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Aerial Design for Shortwave Receivers.

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Tested Superhet Circuits for Shortwave and Communication Receivers Using Micro Alloy Transistors (MAT's)



ERRATA SHEET FOR MANUAL No. 186

1. On Page 10, Section 11, and on Page 18, Section 13.3 use X028 Osc. coil in place of X015.
2. On Page 12, Diagram 12.1, a 220pf capacitor should be connected from top of T.C.11 to earth.
3. Section 13 should start on Page 13 after Parts List of Section 12 with a sub-heading TEN TRANSISTOR COMMUNICATIONS RECEIVER and it should end on Page 14 after second line of L.H. column.
4. On Page 14, R.H. column, end of the first line, C106 should be C101 and eleven lines below that, C106 should be C103.
5. Section 13.1 should start on Page 14 after second line of L.H. column, with a sub-heading as THE R.F. AMPLIFIER.
6. On Page 16, Fig. 13.1, an earth point should be connected in the tuning circuit between VC1 and R103.
7. On Page 18-19, value of R304 should be 560 ohms not 5600 ohms.
8. On Page 20, D2 and C406 should be connected together to A.G.C. ON contact and RV411.
9. On Page 21, L.H. column, line seven, D1 should be D2.
10. On Page 28, Fig. 15.1 value of VC1 and VC2 is 9-200pf, split stator capacitor or 2-gauge capacitor.
11. In Fig 15.1 value of R.F.C.—2.6mH.
12. On Page 9, at the junction of VC2, L22, TC10 and C8 etc., should have an earth connection.
13. Mains Battery voltage of Fig. 15.1 is 9 v.

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THE TRANSISTORS USED IN THE CIRCUITS IN THIS BOOK

In transistorised short wave receivers the most important components are, of course, the transistors themselves. The performance of the receivers depends entirely upon their quality and the excellence of the circuit design. For this reason Sinclair Micro Alloy Transistors have been employed for all V.H.F., R.F., I.F., and small signal A.F. applications except where preassembled strips are used for convenience. For frequencies above about 100 Mc/s. the new Sinclair subminiature alloy diffused transistor, type number ADT 140, has been chosen. This transistor has an alpha cut-off frequency of over 350/400 Mc/s. at 6 V, 6mA, and costs less than half the price of any comparable transistor. It makes a fitting addition to the well-known range of Sinclair micro-alloy transistors which are intended for all applications up to about 100 Mc/s. The prices of the three types of Sinclair transistor used in this book are as follows:—

MAT 120	7/9d.
MAT 121	8/6d.
ADT 140	15/-d.

All these transistors are guaranteed by the manufacturers for 3 years and may be used in the circuits in this book with complete confidence. The type specified should always be employed as the circuits have been specifically designed for these transistors.

* * *

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* * *

Every circuit in this book has been tested in our laboratories, after being built by a panel of Amateur Constructors, and readers are strongly advised that under no circumstances, are they to alter the values of components shown in the circuits, or accept any substitute components as experience has shown that such changes can only result in poor performance of the apparatus and disappointment to the Constructor.

* * *

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* * *

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CONTENTS

	<i>Page</i>
Introduction	4
Seven Transistor Superhet	5
Five waveband Transistor Receiver	7
Eight Transistor Receiver with R.F. stage	11
Ten Transistor Communications Receiver	14
Communications Mixer Unit	15
Oscillator Unit	18
Beat Frequency Oscillator	21
Audio Amplifier	23
Four Waveband Converter	24
144 Mc/s Converter	27
136 Mc/s Satellite Tracking Receiver	30
D.F. Receiver for Boat use	33
Shortwave Transistor Receiver Aerials	36
Etched Circuits	40

LIST OF ILLUSTRATIONS

<i>Figure</i>	<i>Page</i>
10 (1) Block diagram—seven transistor superhet	5
10 (2) Basic I.F./audio amplifier	6
10 (3) Chassis view	6
10 (4) Panel view	6
11 (1) Aerial circuit—five waveband receiver	8
11 (2) Mixer circuit	9
11 (3) Practical layout	10
11 (4) Chassis dimensions	11
12 (1) R.F. stage—eight transistor receiver	12
13 Block diagram—ten transistor communications receiver	15
13 (1) Circuit of R.F. amplifier	16
13 (2) Circuit of mixer	17
13 (3) Circuit of oscillator	19
13 (4) Circuit I.F. strip	20
13 (5a) Circuit B.F.O.	22
13 (5b) B.F.O. layout	22
13 (6) Circuit audio amplifier	22
13 (7) Panel layout	23
14 Circuit basic diagram of four waveband converter	25
14 (1) Circuit diagram	26
14 (2) Component layout diagram	27
15 (1) Circuit diagram—144 Mc/s converter	28
15 (2) Practical layout	28
15 (3) Coil winding data	29
16 (1) Circuit diagram—136 Mc/s converter	31
16 (2) Practical chassis layout	31
16 (3) General layout	32
17 (1) Circuit—D.F. receiver	34
17 (2) Practical layout	35
17 (3) D.F. aerial mounting details	35
18 (1) Simple dipole	37
18 (2) Folded dipole	37
18 (3) Half wave end fed aerial	37
18 (4) Vertical quarter wave aerial	37
18 (5) 136 Mc/s aerial	39
18 (6) 144 Mc/s amateur band aerial	39

INTRODUCTION

In this book are described five shortwave all transistor radio receivers ranging from a seven transistor superheterodyne to a ten transistor communications receiver covering all wavebands. In addition, circuits are given enabling other units such as beat frequency oscillators, four waveband converter, shortwave aeri-als, etc., to be constructed.

Where possible, use has been made of ready assembled and pre-aligned sub-units, thus ensuring optimum performance, and at the same time, obviating the necessity for elaborate testing equipment.

It must be pointed out that the aim of this volume is not that of describing midget receivers, but is aimed at the serious shortwave enthusiast and radio ham.

Readers desiring to construct more simple shortwave receivers are recommended to obtain a copy of our book No. 185 entitled "Tested Shortwave Receiver Circuits using Micro Alloy Transistors (MAT's)", price 5/- covering sections 1 to 9 which precede this present book.

This book is available from all Bookshops and Radio Dealers, and covers the design and construction of nine shortwave receivers ranging from single transistor Reflex Receiver up to a six transistor Superheterodyne.

SECTION 10

SEVEN TRANSISTOR SUPER HETERODYNE

In this section is described a basic receiver, part of a progressive system which is expanded in the next three sections into a ten transistor communications receiver. The intermediate frequency amplifier and the audio amplifier are common to all four receivers.

In order to make each receiver complete in itself, the construction adopted is that of using two chassis which can be bolted together. One chassis carries the intermediate frequency amplifier, the audio amplifier, and space for the battery. The other unit carries the radio frequency sections, including the local oscillator.

The IF/Audio Unit

This, as can be seen from Fig. 10-2, is built on a chassis measuring 7 inches by 4 inches by 1 inch deep. On it are mounted the two packaged units, and the battery, which is held in place by two straps. The input to the IF strip is by means of a small coaxial socket. The output from the IF strip is terminated in a three way captive screw tagstrip, from which point three wires go to the volume control, which is mounted on the front panel. Two wires from the connections marked SW and MINUS on the three way battery connection tagstrip connect to the switch on the back of the volume control. The secondary of the output transformer on the audio amplifier is connected to a two way tagstrip marked O/P. A pair of leads run to the jack on the front panel. The jack is wired in such a manner as to connect a 4.7 ohm resistor across the secondary of the output transformer when the phone jack plug is inserted.

The RF Unit

This is constructed on a chassis 7 inches by 3 inches by 1½ inches deep. Mounted upon the chassis are the packaged converter TSL type TA 12401. The front panel has cut in it a slot in order to allow the push buttons to project. Mounted on the 8 inch by 8 inch front panel is the Eddystone drive, coupled to the ganged tuning capacitor, which is mounted on the rear of the panel. The volume control, phone jack, and the on/off switch are fixed to the front chassis drop, with the bushes projecting through

the front panel. The front panel is secured to the tuner chassis by means of two angle brackets. Rigidity at this point is very important, as at the higher frequencies, movements of the ganged capacitor relative to the converter unit can cause changes of tuning. The aerial input tagstrip is fastened on the chassis and a short length of flex, terminated in a phono type coaxial plug is used to connect the converter output to the IF input. Another short length of

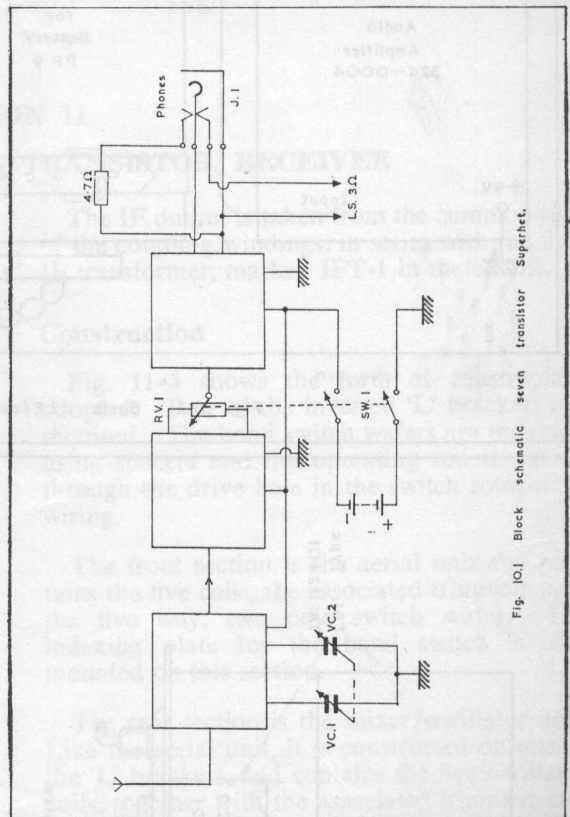


Fig. 10.1 Block schematic seven transistor Superhet.

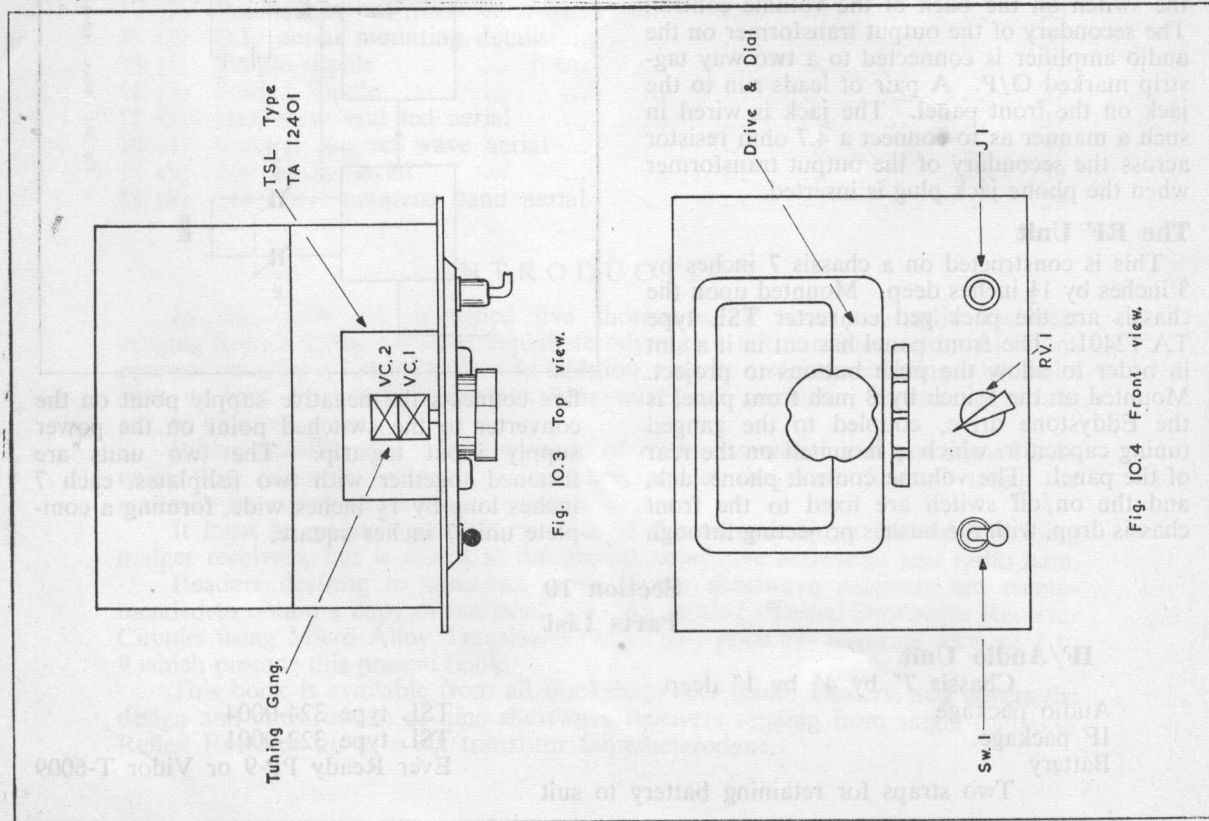
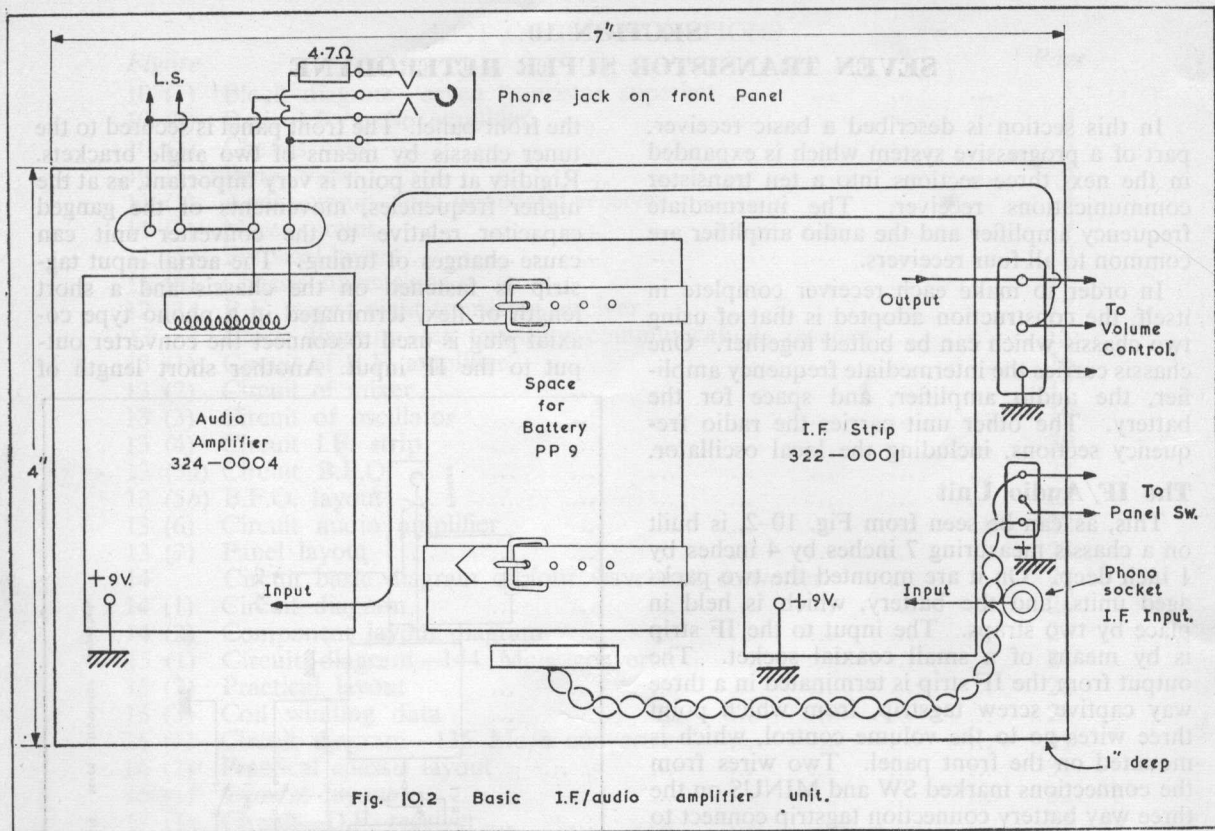
flex connects the negative supply point on the converter to the switched point on the power supply input tagstrip. The two units are fastened together with two fishplates, each 7 inches long by 1½ inches wide, forming a complete unit 7 inches square.

