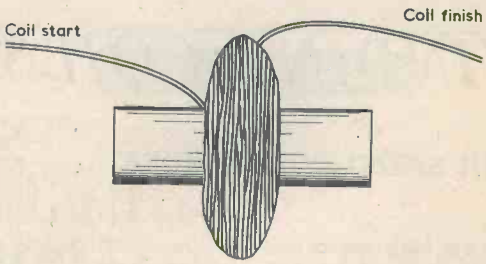


(b)

Fig. 1(a). A typical close-wound coil (b). A coil with turns spaced along the former. The means of anchoring the coil ends is not shown here



(a)



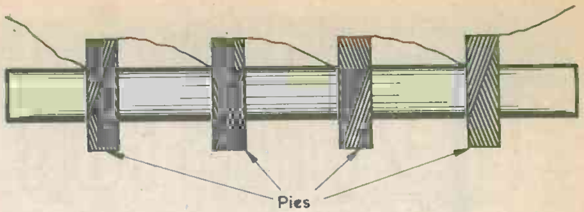
(b)

Fig. 2(a). A commercially manufactured wave-winding has a characteristic wire pattern (b). A home-made scramble-wound coil is not as neat or quite as efficient as a wave-winding but it is still adequate for many applications coil is wound, thereby causing the wire to be laid in a characteristic pattern with each turn alongside the next. Wave-windings have the advantage of being self-supporting and of having a relatively low self-capacitance since the wire near the finish of the winding is as far removed from the wire near the start as the coil structure permits. Wave-windings are encountered in i.f. transformers, long wave signal tuned coils and the like.

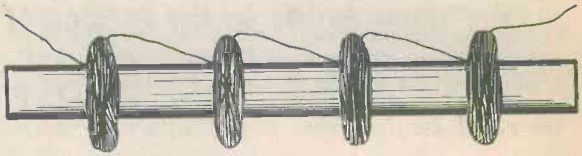
SCRAMBLE-WOUND COILS

The amateur cannot make wave-wound coils but, where a relatively high inductance is required on a short length of former, can produce a 'scramble-wound' or 'random-wound' coil, as illustrated in Fig. 2(b). This has roughly the same inductance as an equal length wave-wound coil having the same number of turns on the same diameter former, but its self-capacitance is higher because the turns near the winding finish are not as well spaced from those near the start as they are in a wave-winding.

A technique for reducing the self-capacitance of wave-wound coils is illustrated in Fig. 3(a), where the coil is wound in a number of sections or 'pies.' The overall self-capacitance is equal to the series combination of self-capacitances in each pie, and is smaller than that of a single pie of the same inductance. The winding approach in Fig. 3(a) is commonly employed in r.f. chokes. It may also be used in tuned windings, usually with an iron-dust core or ferrite rod inside the pies to ensure tight inductive coupling between them.



(a)



(b)

Fig. 3(a). The overall self-capacitance of a wave-wound coil can be reduced by winding it in separate sections connected in series (b). The same approach can be employed with home-made scramble-wound coils

Coils having scramble-wound pies, as in Fig. 3(b), can be wound by the home-constructor and offer a similar reduction in overall self-capacitance. ■

WINDING COILS FOR INDUSTRY

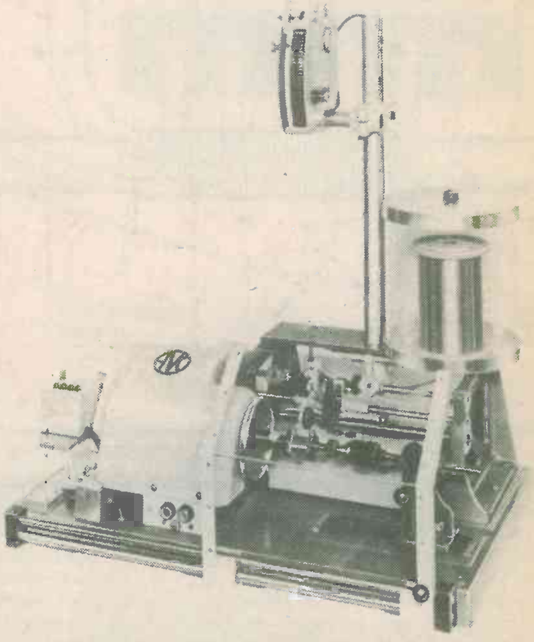
HIGH SPEED COIL WINDER

A new high speed coil winding machine has now been introduced by Avo Limited, Archcliffe Road, Dover, Kent, CT17 9EN. This, the type CW46, is suitable for winding a large variety of electronic coils at speeds of up to 10,000 r.p.m., with wire between 0.05 and 0.45mm. diameter. The machine is relatively small, may be bench mounted and is suited to the production of single coils.

Speed control is electronic and incorporates a slow start-up actuated by a foot control. A 4-figure predetermined turns counter is fitted, and this also controls automatic slow-down and stop points. A calibrated winding pitch control may be adjusted during winding. The coil being wound is observed through a transparent sliding safety guard.

The machine is supplied complete for winding, and there is a choice of wire tension system. This may be the type GTH Graduated Tension Unit together with the RH12 static reel holder, as shown in the photograph, or the RC2 General Purpose Reel Carrier. The Graduated Tension Unit limits the machine's wire capacity to between 0.05 and 0.25mm., but is ideally suited for high speed production of coils using wire diameters within its capacity.

Further information is available from the Coil Winder Division of Avo Limited.



The new Avo CW46 high speed bobbin coil winding machine. This incorporates automatic slow-down and stop programming

INTEGRATED L.F. FUNCTION GENERATOR

This concluding article describes the power supply and the construction of this comprehensive design. Also given are details of the setting up procedure.

Part 2

By Steve A. Money

In the article published last month a description of the circuit operation of the l.f. generator was given.

We now proceed to details of the power supply and of construction.

POWER SUPPLY

A simple regulated power supply providing a positive 10 volt output and a negative 10 volt output is required. The circuit of this is given in Fig. 6. A mains transformer with a centre-tapped secondary and a single bridge rectifier provide the raw d.c. supplies, and simple series transistor regulators with zener diode references give the required stabilization.

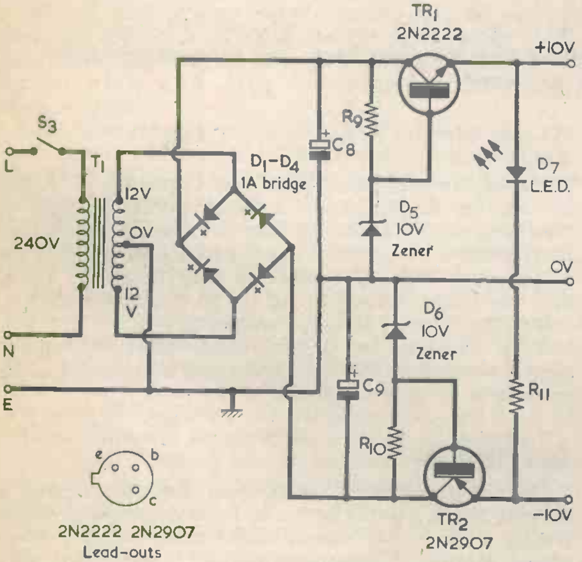


Fig. 6. The power supply for the l.f. generator employs simple voltage stabilizing circuits for both positive and negative outputs

A light-emitting diode, D7, is connected across the output of the power supply circuit to provide a "power on" indication. The l.e.d. can be any standard type and series resistor R11 limits the current which flows in it to about 12mA.

The mains transformer has a secondary of 12-0-12 volts at 0.25 amp. Transformers with this rating appear in the ranges of R. S. Components.

COMPONENTS

Resistors
(All 5%)
R9 1kΩ ¼ watt
R10 1kΩ ¼ watt
R11 1.5kΩ ½ watt

Capacitors
C8 470μF or 500μF electrolytic, 20 V. Wkg.
C9 470μF or 500μF electrolytic, 20 V. Wkg.

Transformer
T1 Mains transformer, secondary 12-0-12V at 0.25A.

Semiconductors
D1-D4 Silicon bridge rectifier, 1A 50 p.i.v.
D5 BZY88C/10
D6 BZY88C/10
D7 Light-emitting diode
TR1 2N2222
TR2 2N2907

Switch
S3 S.P.S.T. rocker switch (R. S. Components)

Miscellaneous
Instrument case, 8 x 5¼ x 2in.
2 graduated knobs (see text).
2 plain knobs
2 insulated terminals
Printed circuit board
3-Core mains lead
Wire, nuts, bolts, etc.