Section 10 Parts List

IF/Audio Unit

- Chassis 7" by 4" by 1" deep
- Audio package
- IF package
- Battery
- Two straps for retaining battery to suit

- TSL type 324-0004
- TSL type 322-0001
- Ever Ready PP-9 or Vidor T-6009



Phono Coax socket	TSL
Two way tagstrip	TSL
Three way tagstrip	TSL
Four way tagstrip	TSL
Miscellaneous hardware	
Radio Frequency Unit	
Chassis 7" by 3" by 2" deep	
Transistor converter	TSL
Two gang tuning capacitor 175 pf each section	Jackson type 00 with trimmer
Panel 8" by 8"	
Full vision drive and dial	Eddystone type 598
Potentiometer — 5,000 ohms	TSL
On/Off switch	TSL
Jack, fitted with change-over contacts	TSL
Resistor 4.7 ohms (or two 10 ohms in parallel)	TSL
Phono coax plug	TSL
Two way tagstrip	TSL
Miscellaneous hardware	

SECTION 11

FIVE WAVEBAND, SEVEN TRANSISTOR, RECEIVER

The receiver described in this section uses the same IF/AF unit as that described in the previous section. The RF unit differs considerably in that five wavebands are covered, and constructional details are given for the front end, which in this receiver, is an autodyne mixer.

Circuit Description (See Figs. 11-1 & 11-2)

For the medium and long wavebands, the aerial coupling coils are L-1 and L-3. The long wave tuned winding L-2, and the medium wave tuned winding L-4 are tuned by the ganged capacitor VC-1. In order to match the input impedance of Tr-1, a capacitive tap formed of C-1 and C-2 is provided. This is effective on all bands. The trawler bands are tuned by L-6, coupled to the aerial by L-5. The two remaining short wave bands are tuned by L-8 and L-10, the coupling windings in these cases being L-7 and L-9.

Fig. 11-2 shows the mixer circuits. The signal input is applied to the base of Tr-1 at the point 'X'. R-1 and R-2 form the potential divider for the base bias of Tr-1. On the medium and long wavebands, L-13 and L-16 are the oscillator tuning windings, and L-11, L-12 are the long wave couplings, while L-14, L-15 are the medium wave couplings. The three short wavebands are tuned by L-18, L-20, and L-22. L-17, L-18 and L-19, respectively, couple the tuned circuits on these ranges into the collector of Tr-1. The feedback path for these ranges is by C-4. The correct coupling for each of the selected ranges is chosen by SW-2a and SW-2c. The tuning capacitor VC-2 is switched across the appropriate coil by means of SW-2b.

The IF output is taken from the common side of the coupling windings, in series with the first IF transformer, marked IFT-1 in the circuit.

Construction

Fig. 11-3 shows the form of construction adopted. Two of the inverted 'L' brackets are required. The band switch wafers are mounted using spacers and the operating rod is passed through the drive hole in the switch rotor after wiring.

The front section is the aerial unit and contains the five coils, the associated trimmers, and the five way, two pole switch wafer. The indexing plate for the band switch is also mounted on this section.

The rear section is the mixer/oscillator unit. Like the aerial unit, it is constructed on one of the 'L' brackets, and contains the five oscillator coils, together with the associated trimmers and padders, and the two switch wafers making up the five way three pole switch. The transistor Tr-1, along with the associated resistors and capacitors in the oscillator circuit are mounted on a small sub-panel.

The tuning gang is secured on the top of the two units by means of four 4 BA screws and nuts, with the feet isolated from the chassis by means of four rubber grommets. The earthing forks for each section have attached two pieces of tinned copper braid, each two inches long, and the free ends are grounded in the positions indicated in Fig. 11-3.

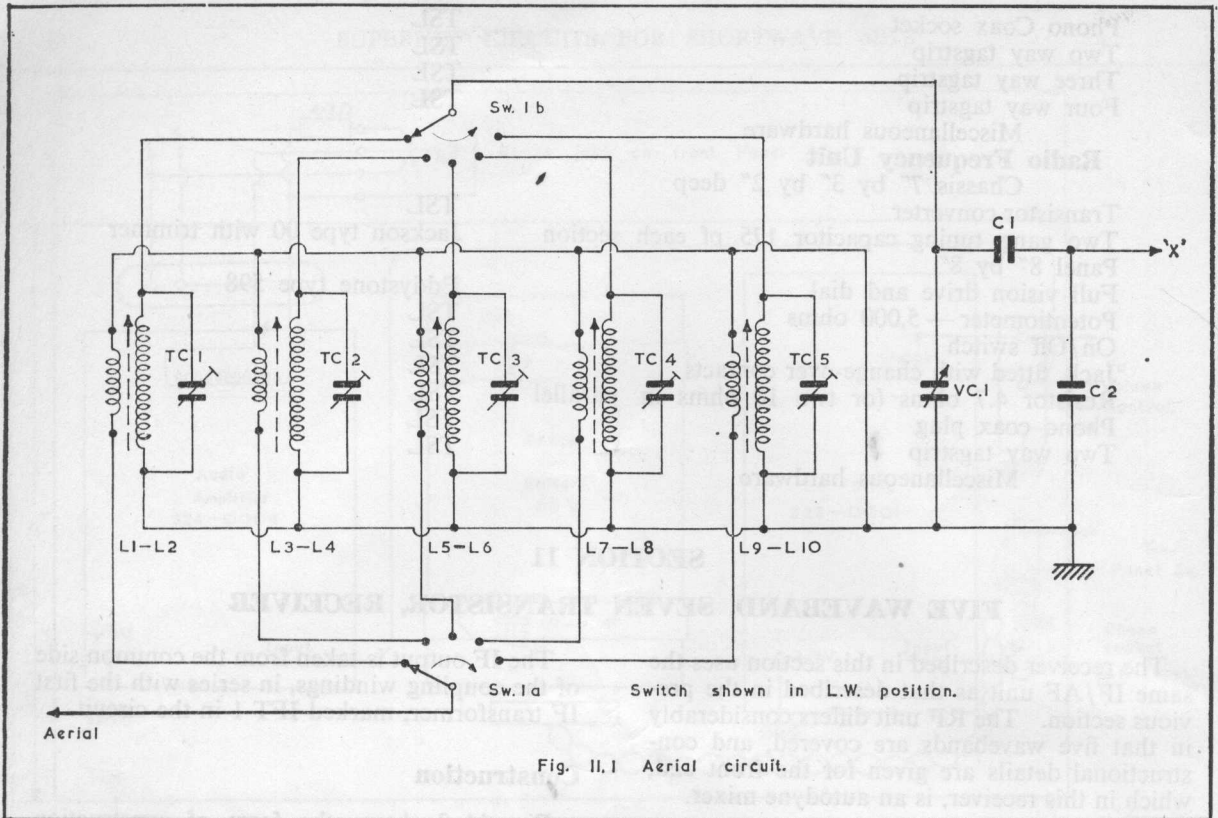


Fig. 11.1 Aerial circuit.

Section 11 Parts List

The IF and Audio section is identical with that described in Section 10—see parts list for components.

Aerial Coil Assembly

C-1	22 pf	silver mica	10% tolerance	TSL
C-2	47 pf	silver mica	10% tolerance	TSL
VC-1 (see general parts list)				
Tc-1 to Tc-5 inclusive	4-22 pf	compression trimmers		TSL

Coils

L-1; L-2—Long Wave Aerial	Repanco XLA18
L-3; L-4—Medium Wave Aerial	Repanco XMA16
L-5; L-6—57 to 180 metre Short Wave Aerial	Denco
L-7; L-8—20 to 60 metre Short Wave Aerial	Denco
L-9; L-10—9.5 to 28 metre Short Wave Aerial	Denco
SW-1a; SW-1b—5 way, 2 pole Oak type	AB Type 'H'
Index plate for SW-1 through SW-2 with 6 inch shaft	AB Type 'H'
Mounting bracket—see Figs. 11-3 and 11-4	

Mixer Coil Assembly

C-3	.022 μ f	Styrafoil 125 v.	20%	TSL
C-4	6.8 pf	silver mica	10%	TSL
C-5	180 pf	silver mica	10%	TSL
C-6	560 pf	silver mica	10%	TSL
C-7	2,200 pf	silver mica	10%	TSL
C-8	4,700 pf	silver mica	10%	TSL
R-1	6,800 ohms	$\frac{1}{4}$ w	20%	TSL
R-2	33,000 ohms	$\frac{1}{4}$ w	20%	TSL
R-3	4,700 ohms	$\frac{1}{4}$ w	20%	TSL
R-4	1,000 ohms	$\frac{1}{4}$ w	20%	TSL
TC-6 to TC-10	4-22 pf	compression type trimmers		TSL

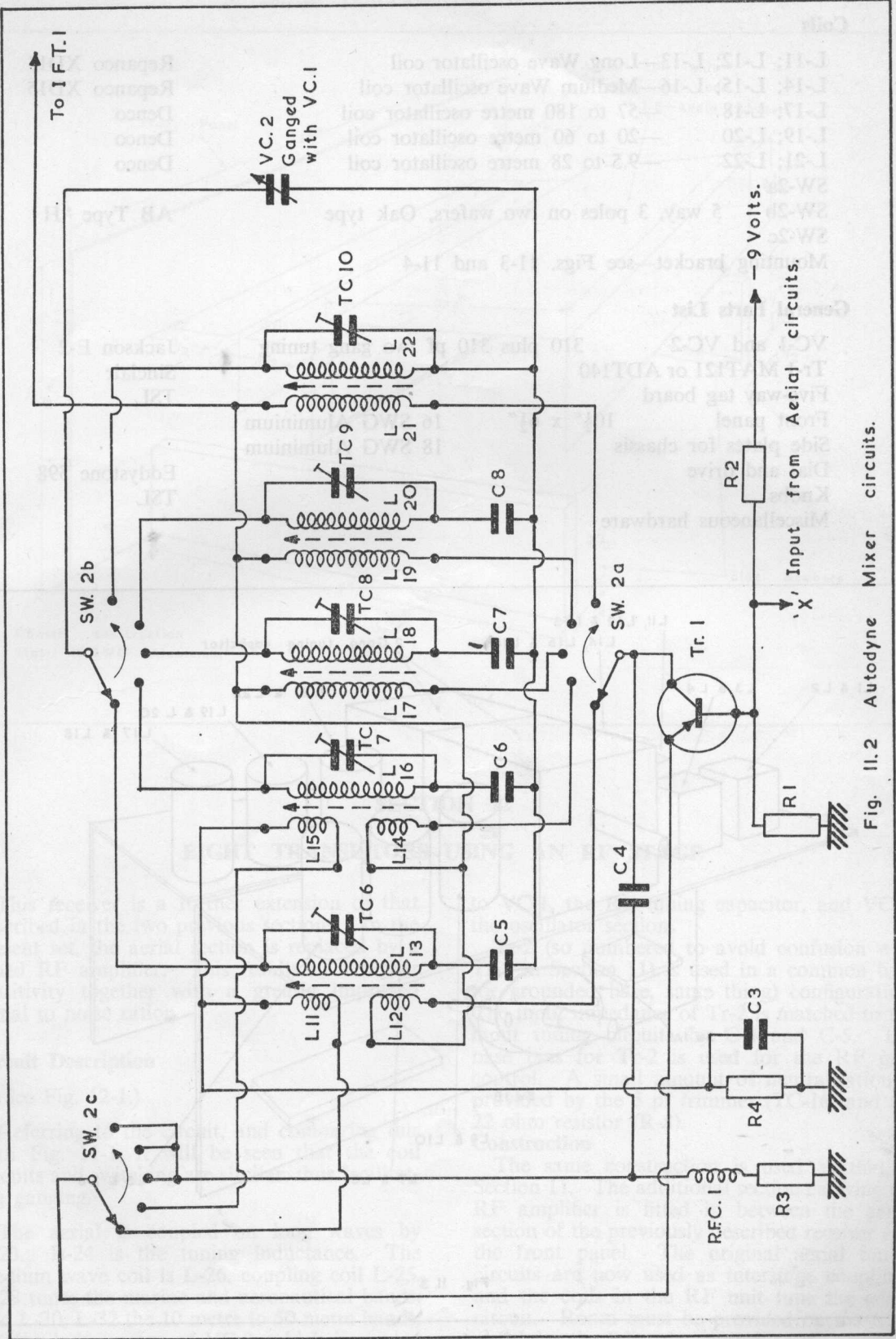


Fig. 11.2 Autodyne Mixer circuits.