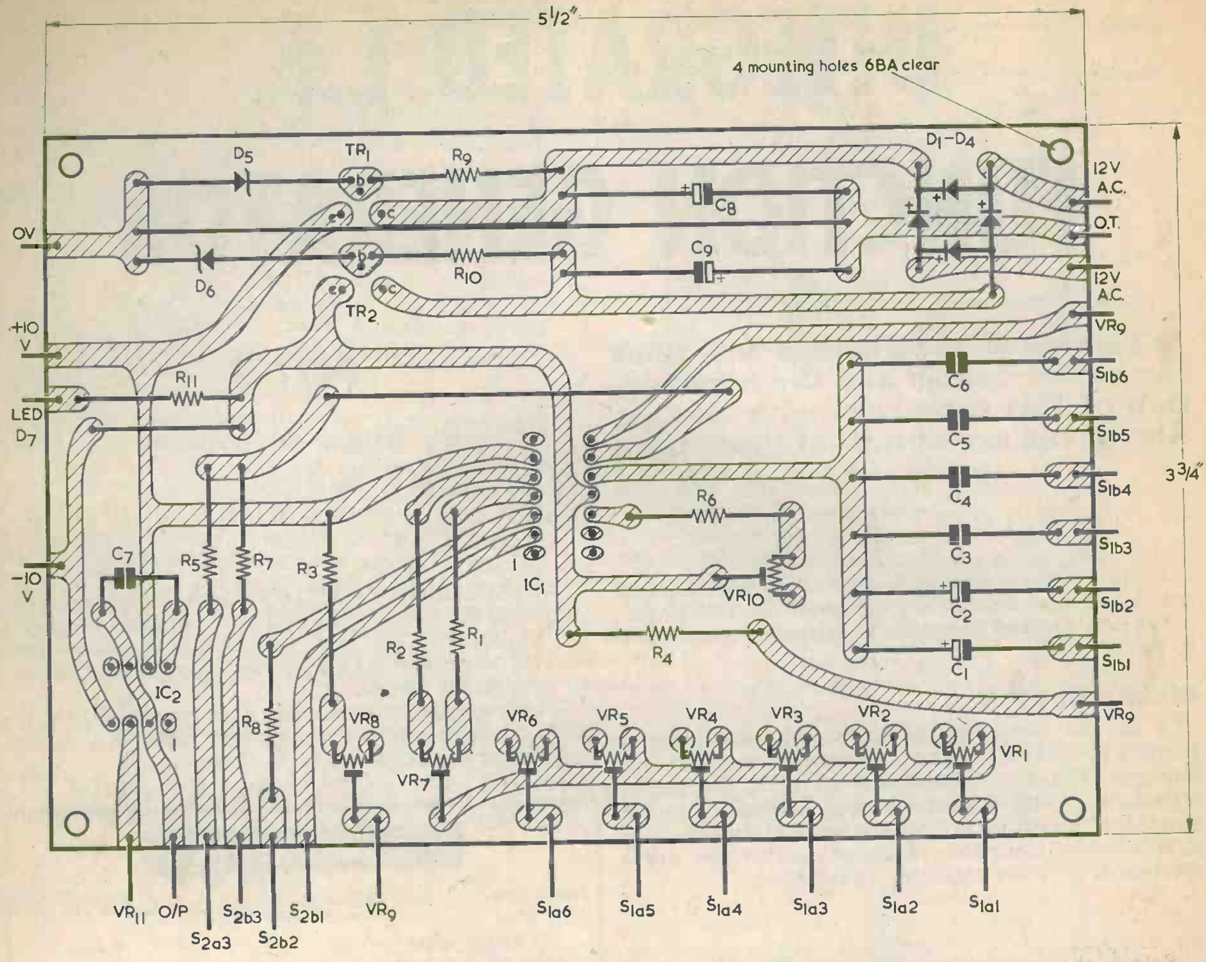


Fig. 7. The printed circuit board for the generator, viewed from the copper side. This is reproduced full-size and may be traced

CONSTRUCTION

A single printed circuit is used to carry both the waveform generating stages and the power supply circuit apart from the mains transformer. Fig. 7 shows the layout for the circuit card. This is reproduced full-size for tracing.

The complete generator is built into an 8 by $5\frac{1}{4}$ by 2in. instrument case, to make a compact and portable unit. A suitable manufactured case is the Bi-Pak type BV1. Fig. 8 shows the layout of the front panel and positioning of the components inside the case. The mains switch employed in the prototype for S3 is an R.S. Components rocker type. The earth lead of the 3-core mains lead connects to the case at a solder tag under one of the securing nuts for the mains transformer.

Since the current drawn by the generator is relatively small it would be possible to make an alternative version powered by internal batteries, thus producing a truly portable instrument.

Because the frequency scale is linear it is possible to use a simple calibrated knob with markings of, say, 0 to 10, on a frequency control potentiometer. A similarly scaled knob can also be used for the output level control Two rotary switches are also fitted to the panel, one, S1(a)(b), selecting the frequency range and the other, S2(a)(b), acting as a mode switch to select the desired output waveform.

VR9 should be wired such that its slider goes towards R4 (thereby increasing frequency) as its spindle is rotated clockwise.

SETTING UP

Having completely assembled the instrument a careful check should be made for any errors in either wiring or assembly which might cause trouble when power is applied. Assuming that all is well the supply can be switched on and the output voltages from the power supply measured. Each half of the supply should give approximately 10 volts output and the light-emitting diode should be glowing.

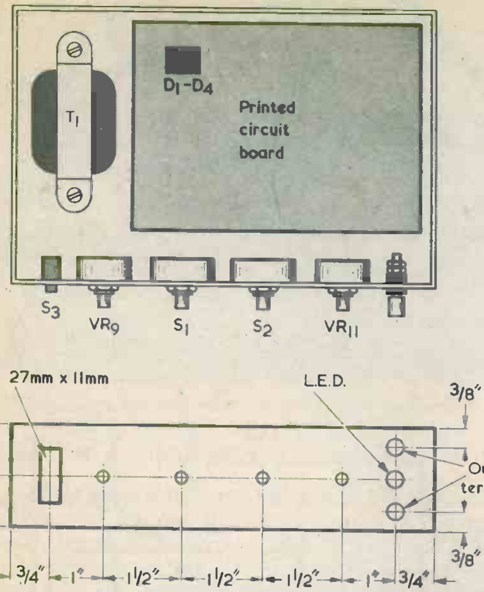


Fig. 8. The layout of components inside the case, and control positions on the front panel

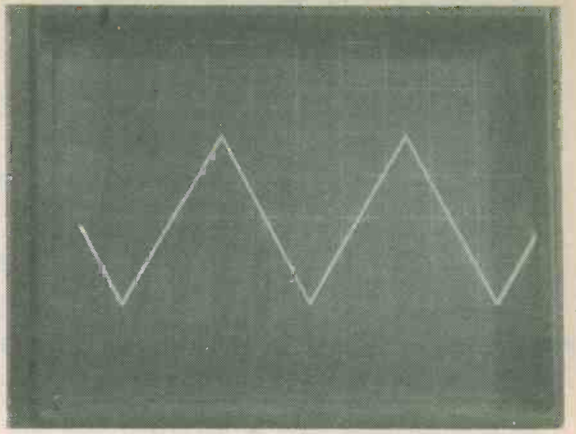
At this stage the outputs of the generator can be checked and the frequency scale set up. Select the "X100" frequency range (100 to 1,000Hz) and set the frequency control to its mid-scale position. The mode switch should be in the sine wave position and the amplitude control at maximum. Connect an oscilloscope to the output terminals and check that a sine wave of about 500Hz is produced. The waveform may be distorted but this will be corrected later. Next check that when the mode switch is in its other two positions the appropriate triangular and square wave forms appear at the output terminals.

Select the square wave mode and adjust the balance control VR7 until the two half-cycles of the waveform have equal time periods. At this stage the triangular and sine waveforms should be symmetrical.

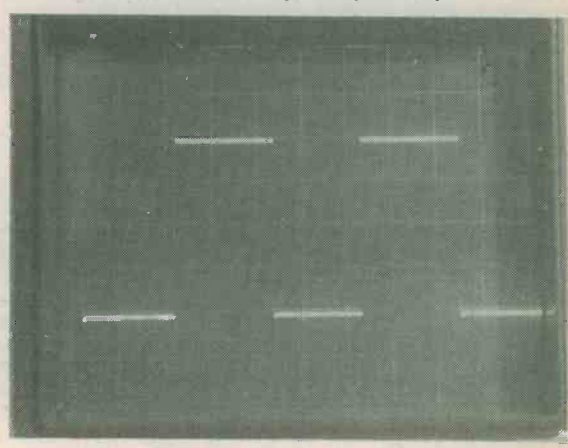
Set VR8 roughly to the middle of its range (or to insert about 160Ω if a 470Ω potentiometer has been used). With the "X100" range selected and the frequency control set to "10" an output frequency around 1kHz should be given. Pre-set potentiometer VR4 can now be adjusted to make the frequency exactly 1kHz. Now set the frequency control to "1" and adjust VR8 until the output frequency is 100Hz. The settings of these two potentiometers are to some extent interdependent so the procedure of adjusting VR4 and VR8 should be repeated until the frequencies are correct at both ends of the frequency control scale. Now the span of frequency is correctly set up and the scale calibrations will be consistent on all six ranges.

Set the frequency control to mid-scale ("5" on the dial) and select each frequency range in turn. Pre-set potentiometers VR1 to VR3, VR5 and VR6 are then adjusted to give the correct mid-scale frequency on each range.

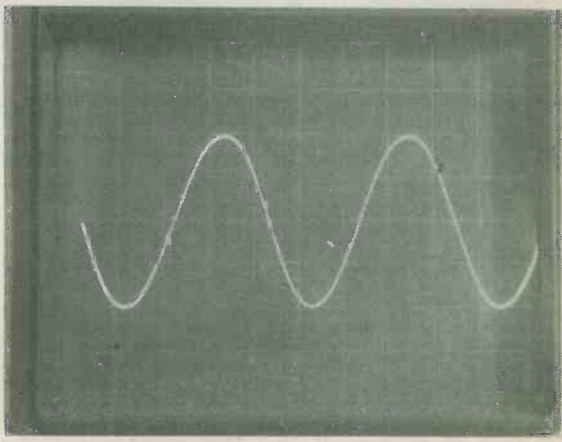
With sine wave output selected, adjust VR10 to produce minimum distortion of the waveform. Check that the control VR11 allows the output level to be adjusted up to a 2 volt peak output at full amplitude.



The triangular wave produced by the function generator has good symmetry



The square wave output. Rise and fall times are very sharp and overshoot is negligibly low



The sine wave output is produced by a shaping network and, as can be seen here, has excellent conformity with the true sine shape

All three outputs should be approximately the same in amplitude.

The instrument is now ready for use.

(Concluded).

WIND FORCE INDICATOR

Keep an eye on the weather outside with the aid of this simple home-constructed anemometer.

By V. S. Evans

Many households have a barometer and thermometer for "weather watching". The wind force indicator described here provides further useful information for making short-term forecasts.

The rotor assembly which senses wind force is mounted in the open away from wind obstructions. It is coupled to a read-out meter which can be positioned at any convenient point inside the house.