Coils

L-11; L-12; L-13—Long Wave oscillator coil	Repanco XD15
L-14; L-15; L-16—Medium Wave oscillator coil	Repanco XD15
L-17; L-18 —57 to 180 metre oscillator coil	Denco
L-19; L-20 —20 to 60 metre oscillator coil	Denco
L-21; L-22 —9.5 to 28 metre oscillator coil	Denco
SW-2a	
SW-2b 5 way, 3 poles on two wafers, Oak type	AB Type 'H'
SW-2c	
Mounting bracket—see Figs. 11-3 and 11-4	

General Parts List

VC-1 and VC-2	310 plus 310 pf two gang tuning	Jackson E-2
Tr-1	MAT121 or ADT140	Sinclair
Five-way tag board		TSL
Front panel	10½" x 6½"	16 SWG Aluminium
Side plates for chassis		18 SWG Aluminium
Dial and drive		Eddystone 598
Knobs		TSL
Miscellaneous hardware		

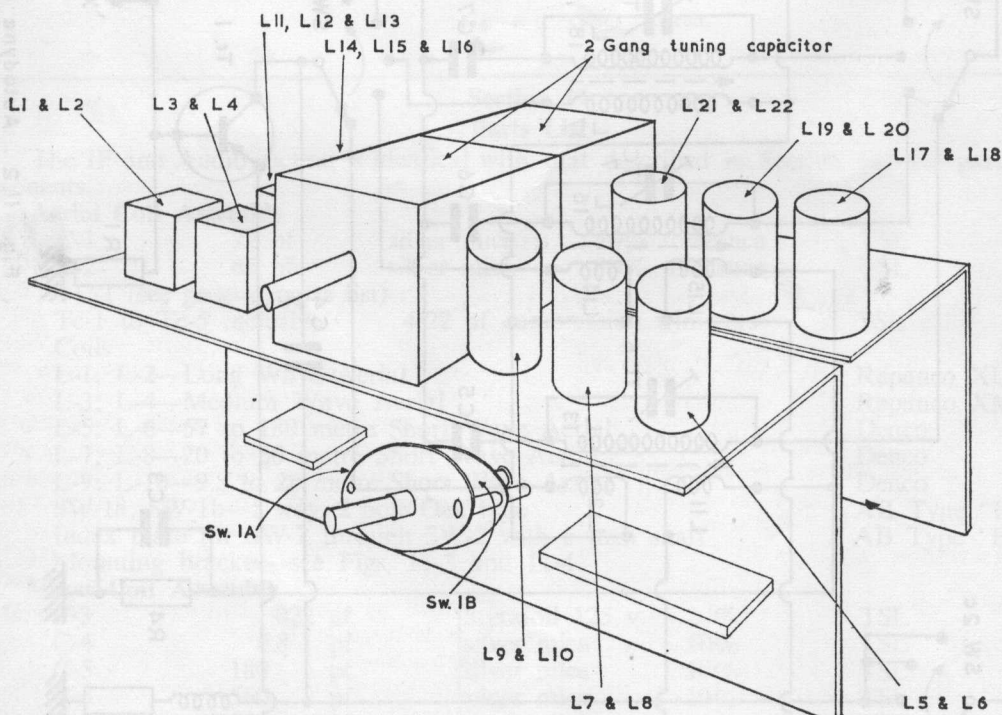
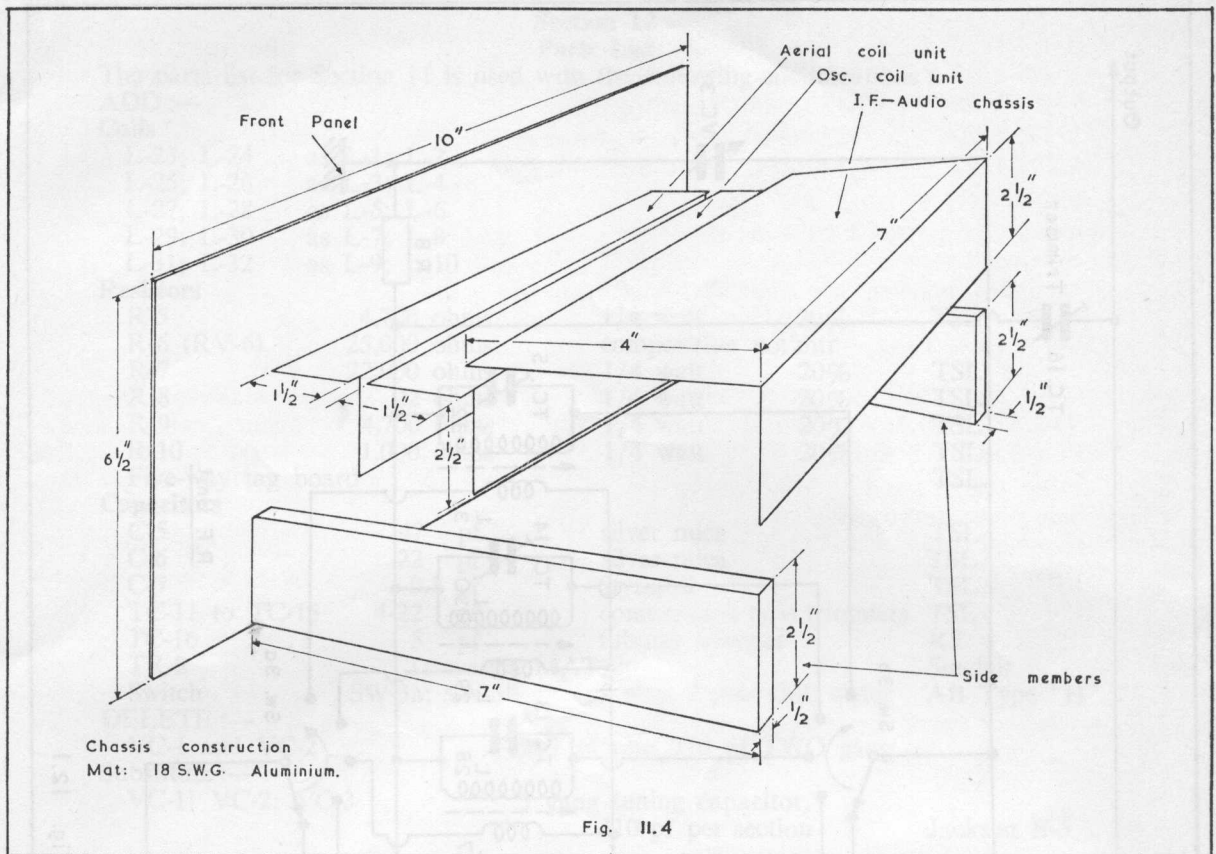


Fig. 11.3



SECTION 12

EIGHT TRANSISTORS USING AN RF STAGE

This receiver is a further extension of that described in the two previous sections. In the present set, the aerial section is replaced by a tuned RF amplifier. This results in a higher sensitivity together with a greatly improved signal to noise ratio.

Circuit Description

(See Fig. 12-1.)

Referring to the circuit, and comparing this with Fig. 11-1, it will be seen that the coil circuits and switching are similar, thus facilitating ganging.

The aerial is coupled on long waves by L-23. L-24 is the tuning inductance. The medium wave coil is L-26, coupling coil L-25. L-28 tunes the marine and aeronautical bands, and L-30, L-32 the 10 metre to 50 metre bands. Tuning is by means of VC-3, which is ganged

to VC-1, the RF tuning capacitor, and VC-2, the oscillator section.

Tr-2 (so numbered to avoid confusion with Tr-1 in Section 11) is used in a common base (or grounded base, same thing) configuration. The input impedance of Tr-2 is matched to the input tuning circuits by C-4 and C-5. The base bias for Tr-2 is used for the RF gain control. A small amount of neutralisation is provided by the 5 pf trimmer (TC-16) and the 22 ohm resistor (R-8).

Construction

The same construction is used as that of Section 11. The additional section carrying the RF amplifier is fitted in between the aerial section of the previously described receiver and the front panel. The original aerial tuning circuits are now used as interstage couplings, and the coils in the RF unit tune the aerial circuit. Room must be provided on the front panel for the RF gain control.

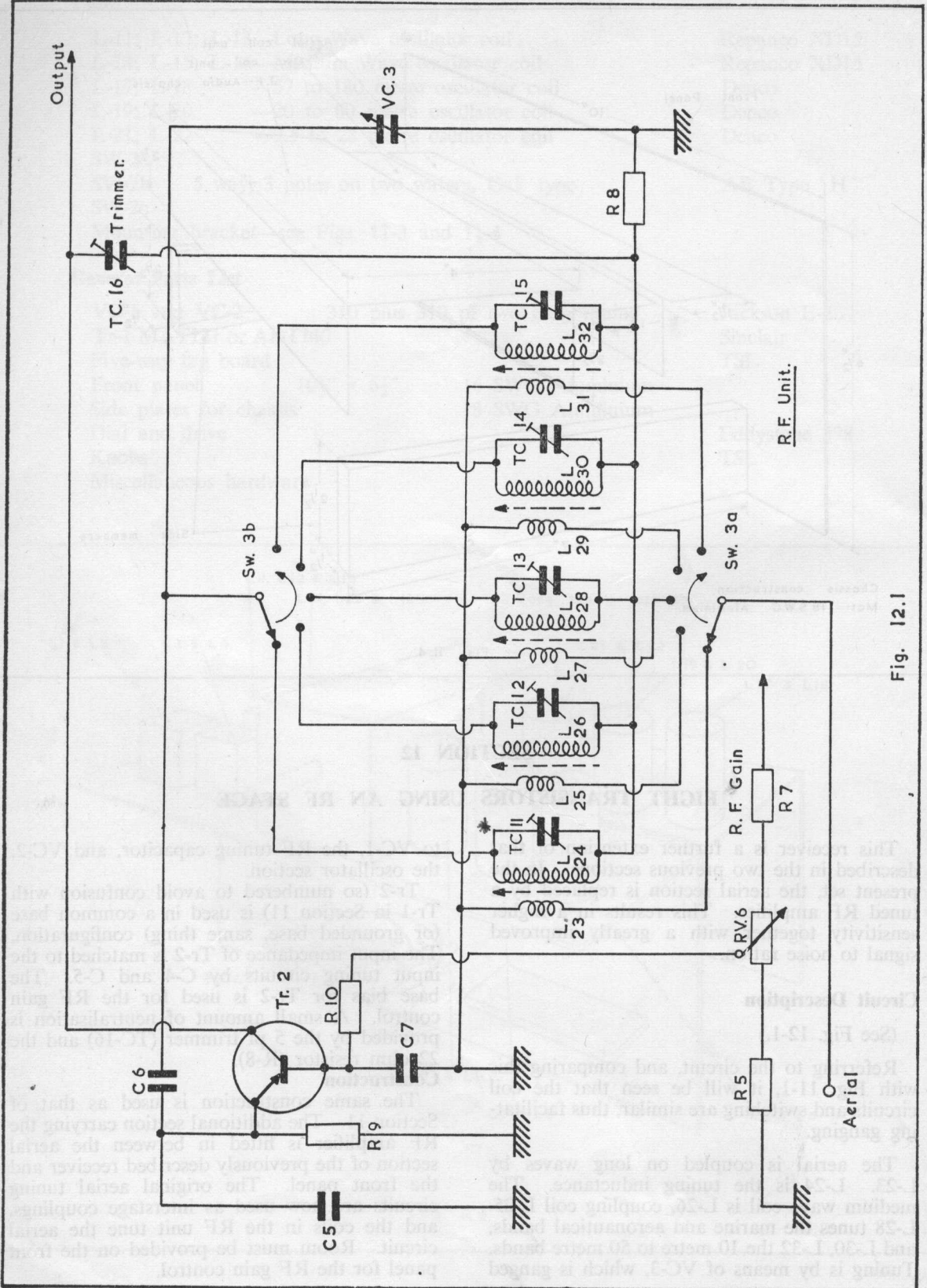


Fig. 12.1

Section 12 Parts List

The parts list for Section 11 is used with the following modifications:—

ADD:—

Coils

L-23; L-24	as L-1; L-2
L-25; L-26	as L-3; L-4
L-27; L-28	as L-5; L-6
L-29; L-30	as L-7; L-8
L-31; L-32	as L-9; L-10

Resistors

R-5	4,700 ohms	1/4 watt	20%	TSL
R-6 (RV-6)	25,000 ohms	composition pot'mtr		
R-7	22,000 ohms	1/4 watt	20%	TSL
R-8	22 ohms	1/4 watt	20%	TSL
R-9	4,700 ohms	1/4 watt	20%	TSL
R-10	1,000 ohms	1/4 watt	20%	TSL
Five-way tag board				TSL

Capacitors

C-5	47 pf	silver mica	TSL
C-6	22 pf	silver mica	TSL
C-7	0.1 μ f	Styrafoil	TSL
TC-11 to TC-15	4-22 pf	compression type trimmers	TSL
TC-16	5 pf	tubular trimmer	RS
TR-2	Transistor MAT120		Sinclair
Switch	SW-3a; SW-3b	5 way, 2 pole Oak wafer	AB Type 'H'

DELETE:—

VC-1 and VC-2 310 pf plus 310 pf TWO gang

Substitute:—

VC-1; VC-2; VC-3 3 gang tuning capacitor,
310 pf per section Jackson E-3

This ambitious project is an excellent portable or fixed station receiver suitable for both the 'Ham' and the shortwave broadcast listener. It gives a continuous frequency coverage from 550 kc/s. to 30 Mc/s., in five bands, each band occupying seven inches of scale length.

The first stage in the receiver is an RF stage using a MAT 121, in a common base configuration. The mixer is a second MAT 121, and a MAT 120 is used as a local oscillator. Using a separate local oscillator means that the mixer can be adjusted for optimum conversion conditions, ensuring the highest sensitivity with the greatest signal to noise ratio. Oscillator stability is greatly assisted by a zener stabiliser on the supply rail. Two IF stages follow, using MAT 120 transistors. A beat frequency oscillator is also fitted. The final IF stage is followed by a diode demodulator and agc rectifier.

The audio section has three stages, the first an OC-71 in a low noise circuit, the second an OC-81D, and the output stage uses a pair of OC-81's in class B push pull. The output transformer matches a three to five ohm load or a pair of headphones. Two six-volt dry cells power the whole receiver and the power output is 500 mW.

Bandspreading

There are two basic methods of bandspreading—one is to use electrical methods, the other is to use a mechanical system. Of these two methods, the latter is probably more convenient from the amateur point of view, since far fewer setting up adjustments are required. There are a number of excellent drives available, and of these the Eddystone type 898 is one of the best. As one might expect, it is not cheap, but the cost is offset by the reduction in the number of components required, with the subsequent saving in assembly time, and, of course, the greatly reduced number of electrical adjustments one would have to make in a purely electrical method of bandspreading.

The example quoted is a gear driven and flywheel loaded mechanism, having a reduction ratio of 110:1. It is fitted with five 7-inch scales, and a circular vernier scale enables the scale to be divided into 500 divisions for purposes of logging.

The ranges of this receiver are:—

Long wave	...	750 metres to 2,000 metres
Medium wave...		194 metres to 580 metres
Marine and		
Aircraft		57 metres to 180 metres

Short wave 1 ... 25 metres to 60 metres
 Short wave 2 ... 9 metres to 28 metres

The RF amplifier is a MAT 121 micro alloy transistor designed for RF, mixer, or oscillator service up to the 100 Mc/s. region. The RF amplifier in this receiver is connected in a common base circuit which is the equivalent of a grounded grid amplifier. The collector and emitter currents are common to the base circuit, giving 100% negative current feedback. This results in a current gain of less than unity and good isolation between the input and output circuits. Although the current gain is less than unity, the common base circuit provides approximately the same voltage gain as would be obtained in a common emitter arrangement.

In the circuit, Fig. 13-1, it will be seen that the input signal is transformer coupled to the emitter of the RF amplifier Tr-1 through a capacitive tap, which matches the comparatively low impedance of the transistor input circuit. Emitter bias is developed by R-101,

and the base is grounded for RF by C-104. The base is returned to the AGC line through the 1 K resistor R-102.

The RF amplifier output is developed across the primary of the appropriate RF transformer selected by SW-2a and SW-2b in the mixer unit. The small amount of neutralisation that may be necessary to offset feedback through stray couplings is provided by feeding a small amount of collector voltage back to the emitter through C-103, the secondary of the aerial coil, and the 22 ohm resistor R-103.

Care must be exercised in the layout of the components of the amplifier, and particular care must be paid to the screening between the input and the output circuits. Unless this screening is efficient, unwanted feedback will be present, and is likely to cause instability.

The DC supplies must also be adequately filtered to prevent common impedance coupling from one part of the circuit to another.

SECTION 13

TEN TRANSISTOR COMMUNICATIONS RECEIVER

SECTION 13-1

THE RF AMPLIFIER

Section 13-1

Parts List

Resistors

R-101	4,700 ohms	1/4 watt	20% tolerance	TSL
R-102	1,000 ohms	1/4 watt	20% tolerance	TSL
R-103	22 ohms	1/4 watt	20% tolerance	TSL

Capacitors

C-101	0.1 μ f	Styrafoil	TSL
C-102	47 pf	silver mica	TSL
C-103	22 pf	silver mica	TSL
C-104	220 pf	silver mica	TSL

Coils

L-1; L-2	Long wave aerial coil	Repanco XLA-18
L-3; L-4	Medium wave aerial coil	Repanco XMA-16
L-5; L-6	57 to 180 metre aerial coil	Denco
L-7; L-8	20 to 60 metre aerial coil	Denco
L-9; L-10	9.5 to 28 metre aerial coil	Denco

Switch

SW-1a, SW-1b 5 way, 2 pole miniature Oak with index plate NSF 'H'

Transistor

MAT 121 Sinclair

Trimmers

TC-1 to TC-5 22 pf max—compression type TSL
 TC-6 5 pf max—tubular ceramic type

Hardware

VC-1 250 pf variable (part of 3-gang tuning capacitor)

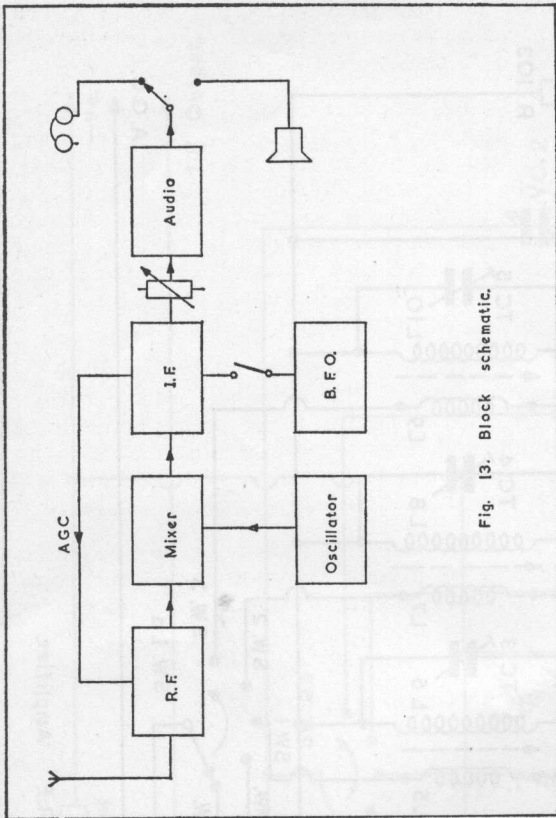


Fig. 13. Block schematic.

The mixer is a common base arrangement with the signal voltage fed into the base circuit through the secondary of the RF transformer. The oscillator voltage is injected into the emitter circuit from the oscillator emitter circuit. The mixer emitter bias and the oscillation injection are adjusted to ensure maximum conversion gain for the band in use. The 460 kc/s. IF signal is taken from the collector and applied to the tap on the first IF transformer, from which point also the supply voltage for the mixer is obtained.

Circuit Description

The circuit diagram of the mixer is given in Fig. 13-2. SW-2b selects the tuning inductance, which is tuned by VC-2. The signal developed across the tuned circuit is applied to the base of Tr-2 (MAT 121) via the capacitive matching network composed of C-202 and C-203. Bias for Tr-2 is taken from the junction of R-203 and R-204. The oscillator injection takes place at the emitter of Tr-2 through the resistor R-202 and the capacitance C-201.

SECTION 13-2

MIXER UNIT

Section 13-2

Parts List

Resistors

R-201	1,000 ohms	1/4 watt	20% tolerance	TSL
R-202	100 ohms	1/4 watt	20% tolerance	TSL
R-203	4,700 ohms	1/4 watt	20% tolerance	TSL
R-204	27,000 ohms	1/4 watt	20% tolerance	TSL

Capacitors

C-201	.01 μ f	Styrafoil	TSL
C-202	47 pf	silver mica	TSL
C-203	22 pf	silver mica	TSL
C-204	220 pf	silver mica	TSL

Coils

L-21; L-22	Long wave RF transformer	Repanco XLF-19
L-23; L-24	Medium wave RF transformer	Repanco XMF-17
L-25; L-26	RF transformer 57 to 180 metres	Denco
L-27; L-28	RF transformer 20 to 60 metres	Denco
L-29; L-30	RF transformer 9.5 to 28 metres	Denco

Transistor

MAT 121	Sinclair
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Switch

Miniature Oak type 5 way, 2 pole. With spacers	NSF 'H'
TC-1 to TC-5 4-22 pf compression type trimmers	TSL
VC-2 250 pf variable (part of 3-gang tuning capacitor)	

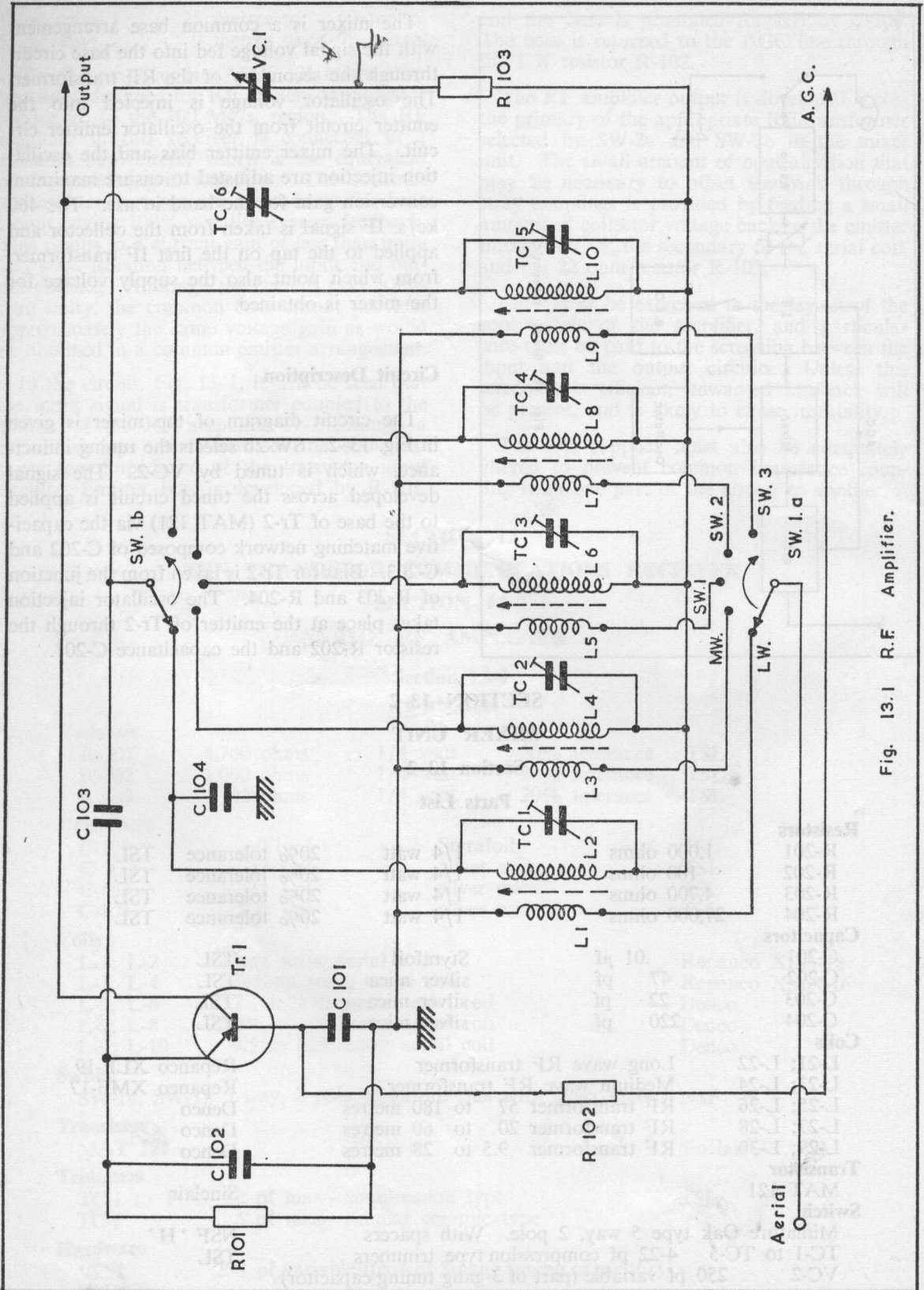


Fig. 13.1 R.F. Amplifier.