ROTOR ASSEMBLY

In the rotor assembly are three plastic funnels, modified to act as cups, which are fixed on arms spaced out at 120° intervals, as in Fig. 1. The arms are fitted to a metal skirt which is, in turn, secured to the spindle of a d.c. generator; the result is that both the skirt and the generator spindle rotate in the wind, the speed of rotation being proportional to the force of the wind. The output of the generator couples via a preset potentiometer to a 0-100μA meter, as in Fig. 2, thereby allowing the meter to give an indication of wind force. The meter is inside the house, being coupled to the generator outside by the two interconnecting wires.

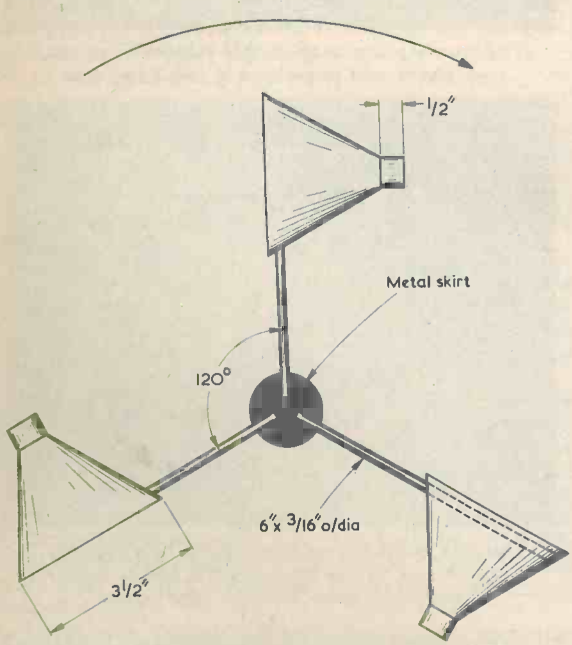


Fig. 1. The rotor assembly has three arms at the end of which are plastic funnels modified to act as wind cups

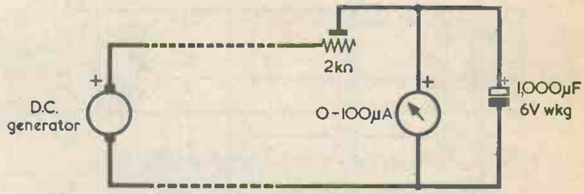
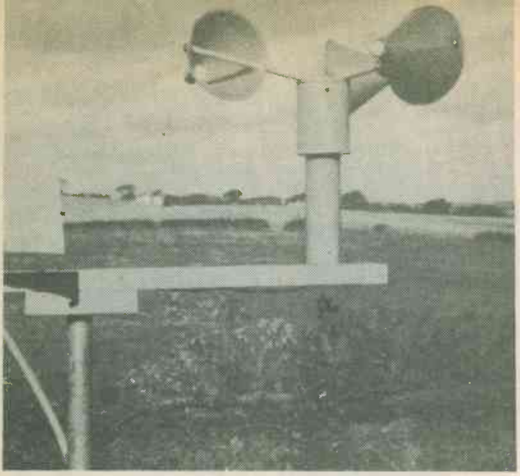


Fig. 2. The electrics comprise a small d.c. motor which functions as a generator and which is coupled to the rotor assembly. The output of the generator deflects the needle of a meter inside the house

The d.c. generator used by the author is an "Acadex" low voltage d.c. motor, which is available from J. Bull (Electrical) Ltd., 102-3 Tamworth Road, West Croydon, Surrey, CR0 1XX. It is found that the motor is a snug fit in a 6in. length of plastic tube of 1¼in. internal diameter, which may be obtained from builders' suppliers and the like. For added security a few turns of adhesive tape may be wrapped around the motor at the top before inserting it in the plastic tube. Two wires from the motor pass down along the inside wall of the tube as in Fig. 3. In this diagram the plastic tube is shown wider than scale to illustrate assembly more readily. Immediately under the motor is a wooden dowel of 1¼in. diameter which is a tight fit inside the plastic tube. The dowel can be any convenient length and its lower end is secured to the mounting beam for the assembly. The dowel has a vertical flat or groove in its surface to allow the passage of the wires from the motor. It is advisable to have the motor on hand before obtaining or preparing the plastic tube and dowel. Measurements for these can then be taken from the motor itself.

The metal skirt on which the three arms are mounted is a small can with an inside diameter of approximately 2in., and this may be prepared from a Heinz baby food tin. It is secured to the motor spindle by means of a Meccano gear wheel, the latter being bolted centrally to the top inside surface of the can.

The same bolts also hold the three arms of the assembly on the top of the can. The arms consist of 6in. lengths of aluminium or aluminium alloy tubing having an outside diameter of $\frac{3}{16}$in. The ends which secure to the top of the skirt are partly flattened in a



The rotor assembly and generator are mounted out in the open. The generator output is connected to a meter postioned inside the house.

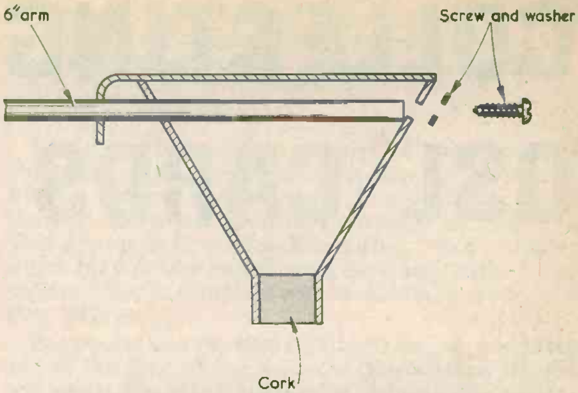


Fig. 4. Each plastic funnel is secured to its arm in the manner shown here

vice and are then drilled for the mounting bolts. Each cup is secured at the end of its arm in the manner shown in Fig. 4. The cups are plastic funnels having a diameter at their widest part of 3½in. Each spout is cut so that only ½in. remains and this is plugged with a suitable length of cork. The funnels used by the author have a small handle at one edge; each 6in. arm passes through this and then through a hole drilled in the funnel proper. A smaller hole is drilled on the other side of the funnel through which passes a large self-threading screw. This passes into the end of the arm, which may if necessary be flattened slightly to enable the screw to obtain good purchase. Application of a good adhesive to the inside surface of the funnel and the arm will give added long-term strength. Adhesive may also be applied to the inside ends of the arms and the top of the metal skirt.

PREPARING THE MOTOR

The motor has a brass ferrule on the end of the spindle which must be carefully reduced in diameter with a small file to enable it to fit the Meccano wheel. This should be an easy fit with no force used, as the motor can be easily damaged if harshly treated. A ¼in. hole is drilled in the metal skirt to allow access to the locking screw of the Meccano wheel.

When the assembly has been checked out and completed, the ¼in. hole in the skirt may be covered with tape. The whole may then be painted.

Initially, the pre-set potentiometer of Fig. 2 should be adjusted to insert maximum resistance into circuit. Its value can then be reduced as required after experience with the installation has been obtained. Should it appear, on the other hand, that the meter needle will be deflected excessively, further resistance may be inserted in series to protect the meter. For these reasons it is preferable to start using the equipment on a day when there is just a moderate breeze. The leads from the d.c. motor should, at first, be connected without the electrolytic capacitor across the meter. If the meter gives a reverse indication the leads are transposed. The electrolytic capacitor may then be connected. It causes meter reading changes to be presented smoothly.

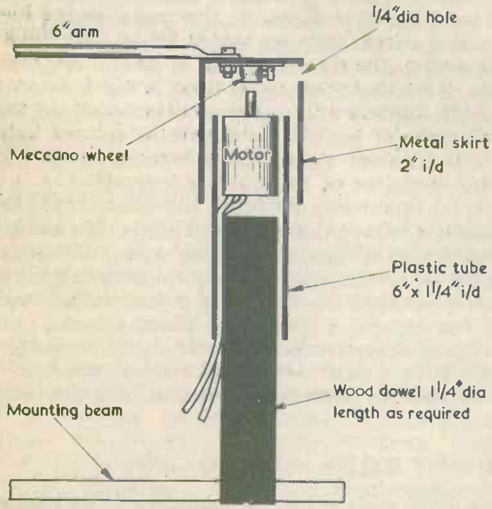


Fig. 3. Sectional side view illustrating the motor, the motor housing and the rotor assembly

Beaufort Wind Scale
(Ratings up to Force 9)

Force	Description	Strength (m.p.h.)
0	Calm	Less than 1
1	Light airs	1-3
2	Light breeze	4-7
3	Gentle wind	8-12
4	Moderate wind	13-18
5	Fresh wind	19-24
6	Strong wind	25-31
7	Moderate gale	32-38
8	Fresh gale	39-46
9	Strong gale	47-54

The writer calibrated his own meter to correspond to the Beaufort Wind Force Scale used by seafarers, yachtsmen and meteorological services. In this scale a wind strength of 47 to 54 m.p.h. is a gale Force 9, which is not often exceeded in the U.K. except in the extreme North. The accompanying table gives the relevant data, and observation of wind conditions over a period will enable an approximate calibration to be made. ■

COLLECTING QSL CARDS

by F. G. Rayer

An added interest for the short wave listener is the collecting of QSL cards from amateur transmitters. This article outlines the simple basic approach that is required for obtaining these prized confirmations of successful Dx reception.

When QSL cards are exchanged between amateur transmitting stations they are a confirmation that radio contact has been made. Various awards and certificates are issued, and can be claimed when the person concerned can produce the QSL cards which show the required contacts. These can be for working all continents, for working one hundred different countries, or for some other activity set out by the originators.

Transmitting amateurs will be conversant with QSL cards, and the details given here are primarily intended for short wave listeners. In the case of such a listener, he may obtain a QSL card from a station when he sends a report indicating reception of that station, together with details of frequency, time and other related information. Many short wave listeners make quite a sustained hobby out of collecting QSL cards.

THE QSL CARD

The QSL card is normally some form of post-card, which may be more or less ornate and which probably has spaces for information about the station issuing the card. This information will usually include details of the power used, mode of transmission, type of aerial, frequency band of operation, time at which operation took place, and so on.