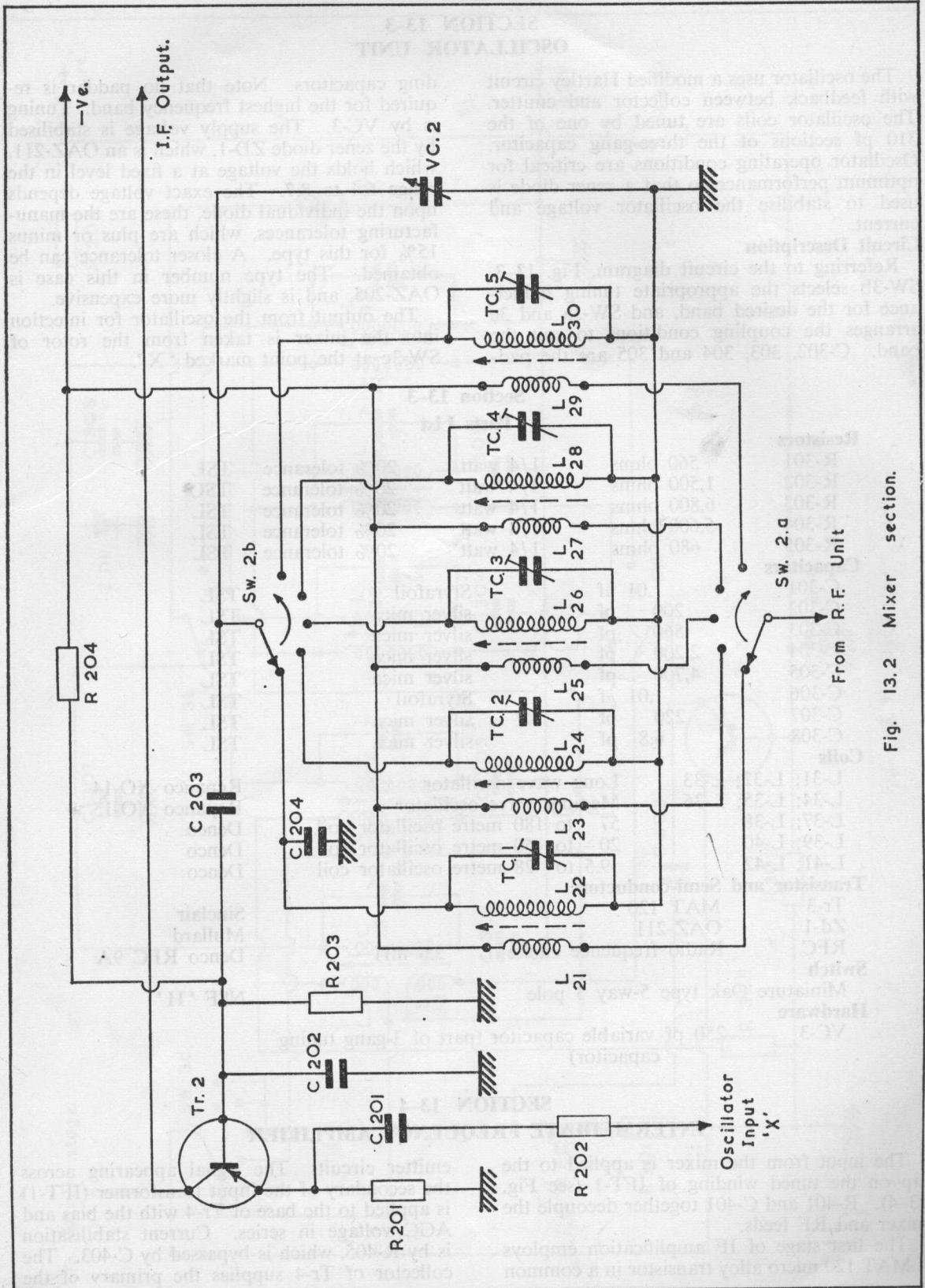


Fig. 13.2 Mixer section.

SECTION 13-3 OSCILLATOR UNIT

The oscillator uses a modified Hartley circuit with feedback between collector and emitter. The oscillator coils are tuned by one of the 310 pf sections of the three-gang capacitor. Oscillator operating conditions are critical for optimum performance so that a zener diode is used to stabilise the oscillator voltage and current.

Circuit Description

Referring to the circuit diagram, Fig. 13-3, SW-3b selects the appropriate tuning inductance for the desired band, and SW-3a and 3c arranges the coupling conditions to suit the band. C-302, 303, 304 and 305 are the pad-

ding capacitors. Note that no padder is required for the highest frequency band. Tuning is by VC-3. The supply voltage is stabilised by the zener diode ZD-1, which is an OAZ-211, which holds the voltage at a fixed level in the range 6.4 to 8.7. The exact voltage depends upon the individual diode, these are the manufacturing tolerances, which are plus or minus 15% for this type. A closer tolerance can be obtained. The type number in this case is OAZ-205, and is slightly more expensive.

The output from the oscillator for injection into the mixer is taken from the rotor of SW-3c at the point marked 'X'.

Section 13-3

Parts List

Resistors

R-301	560 ohms	1/4 watt	20% tolerance	TSL
R-302	1,500 ohms	1/4 watt	20% tolerance	TSL
R-303	6,800 ohms	1/4 watt	20% tolerance	TSL
R-304	5,600 ohms	1/4 watt	20% tolerance	TSL
R-305	680 ohms	1/4 watt	20% tolerance	TSL

Capacitors

C-301	.01 μ f	Styrafoil	TSL
C-302	200 pf	silver mica	TSL
C-303	560 pf	silver mica	TSL
C-304	2,200 pf	silver mica	TSL
C-305	4,700 pf	silver mica	TSL
C-306	.01 μ f	Styrafoil	TSL
C-307	220 pf	silver mica	TSL
C-308	6.8 pf	silver mica	TSL

Coils

L-31; L-32; L-33	Long wave oscillator	Repanco XO-14
L-34; L-35; L-36	Medium wave oscillator	Repanco XO-15 *
L-37; L-38	57 to 180 metre oscillator coil	Denco
L-39; L-40	20 to 60 metre oscillator coil	Denco
L-41; L-42	9.5 to 28 metre oscillator coil	Denco

Transistor and Semi-conductors

Tr-3	MAT 120	Sinclair	
Zd-1	OAZ-211	Mullard	
RFC	Radio frequency choke	2.6 mH	Denco RFC 9A

Switch

Miniature Oak type 5-way 3 pole	NSF 'H'
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Hardware

VC-3	250 pf variable capacitor (part of 3-gang tuning capacitor)
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SECTION 13-4 INTERMEDIATE FREQUENCY AMPLIFIER

The input from the mixer is applied to the tap on the tuned winding of IFT-1 (see Fig. 13-4). R-401 and C-401 together decouple the mixer and RF feeds.

The first stage of IF amplification employs a MAT 120 micro alloy transistor in a common

emitter circuit. The signal appearing across the secondary of the input transformer (IFT-1) is applied to the base of Tr-4 with the bias and AGC voltage in series. Current stabilisation is by R-405, which is bypassed by C-403. The collector of Tr-4 supplies the primary of the

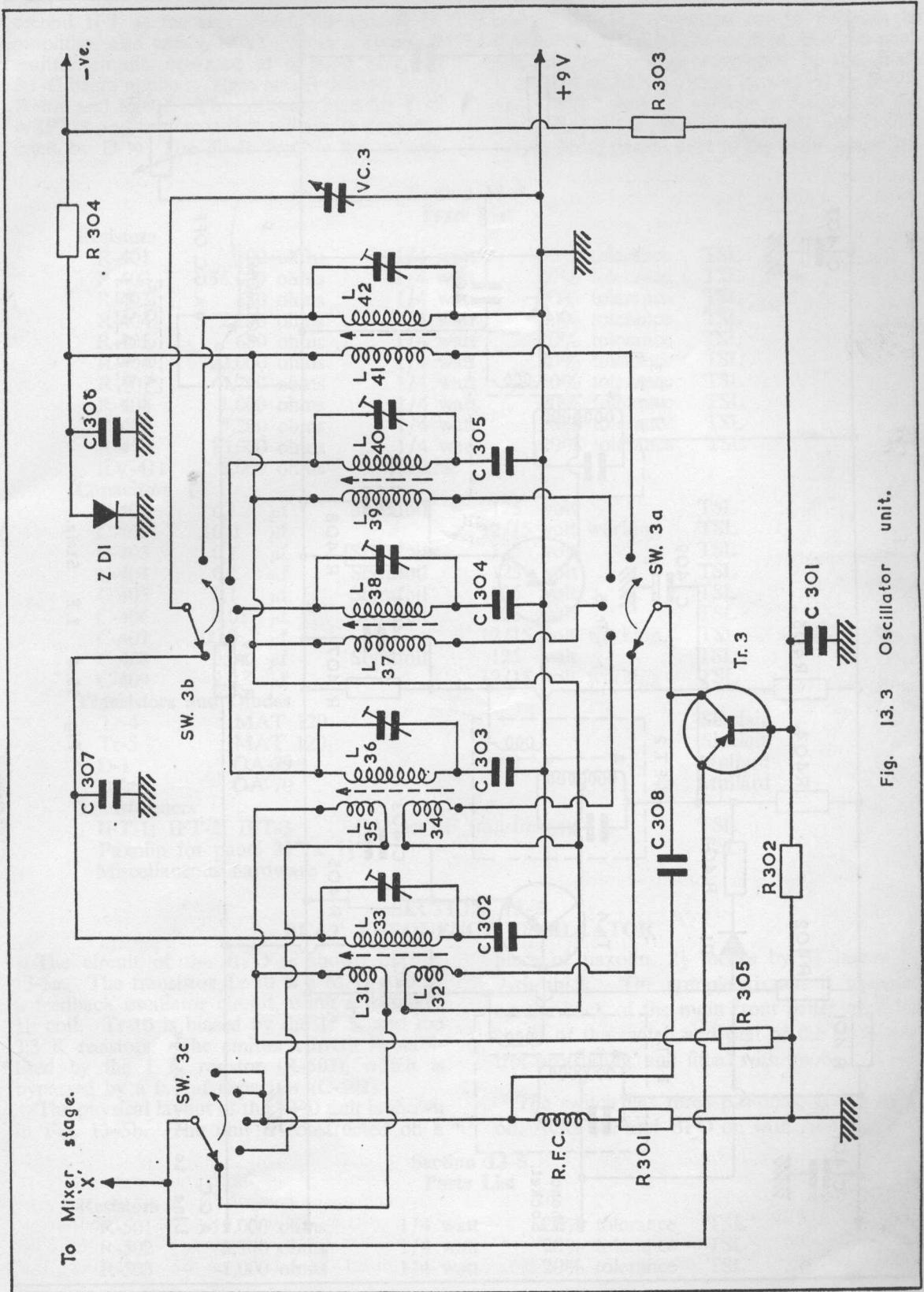


Fig. 13.3 Oscillator unit.

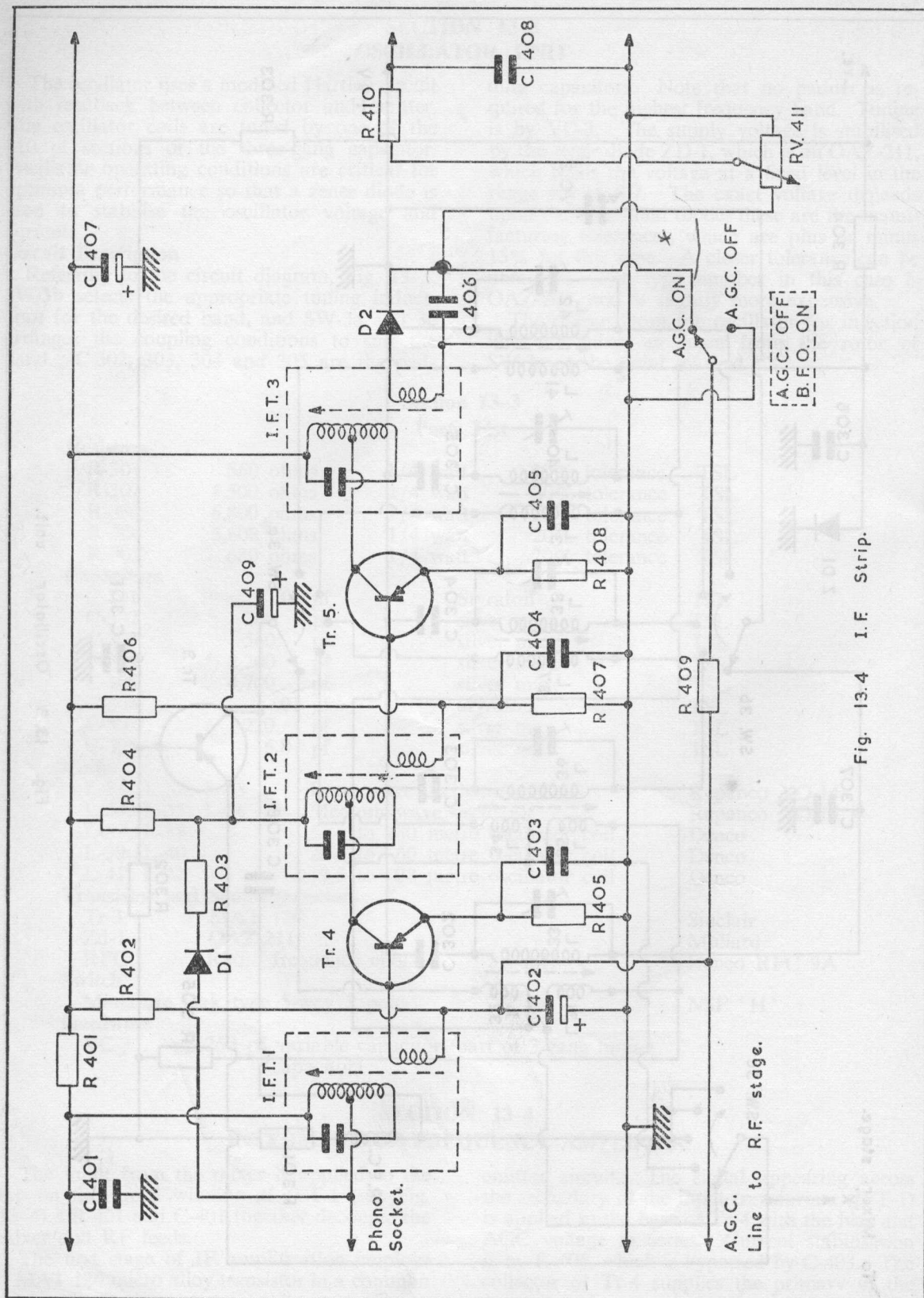


Fig. 13.4 I.F. Strip.

second IFT at the tap. Tr-5, the second IF amplifier, also uses a MAT 120 in a common emitter circuit, operated at a fixed bias, no AGC being applied. Base bias is derived from R-406 and R-407. The collector load for Tr-5 is IFT-3 and the secondary voltage is demodulated by D-1. The diode load is the volume

control RV-411, bypassed for IF voltages by C-406. With the BFO switch in AGC on position, the DC voltage developed by the diode is applied as AGC voltage, decoupled by R-409 and C-402. Any IF voltages remaining in the audio output are removed by R-410 and C-408, before being passed over to the audio amplifier.