The photograph shows a number of QSL cards. These particular cards were obtained by the author as confirmations of 2-way radio contacts, but they are the same types of card which would be issued to a short wave listener.

Enthusiastic short wave listeners usually have their own cards, which are of somewhat similar design and have spaces for the entry of information such as signal strength, time of day and other details. Such cards are occasionally home-made, but are more frequently obtained from printers who specialise in their production. Printed cards are almost essential for the enthusiastic short wave listener who regularly provides reports of stations received.

REASONABLE RETURN

It is not to be supposed that every amateur transmitting station will be wishing to receive all listener reports which may reach him. Nor will every transmitting amateur automatically send a QSL card to the listener who has sent a report.

For a reasonable return of QSL cards the short wave listener should provide a reception report which is of some interest or use to the transmitting station concerned. Some reports would be of very little interest and it would be pointless to send them. For example, if a station in a local town is regularly in contact with friends and other amateur stations in the neighbourhood he will be obtaining instant reports over the air from them, and a listener's report from nearby would be of little use or interest.

It is for this reason that care and selection is needed to obtain a reasonable return of cards. If a station is failing to obtain contacts or is perhaps conducting low power tests or using portable equipment, this is an occasion when even a local report, promptly received by post, could merit a QSL card. There are also special activity stations which usually acknowledge all reports with a card. Otherwise reports are best sent only to stations considered "distant" for the band in use.

THE RST CODE

The RST code allows Readability to be classified from R1 to R5, and signal Strength from S1 to S9. For c.w. transmissions, Tone is classified from T1 to T9.

Readability and Strength can be estimated from

RST Code For Reception Reports

Readability

R1 Unreadable
R2 Barely readable, occasional words distinguishable
R3 Readable with considerable difficulty
R4 Readable with practically no difficulty
R5 Perfectly readable

Signal Strength

S1 Faint, signals barely perceptible
S2 Very weak signals
S3 Weak signals
S4 Fair signals
S5 Fairly good signals
S6 Good signals
S7 Moderately strong signals
S8 Strong signals
S9 Extremely strong signals

Tone

T1 Extremely rough hissing note
T2 Very rough a.c. note, no trace of musicality
T3 Rough, low-pitched a.c. note, slightly musical
T4 Rather rough a.c. note, moderately musical
T5 Musically modulated note
T6 Modulated note, slight trace of whistle
T7 Near d.c. note, smooth ripple
T8 Good d.c. note, just a trace of ripple
T9 Purest d.c. note.

the figures in the table, though some receivers, and especially those designed for short wave reception of this kind, will have signal strength meters. Signal strength may exceed 9, and can then be given in decibels over 9, or as 9-plus. All signal strength reports are to some extent comparative only, as results naturally depend on the listener's receiver and aerial.

Another code, the International SINPO code, may also be used. The letters stand for carrier Strength, Interference, Noise, Propagation disturbance and Overall merit, and each item is classified by a figure from 1 to 5, with 1 representing the worst condition and 5 the best condition. (Details of the SINPO code and other reception codes, together with much other information of value to the short wave listener, are given in *Radio Amateur Operator's Handbook* which is available from the publishers of this journal: Editor).

AMATEUR PREFIXES

The amateur prefixes allow the country of origin of the signal to be identified. A list will be found in such sources as the *Radio Amateur Operator's Handbook.* The prefixes most likely to be heard when starting will depend largely on the band chosen. As examples, on 80 metres G (England), GW (Wales), GM (Scotland) and GI (N. Ireland) would probably be heard first. On a higher frequency such as 20 metres, the reception of may Europeans would be possible, including F (France), EA (Spain), Germany, Norway, Sweden and others. More distant signals, such as those from the U.S.A., Canada, U.S.S.R. and other countries outside Europe will also be heard at suitable times. At least some days of the week will usually provide reception of remote signals such as ZL (New Zealand) or VK (Australia) provided the correct times of day are chosen. There is, of course, more interest in the reception of calls seldom heard, or from remote countries, when using the DX (long distance) bands.

SENDING REPORTS

Probably the quickest return of cards will be obtained by sending reports directly to the station without delay, enclosing an International Reply Coupon and a self-addressed envelope for the card. This approach is worth-while with a "rare" country which may not be heard again for a long time. International Reply Coupons can be obtained from most Post Offices.

Because of the expense of direct posting, and often due to the lack of the station's full address, reports and cards are often distributed through the various QSL card bureau systems which are available for enthusiasts. There is, for instance, a QSL bureau operated for members of the Radio Society of Great Britain, 35 Doughty Street, London, W.C.1.

RECORDS

Transmitting amateurs are required to keep a log book showing periods of transmission and other details, and many short wave listeners keep a somewhat similar book for their own reference. This can have its pages ruled in columns in which can be entered details of time, the frequency or frequency band, station call, signal strength, station contacted by the station logged and so on, in addition to details of the station receiver, changes made to the aerial and other related information. Over a quite short period this will become a valuable reference to results obtained, and columns can be provided to note when a report is sent and a QSL card received. ■

"I'll go Dear. It's probably the postman with that rather special QSL card that arab fellow promised".

DISCRIMINATING CONTINUITY TESTER

By F. G. Lloyd

This tester gives an audible indication of continuity and is also able to discriminate between different values of resistance.

A continuity tester is hardly a glamorous item of test equipment and, in its simplest form, may merely consist of a testmeter switched to a low ohms range. A tester which gives an audible instead of a visual indication is usually to be preferred, however, particularly when complicated wiring is being traced through, since this enables the eyes to be kept continually on the wiring being traced.

An audible continuity tester could comprise an a.f. multivibrator coupled to a speaker with the two test leads in series with the multivibrator supply. Other similar arrangements can be readily conceived, but these are all capable of giving evidence of continuity when relatively large values of resistance are applied to the test leads. False indications can in consequence be obtained when checking continuity in circuits which are partly or fully wired up.

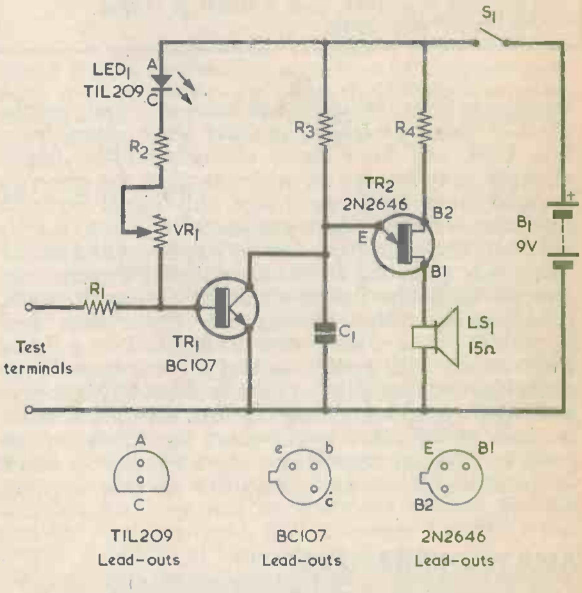
The continuity tester to be described here is capable of discriminating between different values of resistance and responds only to resistances which are lower than a pre-determined level. The pre-determined level ranges from 1 to 10Ω. If, for instance, the tester is set up to just give a response at 5Ω, it will not respond to resistances of 5.5Ω or more. Similar degrees of resolution can be obtained at other resistance values within its range.

UNIJUNCTION TRANSISTOR

The circuit of the continuity tester appears in the accompanying diagram, in which it will be seen that it is powered by a 9 volt battery.

TR2, R3, C1, R4 and LS1 form an a.f. unijunction transistor oscillator. If TR1 is ignored, this functions in the following manner. After switch-on, C1 commences to charge via R3 until the voltage on its upper plate reaches the triggering level for TR2 emitter. The capacitor then rapidly discharges via the emitter and base 1 of the transistor into the loudspeaker, after which it commences to charge once more until another pulse is fed to the speaker. A series of pulses are thus applied to the speaker, their frequency depending upon the values of C1 and R3 and the triggering voltage level of TR2. When the unijunction oscillator is running, LS1 produces a tone of around 400Hz at an adequate level for a normal workshop.

If we now bring TR1 into considefation we find that operation of the unijunction transistor oscillator is modified. When the test terminals are open-circuit a relatively heavy current flows into the base of TR1 via



The discriminating continuity tester has the circuit shown here. Continuity indications are given at resistances below a pre-determined level

COMPONENTS

Resistors
(All fixed values ¼ watt 10% unless otherwise stated)
R1 33Ω 5%
R2 330Ω 5%
R3 6.8kΩ
R4 270Ω
VR1 220Ω potentiometer, linear

Capacitor
C1 0.22μF plastic foil

Transistors
TR1 BC107
TR2 2N2646

Light-Emitting Diode
LED1 TIL209

Speaker
LS1 15Ω

Switch
S1 s.p.s.t. toggle

Battery
B1 9 volt type PP9 (Ever Ready)

Miscellaneous
Knob
2 test terminals
2 test leads with prods/clips
Case

LED1, R2 and VR1. This base current causes TR1 to turn hard on, whereupon its collector holds the upper plate of C1 nearly at the same potential as the negative rail. In consequence C1 cannot charge via R3 and the unijunction oscillator does not run. The only current flowing in TR2 is the small standing current between its base 2 and base 1.

If (after having adjusted VR1 to the requisite setting) the test terminals are short-circuited the voltage at TR1 base falls below the 0.6 volt level required to keep this transistor conductive and it turns off. C1 is now able to charge via R3 and the unijunction oscillator operates. No current flows into TR1 base, and the current passed by LED1, R2 and VR1 now continues to flow through R1 and the short-circuit across the test terminals.

In consequence, we have arrived at the condition in which the unijunction oscillator does not operate when the test terminals are open-circuit, and in which the unijunction oscillator runs and the loudspeaker produces an audible tone when the test terminals are short-circuited. The basic requirement of an audible continuity tester is in consequence achieved.

RESISTANCE ADJUSTMENT

As was just mentioned, VR1 has to be adjusted to an appropriate setting if TR1 is to be turned off when the test terminals are short-circuited. We can now examine this part of the circuit in more detail.

Assuming a voltage drop of 1.6 volts in the l.e.d., R2, VR1, R1 and whatever resistance is applied to the test terminals form a potential divider, with a voltage of 7.4 volts across them. It can be calculated that a voltage of 0.6 volt will appear at the junction of VR1 and R1 (and hence at the base of TR1) if the test terminals are short-circuited when VR1 inserts a resistance into circuit of 46Ω. When a 10Ω resistor is connected across the test terminals the calculated value in VR1 for 0.6 volt at the junction of VR1 and R1 becomes 157Ω. TR1 will change from the non-conductive to the conductive state, and vice versa, when the voltage at the junction of VR1 and R1 is around 0.6 volt, and this voltage will be given at about the calculated values in VR1.

To visualise the operating sense of the circuit, it is helpful to initially assume that VR1 is set to insert minimum resistance into circuit. This will cause TR1 to be turned on, and the oscillator to be silenced, regardless of whether there is a short-circuit or a resistance of 10Ω across the test terminals. If, now, the resistance inserted by VR1 is increased, a setting will be reached at which TR1 turns off and the oscillator starts to run. With a short-circuit across the test terminals the oscillator will start to operate when VR1 inserts about 46Ω. When there is 10Ω across the test terminals the oscillator will start when VR1 inserts about 157Ω.

Unfortunately, VR1 cannot be calibrated directly in terms of test terminal resistance because its setting depends on battery voltage. As battery voltage falls with time the required resistance settings in VR1 become progressively lower. A simple circuit of this nature hardly merits supply voltage stabilization and so VR1 is adjusted from time to time in the same way as the zero adjust control of an ordinary ohmmeter is occasionally adjusted.

VR1 is wired such that the resistance it inserts into circuit increases as its knob is turned clockwise. If it is desired to have the continuity tester respond only to direct connections between the test terminals, these are short-circuited and VR1 is advanced clockwise, from the extreme anti-clockwise position, until the tone is heard in the speaker. Should it be desired to have continuity indications for resistances up to and including say, 7.5Ω, a 7.5Ω resistor is connected to the test terminals and VR1 advanced clockwise for the same effect. When VR1 is turned clockwise, the initial frequency of oscillation is a little lower than that given when VR1 is further advanced. This is because there is a small range of adjustment in VR1 over which TR1 is not fully turned off. This point does not affect the operation of the tester.

The light-emitting diode is included to give an indication that the tester is switched on, and also to make positive use of the fairly heavy current, of around 15mA, which flows in the potential divider components below it. A large battery, such as the PP9, is preferred, and it is discarded when it is found that the oscillator cannot be silenced at any setting of VR1 with the test terminals short-circuited. With the prototype this occurs at a battery voltage just below 8 volts. Operation at a lower battery voltage may be obtained, if desired, by slightly reducing the value of R2. However, the value of R2 should not be so low as to impair operation with a brand-new battery giving a voltage in excess of 9 volts. The author found that the value specified for this resistor gave the best compromise. The total current consumption of the tester is approximately 18mA.

The tester may be assembled in a small case with LED1, VR1 and S1 on the front panel. An aperture can be provided on this panel, also, for the loudspeaker, which may be a small 3 to 4 inch type. VR1 can be a standard size carbon potentiometer, or wire-wound. ■

Trade News . . .

DUAL TRACE OSCILLOSCOPE

The Scopex 10MHz oscilloscope type 4D-10. This is especially suitable for test, fault-finding and quality control applications in elecronics factories

The first photograph illustrates the Scopex dual trace 10MHz oscilloscope type 4D-10. This is manufactured by Scopex Instruments Limited, Pixmore Industrial Estate, Pixmore Avenue, Letchworth, Herts, and has been selected by many electronics companies for production and quality control.

The 4D-10 oscilloscope is designed for operation by semi-skilled personnel. Single trigger control selects both the polarity and trigger level functions, and a trace-locate facility returns a "lost" trace to the viewing area. The layout of the front panel of the 4D-10 together with the lack of superfluous controls makes it easy to use, and it is stated that the test engineer spends his time testing the product and not trying to operate the oscilloscope.

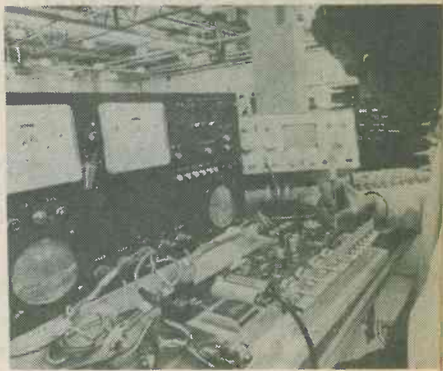
The accuracy rate is plus-or-minus 5% on both vertical and horizontal systems.

The Scopex 4D-10 has been in production for over three years and in this time has acquired a record of high reliability. Indeed, one of the production instruments operated continuously for over 10,800 hours without failure, the test being halted only by power restrictions.

A recent purchase of 35 of the oscilloscopes came from Fidelity Radio Limited for use in their 200,000 sq. ft. factory at Victoria Road, London NW10, where they are being applied to make the task of testing the company's over 15 different products easier, and more accurate and efficient. Fidelity Radio's range of products covers a wide spectrum in the entertainment field, ranging from radios and unit audios to stereo amplifiers and tuners

To solve their testing problem, Fidelity Radio developed a purpose-built test console to supply all the test signals required for checking amplifiers and tuners under test, incorporating meters in the console to monitor the performance of the various sections of the test item (e.g. scratch and rumble filters in the case of an amplifier).

However, metering alone cannot tell the whole story, as it does not allow visual inspection of the output waveform, and when working to low distortion limits this becomes an important factor. This is where the Scopex oscilloscopes come in. The d.c. to 10MHz bandwidth of the oscilloscope gives ample performance, and the dual trace facility allows both the left and right hand channels of a stereo system to be checked simultaneously.



The Scopex oscilloscope in use at the Victoria Road premises of Fidelity Radio. Here, it is checking the performance of a radio tuner

With the combined effect of the purpose-built console and the Scopex 4D-10, Fidelity have improved test times and therefore efficiency which, in turn, guarantees the high standard of their products, many of which are destined for the export market.

The 35 type 4D-10 oscilloscopes now employed at Fidelity are installed in the final test and fault-finding areas. The second photograph shows the oscilloscope in use during the checking of a Fidelity Radio Type 20-20T tuner.

NEW INVERTER

Jermyn Manufacturing, of Sevenoaks, Kent, announce an all-silicon transistor version of their d.c. to a.c. inverters.

When the mains electricity supply fails due to strikes, power cuts or failures, the inverter unit enables central heating, tropical fish tanks, professional equipments (such as dentist's drills, telex machines, etc.), office equipment and ordinary lighting to keep functioning.

Even if nobody is present at the time when the mains fails, the inverter unit automatically switches to the load, running it for up to three hours from an ordinary car battery. The load is switched back automatically to the normal mains when the supply is restored, and the unit then acts as a battery charger, keeping the battery topped up until the next mains failure.

Two versions are available, depending on the size of the load. These are a 150 watt version running from one 12 volt car battery, and a 300 watt version running from two 12 volt car batteries in series.

The inverter unit also allows an ordinary car battery to run any normal household mains equipment, such as a power tool, in the garden or in the country away from mains electricity. It can also power television receivers and lighting when camping, boating or caravanning. The unit is portable, measures 10 by 8 by 6in. and weighs 20lb.

"THE VARIABLE ZENER"

In this article, which appeared on page 348 of the last January issue, the caption to Fig. 3 referred to a 5Ω potentiometer. The potentiometer value should have been 5k Ω, to agree with the text.

In your workshop

'Won't play loud or modern records'. With this mysterious message to work from, Smithy the Serviceman, aided as always by his able assistant Dick, embarks on the repair of a mono record player.

A blustery March wind blew outside the Workshop, causing the television aerial mast on the roof to swing crazily back and forth. A sudden gust made the windows rattle, and the length of corrugated paper, affixed to the door that morning by Dick to stop the draught, made a helpless fluttering noise. A rush of hailstones clattered against the windows, the lower edges of which were opaque under an external layer of dripping half-frozen water.

"A rough one today, Skip," remarked Dick.

"Arr, so it be, Dick lad," replied Smithy with a broad Cornish accent.

"Force 8 at times, I reckon."

"Arr, that could be true, me boyo."

"I think," said Dick, "that I'd better nip round and batten down the hatches, throw out the fenders, splice the mainbrace and make ready to heave to."

"Arr," said Smithy.

"Arr," said Dick.

RECORD PLAYER

The pair looked at each other and chuckled. They had reason to be pleased with themselves. All was warm and snug inside the Workshop and they had both had a very successful day, with the result that the "Repaired" rack groaned under the weight of satisfactorily serviced radio and television receivers. There was only an hour to go before they made their ways home, and they looked forward to a comfortable evening in front of the box watching BBC2 (Smithy) and ITV (Dick).

"There's just one job left," remarked Smithy, pointing to a solitary record player on the "For Repair" rack.

"Shall we," asked Dick, "have a go at it together?"

"That would be an excellent idea," replied Smithy. "Perhaps you could bring it over to my bench."

Obligingly Dick rose, walked over to the rack, picked up the record player and carried it to Smithy's bench. He glanced at its exterior, noting that it had its own internal speaker, then opened its lid.

"Hallo," remarked Smithy. "Someone's tied a label to the turntable spindle."

He leaned forward and quickly removed the label.

"It's got something written on it," said Dick, interested.

"You're right," confirmed Smithy, as he peered at the label. "It says: 'Won't play loud or modern records'."

"Stap me," remarked Dick. "That's a bit cryptic, isn't it?"

"It is rather," agreed Smithy. "Obviously it's the customer who tied that label on."