Section 13-4 Parts List

Resistors

R-401	100 ohms	1/4 watt	20% tolerance	TSL
R-402	56,000 ohms	1/4 watt	20% tolerance	TSL
R-403	680 ohms	1/4 watt	20% tolerance	TSL
R-404	2,200 ohms	1/4 watt	20% tolerance	TSL
R-405	680 ohms	1/4 watt	20% tolerance	TSL
R-406	22,000 ohms	1/4 watt	20% tolerance	TSL
R-407	4,700 ohms	1/4 watt	20% tolerance	TSL
R-408	1,000 ohms	1/4 watt	20% tolerance	TSL
R-409	8,200 ohms	1/4 watt	20% tolerance	TSL
R-410	10,000 ohms	1/4 watt	20% tolerance	TSL
RV-411	5,000 ohms	variable		

Capacitors

C-401	0.1 μ f	Styrafoil	125 volt	TSL
C-402	10.0 μ f		12/15 volt working	TSL
C-403	0.1 μ f	Styrafoil	125 volt	TSL
C-404	0.1 μ f	Styrafoil	125 volt	TSL
C-405	0.1 μ f	Styrafoil	125 volt	TSL
C-406	0.01 μ f	Styrafoil	125 volt	TSL
C-407	100.0 μ f		12/15 volt working	TSL
C-408	0.001 μ f	Styrafoil	125 volt	TSL
C-409	2.0 μ f		12/15 volt working	TSL

Transistors and Diodes

Tr-4	MAT 120	Sinclair
Tr-5	MAT 120	Sinclair
D-1	OA-79	Mullard
D-2	OA-70	Mullard

Transformers

IFT-1; IFT-2; IFT-3	One set IF transformers	TSL
Paxolin for panel $3\frac{1}{2}$ " x $1\frac{1}{2}$ "		TSL
Miscellaneous hardware		

SECTION 13-5 BEAT FREQUENCY OSCILLATOR

The circuit of the BFO is shown in Fig. 13-5a. The transistor Tr-10 is a MAT 120 in a feedback oscillator circuit, using a standard IF coil. Tr-10 is biased by the 15 K and the 3.3 K resistors. The emitter current is stabilised by the 1 K resistor (R-503), which is bypassed by a 0.1 μ f capacitor (C-502).

The physical layout of the BFO unit is shown in Fig. 13-5b. The unit is constructed on a

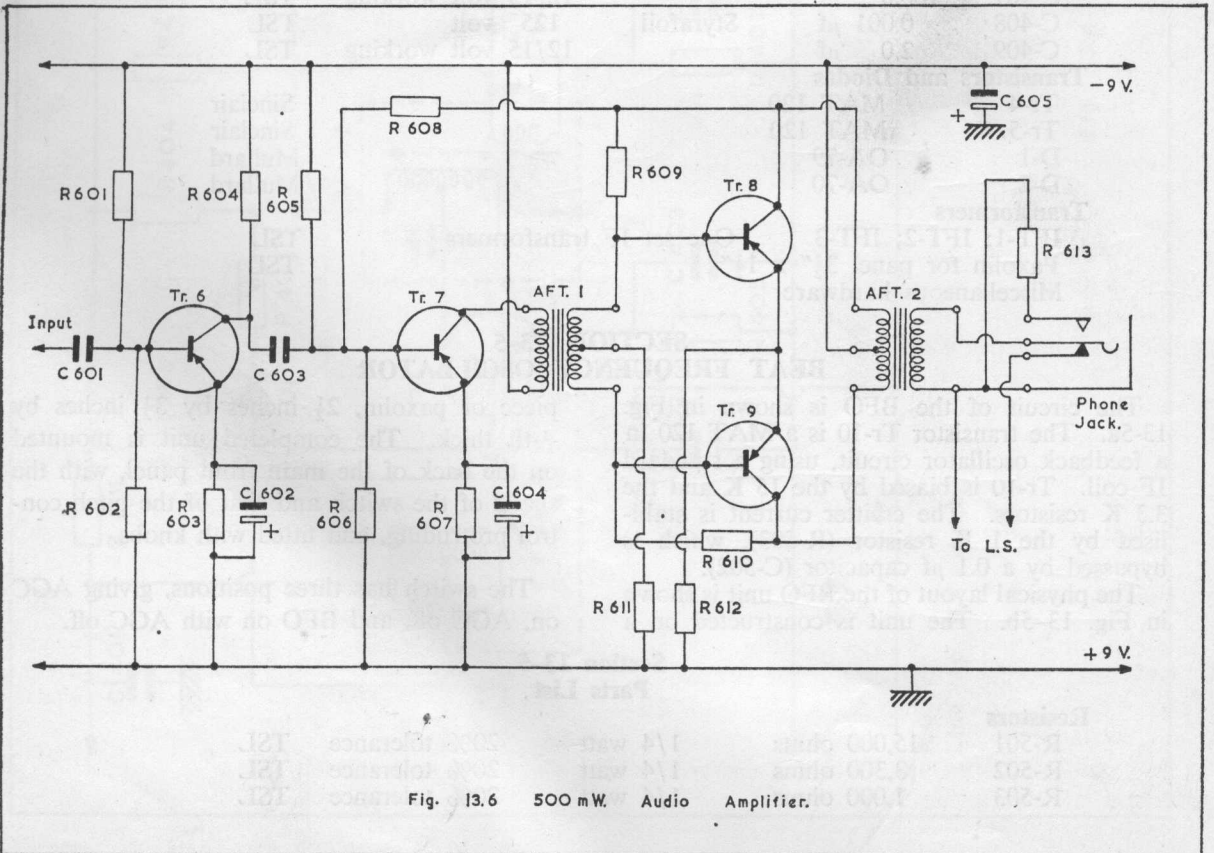
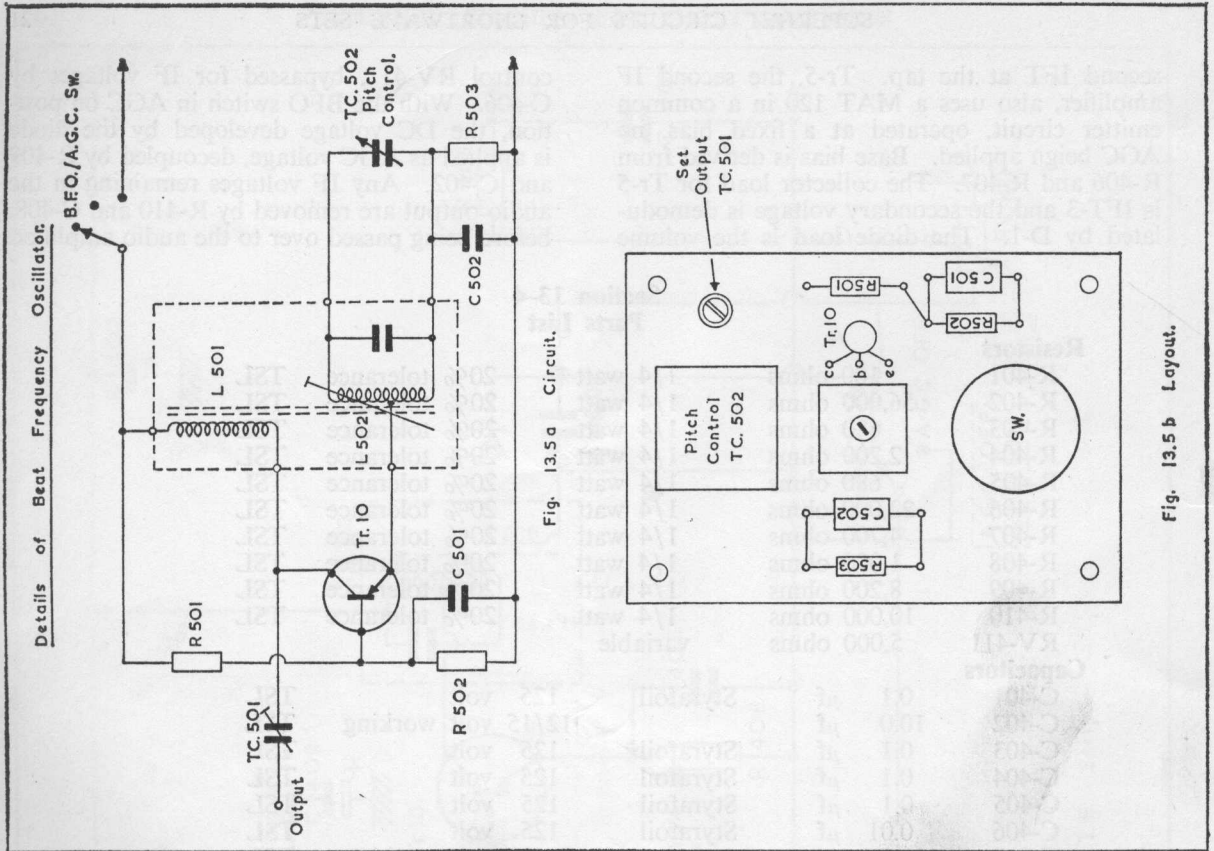
piece of paxolin, $2\frac{1}{2}$ inches by $3\frac{1}{2}$ inches by $\frac{1}{16}$ th thick. The completed unit is mounted on the back of the main front panel, with the shafts of the switch and that of the pitch control protruding, and fitted with knobs.

The switch has three positions, giving AGC on, AGC off, and BFO on with AGC off.

Section 13-5 Parts List

Resistors

R-501	15,000 ohms	1/4 watt	20% tolerance	TSL
R-502	3,300 ohms	1/4 watt	20% tolerance	TSL
R-503	1,000 ohms	1/4 watt	20% tolerance	TSL



Capacitors

C-501	0.1 μ f	Styrafoil	TSL
C-502	0.1 μ f	Styrafoil	TSL

Trimmer Capacitors

TC-501	15 pf	miniature tubular	
TC-502	25 pf	air spaced trimmer	Jackson C-801

Coil

L-501	Transistor type IF coil 470 kc/s.	Repanco XT-6
L-502		

Transistor

Tr-10	MAT 120	Sinclair
-------	---------	----------

Switch

Three way, two pole miniature Oak type switch	AB or NSF
Paxolin $2\frac{1}{2}$ " x $3\frac{1}{2}$ " x $\frac{1}{16}$ "	
Miscellaneous hardware	

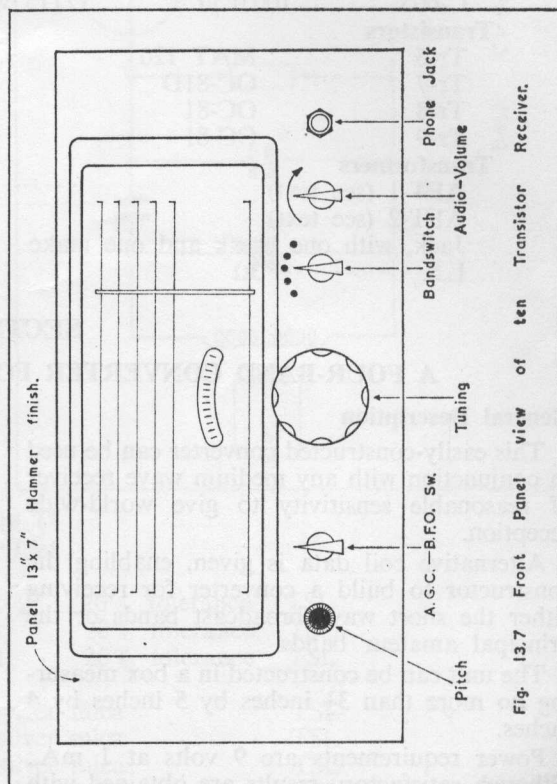
SECTION 13-6

AUDIO AMPLIFIER

The circuit of the audio section is shown in Fig. 13-6. Bias for the first stage (MAT 120) is by R-601 and R-602. At first sight, the emitter resistor of 8.2 K may seem rather high, but this stage is operated at a very low operating current in order to ensure a low noise level. The collector load is R-604, 12 K, with capacitive coupling to the driver stage, which is transformer coupled to the output stage, a pair of OC-81's in class B. In addition to the overall feedback due to R-608 and R-606, there are two local feedback loops over the output transistors. Transformer coupling is employed between the output stage and the load. The loudspeaker is connected as shown, and with the phone plug out, the speaker is operative. With the plug inserted, however, the loudspeaker is disconnected, and a 4.7 ohm load resistor is shunted across the phones. The resistor serves two functions, one, to preserve the correct load conditions on the output transistors, and two, to dissipate some of the energy developed. After all, one does not want half a watt of energy in a pair of sensitive phones.

Transformers

The input and the output transformers can be wound by the constructor. The cores used are No. 228 lams $\frac{5}{8}$ inch stack. If these are not available, it should be possible to reclaim two small battery type output transformers having laminations near this size.

**Winding details :—**

- AFT-1 Primary, 1,400 turns of 42 SWG en.
Secondary, 2 x 350 turns of 38 SWG
En bifilar wound, that is two wires wound together.
- AFT-2 Primary, 2 x 230 turns of 36 SWG en
bifilar wound.
Secondary, 50 turns of 22 SWG en.

Parts List

Section 13-6

Resistors

R-601	120,000	ohms	1/4 watt	20% tolerance	TSL
R-602	47,000	ohms	1/4 watt	20% tolerance	TSL
R-603	8,200	ohms	1/4 watt	20% tolerance	TSL
R-604	12,000	ohms	1/4 watt	20% tolerance	TSL
R-605	100,000	ohms	1/4 watt	20% tolerance	TSL
R-606	22,000	ohms	1/4 watt	20% tolerance	TSL
R-607	680	ohms	1/4 watt	20% tolerance	TSL
R-608	270,000	ohms	1/4 watt	20% tolerance	TSL
R-609	8,200	ohms	1/4 watt	20% tolerance	TSL
R-611	68	ohms	1/4 watt	20% tolerance	TSL
R-612	5.6	ohms	1/4 watt	20% tolerance	TSL
R-610	8,200	ohms	1/4 watt	20% tolerance	TSL
R-613	4.7	ohms	1/4 watt	20% tolerance	TSL

Capacitors

C-601	1.0	μ f	12/15 volt working	TSL
C-602	100.0	μ f	12/15 volt working	TSL
C-603	1.0	μ f	12/15 volt working	TSL
C-604	100.0	μ f	12/15 volt working	TSL
C-605	100.0	μ f	12/15 volt working	TSL

Transistors

Tr-6	MAT 120	Sinclair
Tr-7	OC-81D	Mullard
Tr-8	OC-81	Mullard
Tr-9	OC-81	Mullard

Transformers

AFT-1 (see text)		
AFT-2 (see text)		
Jack, with one break and one make		Bulgin J-13
L.S.	3 Ω	TSL

SECTION 14**A FOUR-BAND CONVERTER FOR BROADCAST OR HAM BANDS****General Description**

This easily-constructed converter can be used in conjunction with any medium wave receiver of reasonable sensitivity to give world-wide reception.