Dick took it from him.

"The writing's pretty shaky," he commented. "Perhaps this record player belongs to someone who's getting on a bit."

"That's possible," conceded Smithy. "Let's try and analyse what the message means. It doesn't make sense to assume that the record player will play any record provided that it isn't loud or modern, so the message must mean that there are two faults in the player. One is that it won't play loud and the other is that it won't play modern records."

"I wonder," said Dick thoughtfully, "what is meant by 'modern records'."

"Perhaps," suggested Smithy, 'it means l.p.'s. Perhaps this old bloke has got a lot of 78's which the record player can cope with, whereas it won't work with l.p.'s."

"Don't tell me," said Dick incredulously, "that anybody actually *plays* 78's these days."

"They could do," replied Smithy defensively. "If the chap who owns this record player is an old geyser he may be quite happy playing 78's. In any case, how otherwise can you explain the reference to 'modern records'?"

"Well," said Dick doubtfully, "if that's the case there must be a fault on the pick-up head which allows only 78's to be played."

Smithy came to a decision.

"All right," he said. "Then we'll proceed from that supposition and check the player first with a 78 record."

He looked more closely at the record player.

"Ah yes," he went on. "I recall this job now. It's a fairly recent model and it gives a mono output on its own internal speaker. You can get stereo out of it by plugging another amplifier and speaker into a jack socket at its side. The external amplifier then handles the left-hand channel whilst the internal amplifier deals with the right-hand channel. Dig out a 78 record and put it on, Dick, whilst I have a look for the service manual."

Smithy walked over to the filing cabinet. Dick looked through a small stack of records on the shelf of Smithy's bench and selected a 78 r.p.m. disc with a scratched label. He set up the record player for 78 r.p.m. operation, plugged it into one of the mains sockets at the rear of Smithy's bench and switched it on. Next, he placed the record on the changer mechanism and activated it. The disc clattered down onto the turntable, the pick-up arm rose and then obediently lowered itself on the edge of the disc. A scratchy hiss became audible from the speaker of the record player, to be folllowed by the sound of music at a comfortable volume level.

"Humph," remarked Smithy, "that doesn't sound too bad to me."

The Serviceman had returned from the filing cabinet and now stood behind his assistant with a service sheet in his hand.

"There's only one tone control," stated Dick. "Let's see what that does."

Dick adjusted the tone control, to find that it operated smoothly, cutting down the treble as it was turned clockwise.

"Nothing wrong there," commented Smithy. "Try turning the wick up."

Dick advanced the volume control. The level of sound from the speaker increased, and there was now obvious distortion on the louder passages. As Dick increased the volume level the distortion became more and more evident, with only the quieter parts of the recording being reproduced correctly. Dick turned down the volume control.

"Well," commented Smithy, "that explains the 'won't play loud' part of the customer's message. The amplifier in this record player is obviously clipping at a much lower signal voltage level than it should do. We shouldn't have much of a problem here, so switch it off and let's take a look at the circuit diagram."

Dick turned off the record player, after which Smithy opened the service manual at its circuit diagram and laid it out on the bench. (Fig. 1.)

"There aren't many complications here," remarked the Serviceman in a pleased tone of voice. "In fact, it's a very nice straightforward circuit. You don't have to look far, for instance, to see that there's a voltage gain of about 100 times from the base of TR2 to the emitters of the output transistors."

VOLTAGE GAIN

Dick peered at the circuit and frowned.

"Where," he asked, "does it say that?"

"There isn't a statement in so many words," replied Smithy. "The voltage gain is defined by the values of the

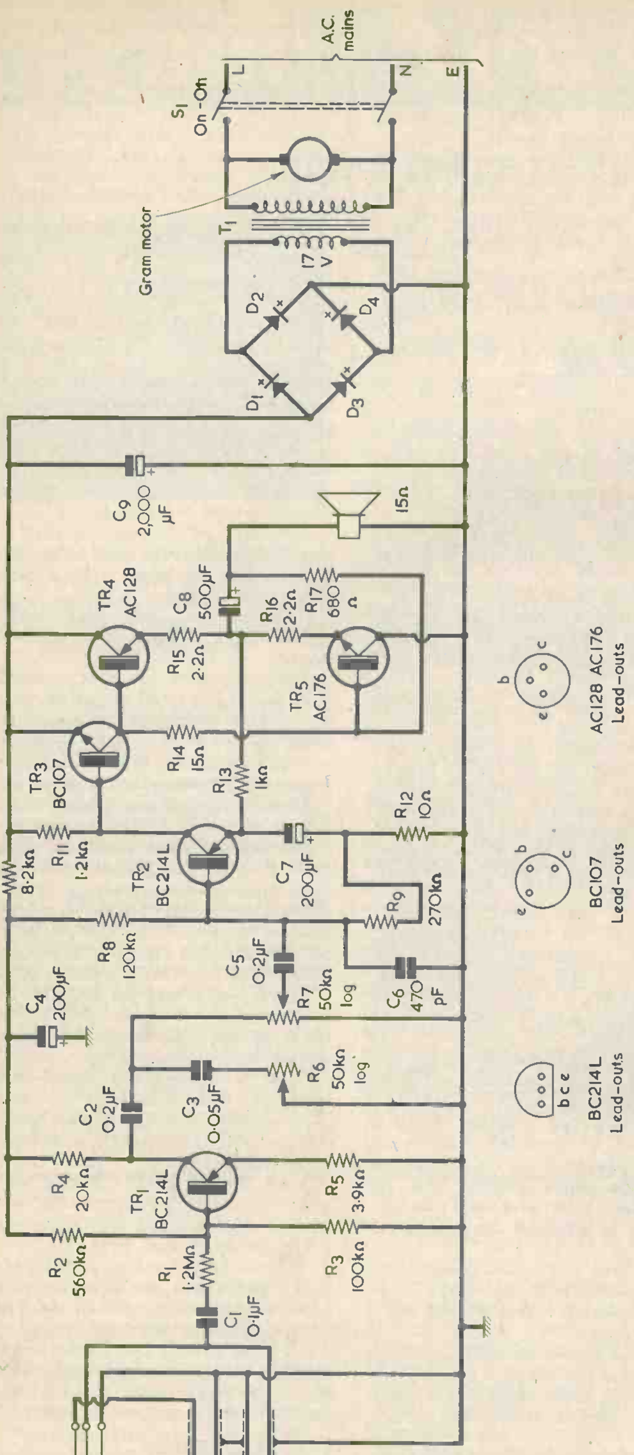


Fig. 1. Representative circuit for a record player having an integral loudspeaker. The left-hand channel can be taken to an external amplifier from the stereo jack. R6 is the tone control and R7 the volume control

feedback resistors, and is equal to R13 divided by R12. This is 1k Ω divided by 10 Ω, which is equal to 100 times."

"Oh, I see what you mean now," said Dick. "There's a.f. feedback from the output emitters via R13 to the emitter of TR2. This *must* give negative feedback because when, say, the emitter of TR2 goes positive so also does its collector, whereupon TR3 gives phase inversion."

"You've got the idea," confirmed Smithy. "The output emitters are in phase with the collector of TR3 and so, when the emitter of TR2 goes positive the output emitters go negative and apply feedback to TR2 emitter via R13. The overall gain is then defined by R13 divided by R12. There's negative feedback at d.c. as well. This time the feedback is 100% by way of R13 on its own since C7 can be looked upon as an open-circuit at d.c. The standing output emitter voltage is then equal to the emitter voltage of TR2 less a small voltage dropped in R13 due to TR2 emitter current. The output emitter voltage is set up at about half supply potential by giving R8 and R9 values which cause the base of TR2 to be just a little higher than half the supply voltage."

"Fair enough," remarked Dick. "You were pretty certain about the voltage gain from TR2 onwards. What about the voltage gain in TR1?"

"If," replied Smithy, "the collector load for TR1 is R4 on its own, the voltage gain would be about 5 times." (Fig. 2(a).)

"Hell's teeth," snorted Dick vexedly. "How on earth can you be so *sure*?"

"Just look at the circuit," stated Smithy in reply. "TR1 has an unbypassed emitter resistor of 3.9k Ω and a collector load resistor of 20k Ω. If a signal voltage is applied to TR1 base, emitter follower action will result in a signal of almost equal voltage amplitude appearing across R5. There will then be a corresponding signal current flowing in this resistor. Now the collector current of the transistor will be almost exactly equal to its emitter current, and so the same signal current flows in R4. Since R4 has about 5 times the value of R5, the signal voltage developed across R4 will then be about 5 times that across R5, which is the same as saying that it's about 5 times the input signal voltage at the base."

"Oh, I get it," responded Dick. "In other words the voltage gain is simply equal to R4 divided by R5."

"That's right," confirmed Smithy. "This only applies, of course, when the emitter resistor is unbypassed. Also, the relationship doesn't hold true if the collector load resistance is very much higher than the emitter resistance because the gain of the transistor has then to be taken into account. But for low ratios, such as the 5 to 1 ratio we have here, the gain is defined by the values of the two resistors. Actually, this is rather a good circuit for a low gain single transistor a.f. stage because

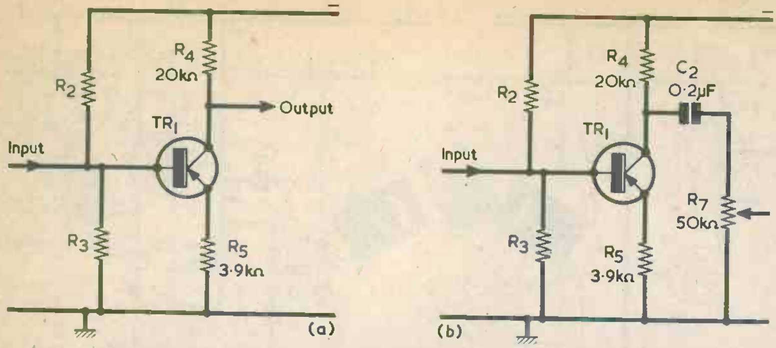


Fig. 2(a) Voltage gain of a single amplifier stage such as this can be governed by the values of the collector and emitter resistors (b) In the record player amplifier, the volume control is effectively in parallel with the collector load

of its fixed gain and the fact that it incorporates a high level of negative feedback."

"You said," stated Dick, "that the gain figure of 5 times applies when TR1 collector load is R4 on its own."

"That's right," agreed Smithy. "We have to remember that in practice R4 is coupled via C2 to the treble cut tone control circuit given by C3 and R6, and to the volume control R7. If we ignore the tone control, and if we assume that the volume control is at a low setting, then the collector load becomes R7 in parallel with R4, which works out, rough check, at about 14kΩ. So the voltage gain in TR1 when R7 is taken into account falls to about 14kΩ divided by 3.9kΩ, or approximately 3.5 times." (Fig. 2(b).)

"What happens if you put R7 to a high volume level?"

"When R7 is at its maximum setting the input impedance of TR2 base is also coupled across R4. The input impedance at TR2 base, in the negative feedback circuit in which it appears, will be some 50k Ω or so, and this will further reduce the gain in TR1 a little. This reduction in gain will, however, be much lower than the increasing overall gain in the complete amplifier as the setting of R7 is advanced and so the effect will be unnoticed."

"Will the tone control circuit also affect gain?"

"Oh yes," said Smithy. "The tone control given by R6 and C3 is a bit of a brute-force arrangement, but it is very effective nevertheless. When R6 inserts minimum resistance into circuit, C3 is virtually connected directly across the collector load of TR1, whereupon the effective collector load value, and hence TR1 gain, decreases as frequency increases. This gives a high level of top cut. As the resistance inserted by R6 is increased the top cut effect reduces until, with R6 at maximum resistance, it is nearly absent. Okay?"

"Yeah, sure."

"Good," said Smithy briskly. "Now let's stop nattering and think about fixing this record player. We know that it's clipping at a fairly moderate volume level, so the next job is to get the works out and take a few voltage measurements."

Dick checked through the service manual instructions and then, after securing the pick-up arm to its rest and removing the record player mains plug, he took off the bottom of the case. After some minutes' work he was able to remove the printed circuit board, which he rested against the open bottom of the record player. The board was coupled to the other components inside the base by way of the input and output leads and the power supply leads. These leads were short, making it necessary for the case to be on its side.

"Humph," grumbled Smithy, "we won't be able to play any records through the amplifier if the dratted case has to go on its side. Oh well, we'll have to see what we can find with straightforward direct voltage checks. Switch it on again, Dick."

VOLTAGE CHECKING

Dick plugged the record player into the mains supply, then switched on. Smithy pulled his testmeter towards him and selected a voltage range.

"Now, the first thing to do," he remarked, "is the obvious one of checking the main rectified supply voltage. This amplifier has got the positive line at chassis potential, so I'll clip the positive lead to its metalwork."

Having carried out this action, Smithy examined the printed board carefully. He then applied the negative test prod to a copper area which snaked across the board. (Fig. 3(a).)

"Ah," he remarked. "This is what I'd expect: about 23 volts. The output emitters come next, so let's see what voltage we've got there."

Smithy applied his negative test prod to the board at the junction of the low-value resistors, R15 and R16. (Fig. 3(b).) He looked at the meter and grinned.

"Blood!" he exclaimed happily. "The meter reading is only about 3 volts. Well, that explains the clipping distortion we had. The output stage can only handle output signals up to 3 volts peak, after which it starts clipping on positive half-cycles."

"Could this mean," said Dick, "that

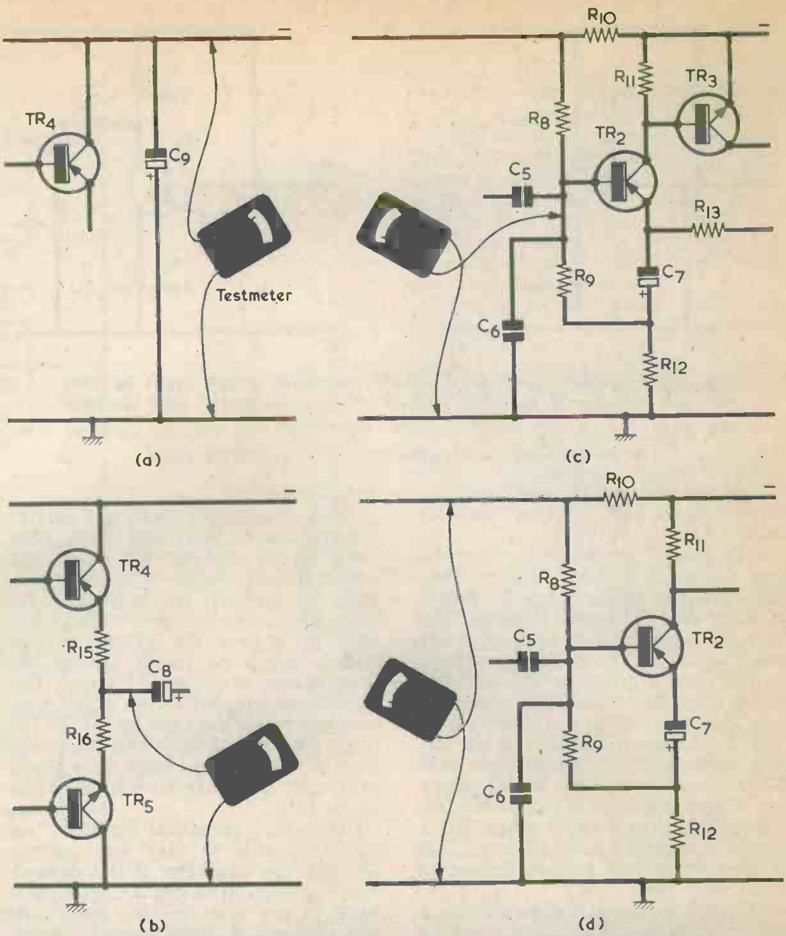


Fig. 3. Successive steps in tracing the course of clipping at low volume levels in the record player amplifier. The supply voltage is checked in (a), and the voltage at the output emitters in (b). Next to be measured is the voltage at TR2 base, and, finally, the supply voltage after the decoupling resistor, R10

TR5 is faulty? Perhaps it's drawing too much current and is therefore pulling down the voltage at the emitters."

"That's extremely unlikely," retorted Smithy a little irritably. "The output transistors handled the signal quite happily below the clipping level and so there's no reason to imagine that either of them could be faulty. It's much more likely that they're getting a wrong control voltage from TR2. The next thing to do is to see what sort of voltage there is at TR2 base."

After checking with the printed circuit layout diagram in the service manual, Smithy applied his test prod to the base of TR2. There was a crackle from the record player speaker. He glanced at his meter, selected a lower voltage range and gave a grunt of pleasure. (Fig. 3(c).)

"Now, that's what I like to see," he pronounced jubilantly.

"What's the voltage?"

"Just over 1.5 volts," said Smithy cheerfully. The voltage at TR2 base is much too low and so, in consequence, is the voltage at the output emitters."

"Shouldn't the voltage at TR2 base be higher than the voltage at the output emitters? You said just now that a voltage was dropped across R13 due to TR2 emitter current. There will also be a further 0.6 volt drop in TR2 base-emitter junction."

"The voltage at TR2 base will almost certainly be higher than that at the output emitters when I take the test prod off," replied Smithy. "Don't forget that I'm getting the base voltage reading by way of the high-value resistor, R8, and so the current drawn by the meter will make the voltage reading lower than its actual value. Still, I must confess it shouldn't be all *that* low. I think I'll risk a guess right now, and say that R8 has gone high in value. Before I commit myself, though, I'll just confirm that it's got a decent supply voltage at its top end."

Smithy switched to the previous voltage range and applied the negative test prod to the decoupled rail supplying R8. (Fig. 3(d).)

"There's nothing wrong here," he remarked. "I'm getting a reading of about 19 volts. Okay, Dick, switch the record player off and I'll check the value of R8."

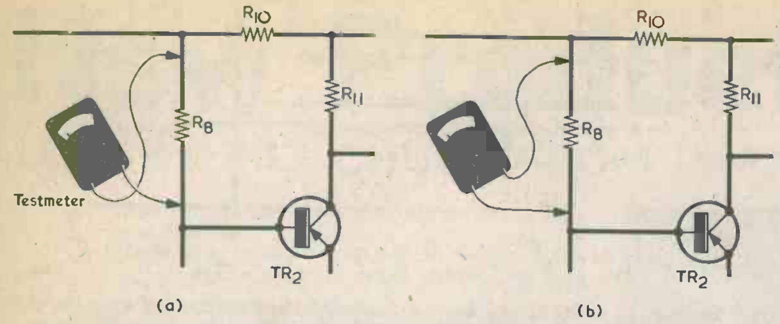


Fig. 4(a). When Smithy first checked the value of R8m he obtained a falsely low resistance reading
(b). A more realistic reading was given when the test prods were transposed

As Dick turned off the record player Smithy removed the positive test clip from the chassis, switched the testmeter to a high resistance range and adjusted its set zero control. He then applied the test prods across R8. (Fig. 4(a).)

"What's the meter reading, Dick?"

Dick looked down at the meter, then frowned.

"Blimey," he said. "That resistor hasn't gone high in value, it's gone *low*! The meter reading is only about 15kΩ."

Smithy chuckled, then reversed the test leads. (Fig. 4(b).)

"What's the meter say now?"

"Ah," said Dick, "that's more like it. It's showing about 600kΩ."

"Good, good," remarked Smithy, pleased. "Now, that's much higher than the 120kΩ value which R8 should have and so it looks as though we've run this snag down to earth. Quite an easy one, wasn't it? I'll leave you to replace that resistor, Dick."

"Okeydoke," responded Dick equably, as he walked towards the spares cupboard. "It's about time I had a bit more of the action on this player. Incidentally, why did the meter give a low resistance reading when you first connected it to R8?"