Alternative coil data is given, enabling the constructor to build a converter for receiving either the short wave broadcast bands or the principal amateur bands.

The unit can be constructed in a box measuring no more than 3½ inches by 5 inches by 4 inches.

Power requirements are 9 volts at 1 mA., although satisfactory results are obtained with 4½ volts. The life of the battery under these conditions is the shelf or storage life of the battery. The converter input is connected to the aerial, and the output to the aerial/earth socket(s) of the receiver with which it is to be used.

When the band switch is in the medium and long wave position, the converter is 'OFF',

and the act of changing to any of the short wave bands switches the converter 'ON'.

Band spread is incorporated, the swing of the tuning condenser covering only the band to which the bandswitch is set.

Coil Winding Details

	<i>Coupling Winding</i>	<i>Tuned Winding</i>
L-1	15 t 38 ssc	76 t 38 ssc
L-2	9 t 38 ssc	33 t 38 ssc
L-3	6 t 38 ssc	19 t 38 ssc
L-4	4 t 33 ssc	8 t 33 ssc
L-5	20 t 38 ssc	47 t 38 ssc
L-6	15 t 38 ssc	32 t 38 ssc
L-7	7 t 33 ssc	14 t 38 ssc
L-8	4 t 33 ssc	6 t 33 ssc
L-9	Medium wave aerial coil with a high impedance primary (Denco Range 2)	

The coils are all wound (with the exception of L-9) on Denco miniature formers ⅜ inch diameter, 1½ inches long, fitted with dust cores.

Construction

The converter is assembled on a piece of 1/8-inch paxolin. Number 53 holes (1/16 inch) are drilled to take brass pins 1/2 inch long for the resistors and capacitors. The coil formers on which L-1 to L-8 are wound require 1/4-inch holes for fixing. The bandswitch requires a 3/8-inch clearance hole. The trimmers are mounted directly on the coils.

Wire up, using 24 SWG tinned copper wire. Use no flux other than that in the solder.

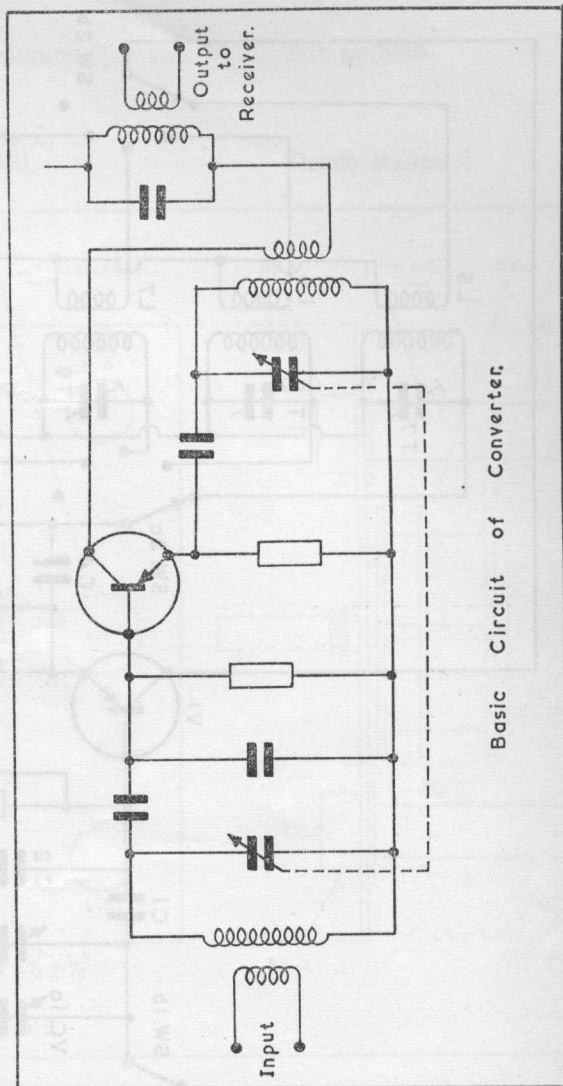
The choice of cabinet is left to the individual constructor.

Operation

After completing the wiring, check carefully to ensure that no wiring errors or omissions have been made. It is surprising how infuriating a missing connection can be. Once satisfied that no wiring errors exist, the next step is to connect the battery and also the lead from the output of the converter to the receiver with which it is to be used. At this stage no aerial is needed. Switch on both the converter and the receiver, and tune the receiver to a point near the bottom of the medium wave band, where no station can be heard. Turn up the volume until a hiss can be heard. Adjust L-9 in the converter for the loudest hiss. Turn the tuning capacitor in the converter to somewhere near the minimum capacitance, and adjust the aerial trimmer corresponding to the band in use for maximum noise in the receiver's output. Turn the tuning capacitor to maximum C, and this time adjust the core of the aerial coil for maximum noise.

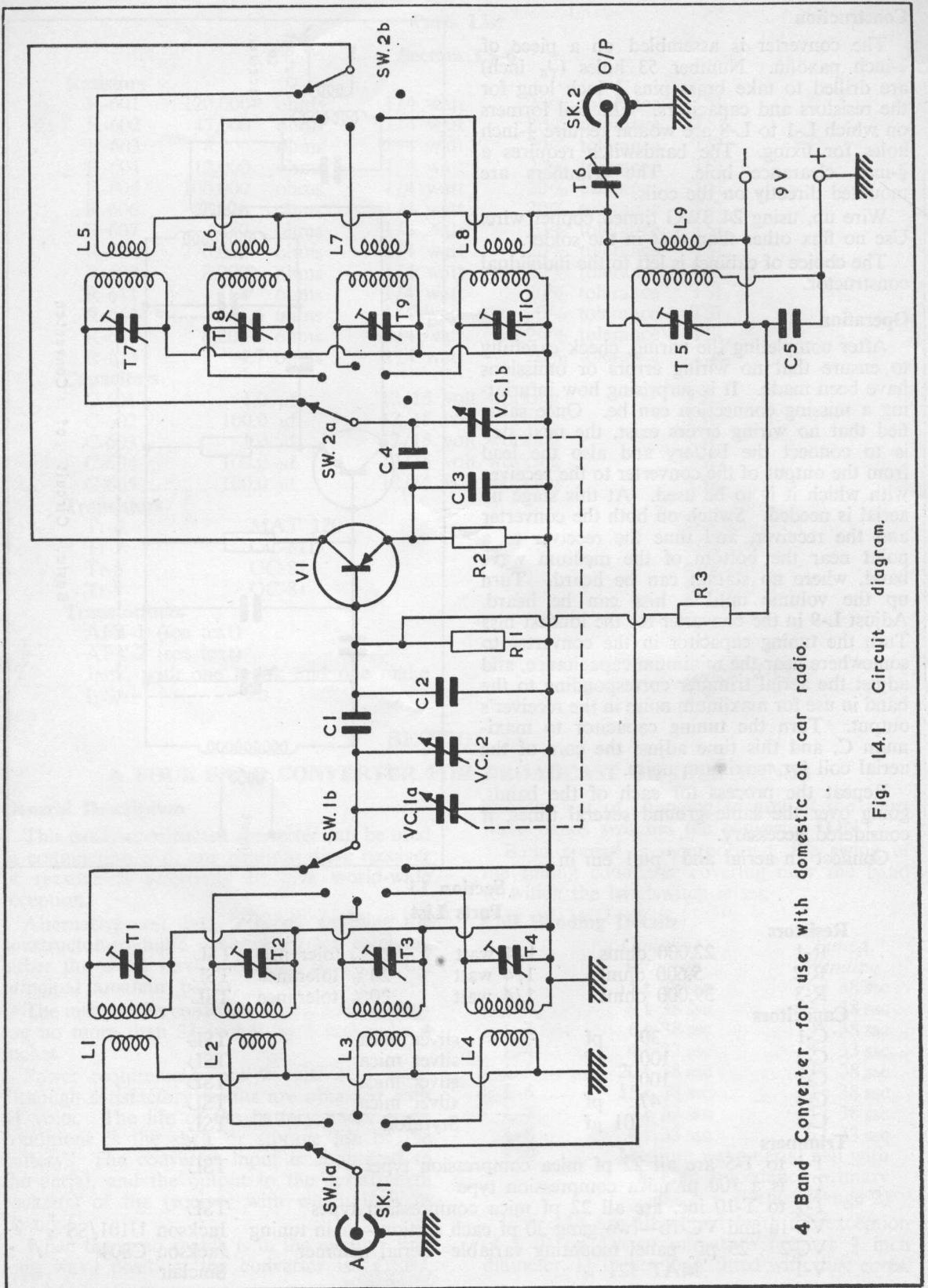
Repeat the process for each of the bands, going over the same ground several times, if considered necessary.

Connect an aerial and 'pull 'em in'.



**Section 14
Parts List**

Resistors					
R-1	22,000 ohms	1/4 watt	20% tolerance	TSL	
R-2	5,600 ohms	1/4 watt	20% tolerance	TSL	
R-3	39,000 ohms	1/4 watt	20% tolerance	TSL	
Capacitors					
C-1	30 pf		silver mica	TSL	
C-2	100 pf		silver mica	TSL	
C-3	100 pf		silver mica	TSL	
C-4	47 pf		silver mica	TSL	
C-5	.01 µf		Styrafoil	TSL	
Trimmers					
T-1 to T-5 are all 22 pf mica compression types				TSL	
T-6 is a 100 pf mica compression type					
T-7 to T-10 inc. are all 22 pf mica compression types				TSL	
VC-1a and VC-1b—two gang 30 pf each section—main tuning				Jackson U101/SS	
VC-2 25 pf panel mounting variable—aerial trimmer				Jackson C804	
V-1	MAT 121			Sinclair	



4 Band Converter for use with domestic or car radio.

Fig. 14.1 Circuit diagram.

SK-1 and SK-2 co-axial sockets
 Battery Ever Ready PP3
 SW-1; SW-2 Four pole five way miniature Oak switch
 Hardware, Knobs, etc.

TSL
 AB or NSF

Coils

L-1 to L-8—see text (Table 1 and Table 2)
 L-9 Standard medium wave aerial coil

Denco Range 2

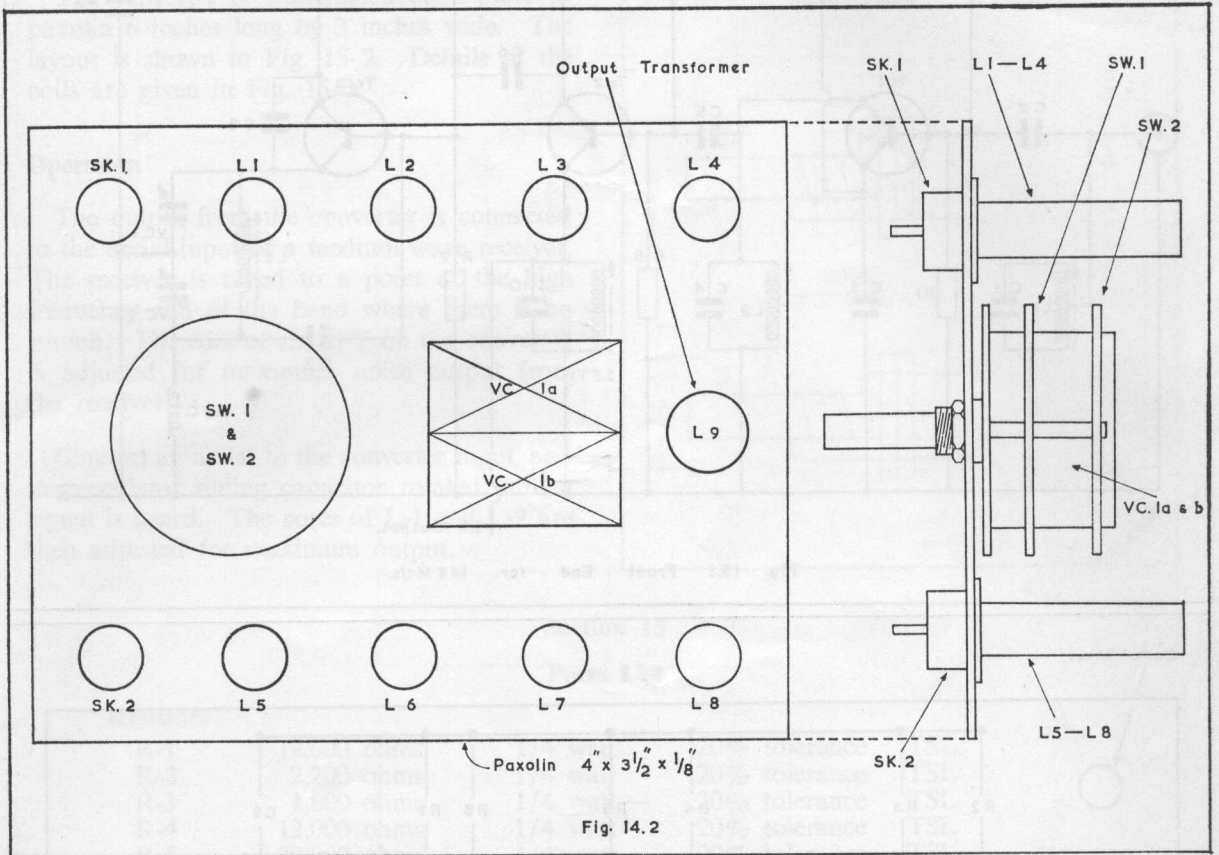


Fig. 14.2

SECTION 15

CONVERTER FOR THE 144 M/cs. BAND

This converter uses three alloy diffused transistors. One is used as a tuned RF stage, one as a mixer and the third as a local oscillator. The RF amplifier is used in a common emitter circuit. Both the aerial input and the collector load are tuned. The mixer is operated as a common emitter, with the local oscillator injected into the emitter circuit. The signal is applied to the base, and the IF output appears across the collector load. The oscillator is a Colpitt's.