Smithy glanced at the circuit.

"What was happening," he remarked, "was that I'd connected the testmeter with a polarity which caused current from its internal battery to flow through R10, R11 and the forward biased collector-base junction of TR2. So R10 and R11 were effective in parallel with R8. The reading was higher than the actual value of these two resistors because of the 0.6 volt drop in the collector-base junction." (Fig. 5.)

"Oh, I see," replied Dick, returning to the bench with a replacement 120k Ω resistor. "So you just swapped the two testmeter leads over?"

"That's right," confirmed Smithy. "All circuits employing transistors can be looked upon as bristling with hidden diodes when the power is switched off, the diodes being given by transistor base-emitter and base-collector junctions. So whenever you're checking resistances in a transistor circuit you should always connect the testmeter leads first one way and then the other. If the two readings so given are different, you then assume

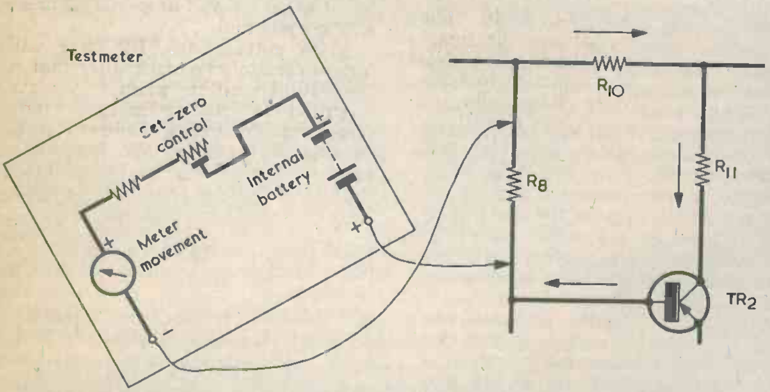


Fig. 5. Illustrating why a low reading was given in Fig. 4(a). The internal circuitry in the testmeter when switched to read resistance is shown in simplified form. Current flows from the positive terminal of the battery through the meter movement, R10, R11 and the forward biased collector-base junction of the transistor to the battery negative terminal

that the higher one is nearer the truth and that the lower one is due to a transistor acting as a diode somewhere. When you get that faulty resistor out you'll find that its actual resistance is higher than the 600k Ω meter reading we had just now. This is because, whilst it's on the board, it's shunted by R9, R12, R3 and R2 in series."

It was not long before Dick removed the resistor. As a matter of interest he checked its value, and found it to be approximately 1.5MΩ.

MODERN RECORDS

Cheerfully, Dick set about soldering in the new resistor. After some moments he replaced Smithy's soldering iron on its rest with a flourish, and then examined his handiwork. As was always the case with Dick, the solder joints were immaculate.

"All ready to go, Smithy."

"Fair enough," replied the Serviceman, switching the testmeter back to its voltage range.

Dick turned on the record player amplifier, and Smithy applied the testmeter leads once more between chassis and the output emitters at the junction of R15 and R16. The needle rose to indicate 11 volts.

"That," said Smithy exultantly, "is much more like it. Now, if you could re-install that printed circuit temporarily in the case we'll check out the performance of this amplifier."

Smithy watched his assistant benignly, as the latter replaced the printed board inside the record player cabinet. He then turned the record player upright and once more set up the 78 test record on the changer. Unclipping the pick-up arm, he next switched on and actuated the changer mechanism. As the record rotated the pick-up descended on it and the recording became audible from the speaker.

Dick adjusted the volume control. The amplifier now operated satisfactorily at all volume levels up to maximum. Dick operated the "Reject" control and the pick-up arm returned to its rest.

"Well,' said Smithy, "it's playing loud now, so that's got the first snag on that label cleared."

"There's still the 'modern record' bit," Dick reminded him. "We've got it working with 78's only up to now."

"True," agreed Smithy. "So, turn the pick-up over and try an l.p."

Dick removed the 78 r.p.m. record, and found a rather battered l.p. disc, which he put on the changer. He altered the turntable speed and turned over the pick-up indicator flag, then started the mechanism again.

Dick and Smithy listened carefully.

"It sounds all right to me," remarked Smithy critically, as he adjusted the volume control. "Perhaps the full volume level is a wee bit lower than I'd expect, but it's not so noticeably low as to constitute a fault. Let's have a look at that label again."

"Here it is."

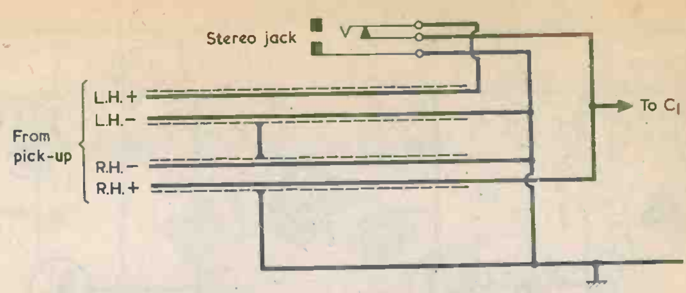


Fig. 6. The input circuit of the record player amplifier. The plus and minus signs indicate phase

Dick handed it over to the Serviceman who scrutinised it and frowned.

" 'Won't play loud or modern records'," he repeated in a puzzled tone. "But the darned thing *is* playing a modern record."

The Serviceman scowled at the record player, then re-examined its circuit diagram in the service manual.

"Eureka!" he said suddenly.

"Have you thought of something?"

"Indeed I have," replied Smithy excitedly. "I think I've solved this little mystery."

He rushed towards the pile of test records, and selected another l.p. Returning to the record player, he placed the new disc on the changer, then actuated the mechanism to reject the existing one. The new record fell onto the turntable and the pick-up once more moved over.

The loudspeaker reproduced the sound from the new record.

"There's something wrong here," said Dick, scratching his head as he listened. "I can't quite put my finger on it but that record doesn't sound at all right to me. It's not distorted or anything like that, it just sounds wrong."

But Smithy had no ears for his assistant and was busily rummaging in his spares box. Suddenly he found what he was looking for: a ¼in. jack plug.

"Right," he said. "Now, if I insert this plug into the stereo jack socket I should disconnect the left-hand output from the pick-up."

Smithy fitted the plug into the socket. The sound from the speaker remained unaltered.

"That's it," he called out triumphantly. "What that label meant by 'modern records' were not l.p.'s but stereo records. Only the right hand channel is getting through and we did not realise this because the first l.p. we put on was an old *mono* recording. This last record I'm playing is a stereo one, and as you can hear, there's only one channel being reproduced."

Exultantly, Smithy removed the jack plug from the socket. At once, the sound from the speaker acquired a new dimension and was as full and broad in character as any self-respecting modern record should be, even when played over a mono system.

"Hey,' asked Dick, startled. "What did you do then?"

"When I put that plug in and then pulled it out," said Smithy, "I must have dislodged the dirt or whatever it is in the jack socket contacts which was preventing the left-hand channel from the pick-up getting through."

"I still don't get it."

"Look at the input part of the circuit diagram," said Smithy, pointing at the service manual with his finger. (Fig. 6.)

"Yes?"

"The right-hand channel from the pick-up,' stated Smithy, "goes straight into the amplifier. But the left-hand channel from the pick-up goes through two contacts in the stereo jack socket before it goes to the amplifier. The idea is that you can put in a jack plug to take off the left-hand channel if you want to, whereupon it doesn't get to the amplifer in the record player."

"Of course," said Dick, light dawning at last. "I see what you're getting at now. For mono operation from a stereo record, the two pick-up outputs have obviously to be in parallel. It looks as though I'd better have a look at that jack socket and clean its contacts up a bit."

"That would be a good idea," agreed Smithy approvingly. "It was just a stroke of luck that I displaced whatever was preventing those two jack contacts from touching when I inserted and took out the plug. Anyway, we have now solved the problem of the record player which 'won't play modern records'."

FINISHING OFF

Dick grinned.

"It had us guessing for a while."

"It certainly did," agreed Smithy.

He glanced at his watch.

"Dear me," he continued, "it looks as though you'd better finish off the record player tomorrow morning. We've been so engrossed with it that we've been working for nearly quarter of an hour after packing-up time."

"We've been so engrossed, too," stated Dick, looking at the storm outside, "that we've forgotten all about the weather."

"Arr," said Smithy, reassuming his Cornish accent, "we've been right snug in our harbour, Dick lad."

"Would you," Dick asked, "be giving an old shipmate a lift home in your car?"

"Arr, likely I'll be, boy."

"It's foul weather in these latitudes, Skip."

"Arr," said Smithy.

"Arr," said Dick. ■

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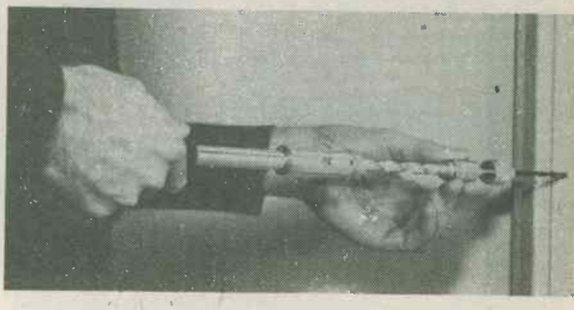

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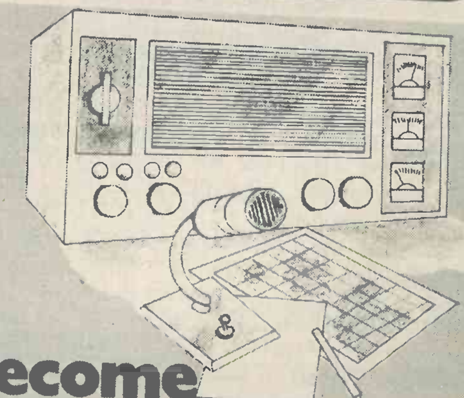

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(Continued from page 517)

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(Continued from page 518)

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