Circuit Description (see Fig. 15-1)

The aerial input is applied to the tap on L-1, which is tuned by C-1. The signal is transferred to the base of Tr-1 which is an

ADT 140 using C-2, the value of which is chosen to match the input of the transistor to 70 ohms. Tr-1 is biased by the potential divider formed of R-1 and R-2. The emitter resistor is bypassed by C-3.

The collector load of Tr-1 is L-2 tuned by C-4, and the signal is conveyed to the base of Tr-2 by the 15 pf capacitor C-5. Tr-2 is biased by means of R-4 and R-5. The emitter resistor is R-6, which is not bypassed to allow this point to be used for injecting the oscillator voltage. Tr-3 is the oscillator. The frequency of oscillation is determined by L-3, tuned by a split stator capacitor VC-1 and VC-2. The oscillator coupling capacitance is C-8. Correct

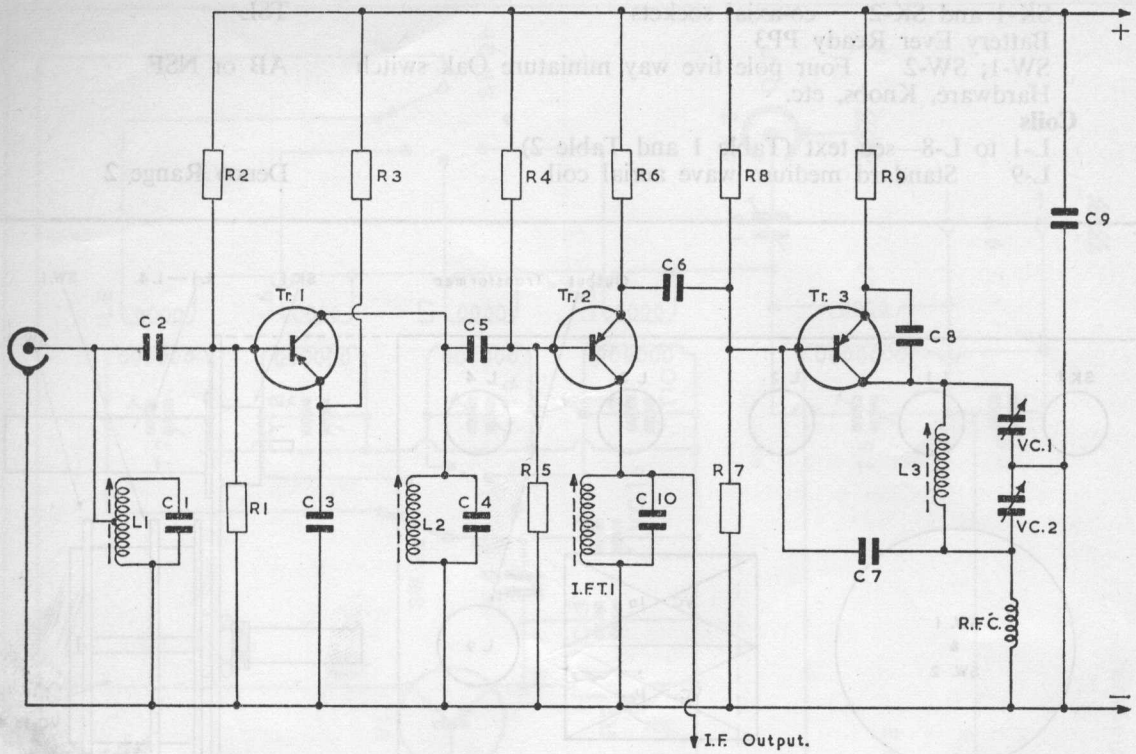
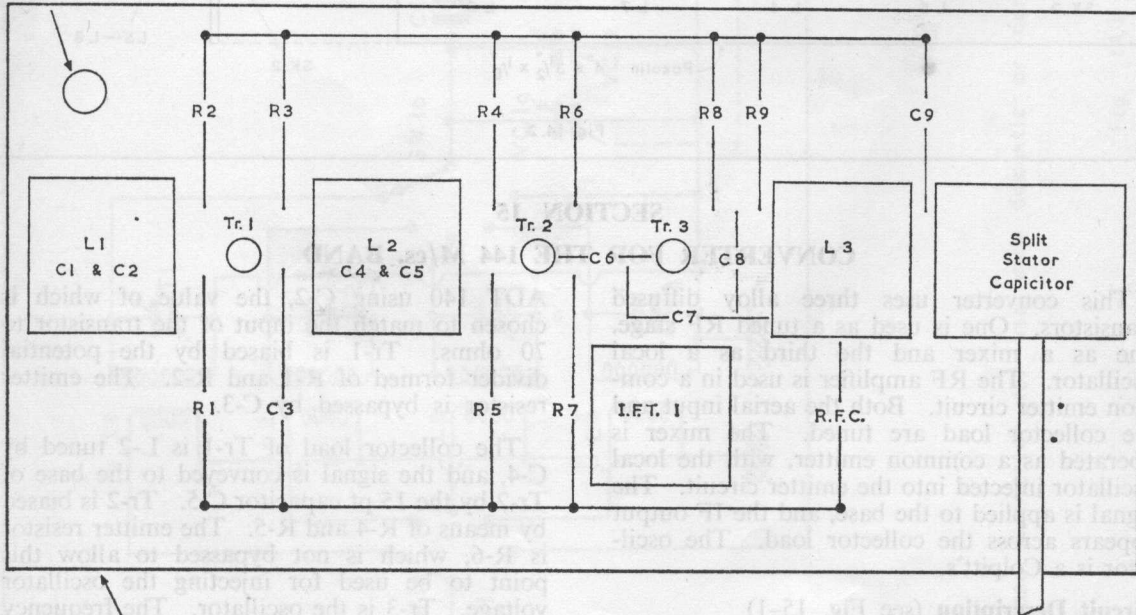


Fig. 15.1 Front End for 144 Mc/s.

Coax Input.



Paxolin 6 x 3 x 1/8"

Fig. 15.2

bias conditions for Tr-3 are determined by R-7 and R-8. R-9 is the emitter resistor, and the supply rail is decoupled by C-9.

Construction

The converter is constructed on a piece of paxolin 6 inches long by 3 inches wide. The layout is shown in Fig. 15-2. Details of the coils are given in Fig. 15-3.

Operation

The output from the converter is connected to the aerial input of a medium wave receiver. The receiver is tuned to a point at the high frequency end of the band where there is no station. The core of the IFT on the converter is adjusted for maximum noise output from the receiver.

Connect an aerial to the converter input, and the oscillator tuning capacitor rotated until a signal is heard. The cores of L-1 and L-2 are then adjusted for maximum output.

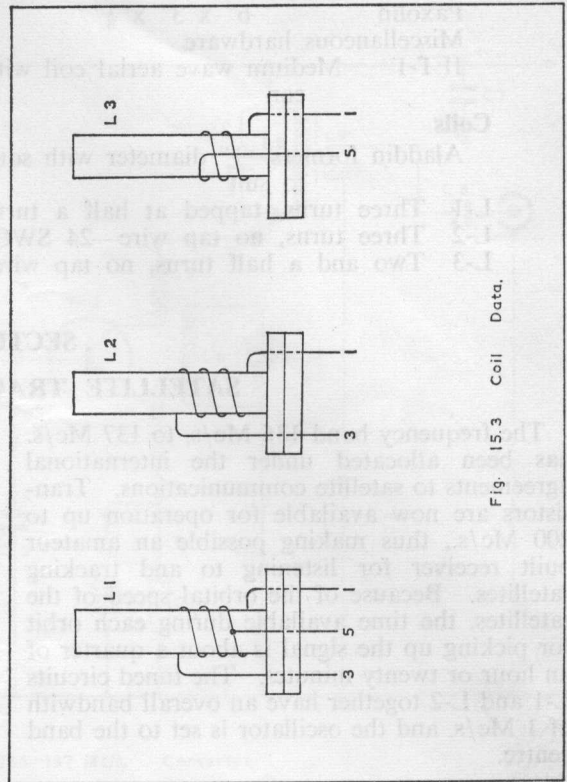


Fig. 15.3 Coil Data.

Section 15

Parts List

Resistors

R-1	12,000	ohms	1/4 watt	20% tolerance	TSL
R-2	2,200	ohms	1/4 watt	20% tolerance	TSL
R-3	1,800	ohms	1/4 watt	20% tolerance	TSL
R-4	12,000	ohms	1/4 watt	20% tolerance	TSL
R-5	39,000	ohms	1/4 watt	20% tolerance	TSL
R-6	1,200	ohms	1/4 watt	20% tolerance	TSL
R-7	12,000	ohms	1/4 watt	20% tolerance	TSL
R-8	5,600	ohms	1/4 watt	20% tolerance	TSL
R-9	1,500	ohms	1/4 watt	20% tolerance	TSL

Capacitors

C-1	5	pf	silver mica		TSL
C-2	22	pf	silver mica		TSL
C-3	.001	μ f	Styrafoil	125 volt	TSL
C-4	5	pf	silver mica		TSL
C-5	15	pf	silver mica		TSL
C-6	6	pf	silver mica		TSL
C-7	.001	μ f	Styrafoil	125 volt	TSL
C-8	2	pf	silver mica		TSL
C-9	.001	μ f	Styrafoil	125 volt	TSL
C-10	15	pf	silver mica		TSL

Transistors

Tr-1	ADT 140	Sinclair
Tr-2	ADT 140	Sinclair
Tr-3	ADT 140	Sinclair

Paxolin 6" x 3" x $\frac{1}{8}$ "
 Miscellaneous hardware
 IFT-1 Medium wave aerial coil with dust core, in screening can

Coils

- Aladdin formers— $\frac{1}{4}$ " diameter with square base—screening cans to suit
- L-1 Three turns, tapped at half a turn from the bottom end wire—24 SWG en
 L-2 Three turns, no tap wire—24 SWG en
 L-3 Two and a half turns, no tap wire—24 SWG en

SECTION 16**SATELLITE TRACKING RECEIVER**

The frequency band 136 Mc/s. to 137 Mc/s. has been allocated under the international agreements to satellite communications. Transistors are now available for operation up to 200 Mc/s., thus making possible an amateur built receiver for listening to and tracking satellites. Because of the orbital speed of the satellites, the time available during each orbit for picking up the signal is about a quarter of an hour or twenty minutes. The tuned circuits L-1 and L-2 together have an overall bandwidth of 1 Mc/s. and the oscillator is set to the band centre.

The aerial is inductively coupled to L-2 by means of L-1. The signal is applied to the base of Tr-1, which operates in a grounded emitter mode. Bias is derived from the 9-volt supply rail by the potential divider formed of R-1 and R-2. The collector circuit of Tr-1 is formed of L-3 and Tc-2. L-3 is inductively coupled to L-4 which is tuned to the mid band by Tc-3. Tr-2 is a self-oscillating mixer in a grounded base configuration, with the signal frequency impressed on the base. Oscillation is maintained by L-5 and L-7, and the frequency of oscillation is determined by L-6, tuned by Tc-4. The IF output appears across the tuned circuit formed of L-8 and C-5, and is applied to the receiver via C-6.

The IF output is set to one of the locally unused band 1 TV channels in the area in which the constructor lives. Details of L-8 are given for each of the television channels.

The converter is constructed upon a piece of paxolin $\frac{1}{8}$ inch thick, 3 inches square. An L-shaped bracket is required for mounting the Aladdin coil formers of dimensions 3 inches long, 1 inch high, with $\frac{1}{2}$ inch lip for mounting. (See Fig. 16-2.)

The coils are wound of tinned copper wire as follows:—

TABLE 1

L-1, two turns of 32 SSC, interwound with L-2.

- L-2, three turns of 20 SWG tinned cu, space-wound.
 L-3, three turns of 20 SWG tinned cu, space-wound.
 L-4, three turns of 20 SWG tinned cu, space-wound.
 L-5, two turns of 20 SWG tinned cu, space-wound.
 L-6, four turns of 18 SWG tinned cu, space-wound.

TABLE 2

L-8 is wound to suit the channel selected (see text).

- Channel 1 15 turns of 32 enamelled wire.
 Channel 2 15 turns of 32 enamelled wire.
 Channel 3 10 turns of 32 enamelled wire.
 Channel 4 10 turns of 32 enamelled wire.
 Channel 5 8 turns of 32 enamelled wire.

L-9, the secondary is the same in each case, five turns of thin PVC covered wire.

When winding L-2, L-3, L-4, L-5, L-6, the wire is first cut into 6-inch lengths and straightened by stretching slightly. The appropriate number of turns are then wound round one of the formers, and, with the coil held in place, the ends are bent sharply outwards from the former, so that the ends come one over the other. L-1 is wound *in situ* after the formers have been assembled and the coils located.

Construction

The paxolin panel has first to be drilled. The positions of the major components are shown in the drawing (Fig. 16-3). The coils are anchored in position by the ends, which are passed through $\frac{1}{8}$ -inch holes drilled in the panel, parallel to, and immediately under the coil former axis. The coil ends are cut so that about $\frac{3}{8}$ inch of wire projects through the under surface of the panel, i.e., of sufficient length to be used for making the circuit connections. The coil formers are thus used to position the coils rather than to act as the support upon which they are wound. The

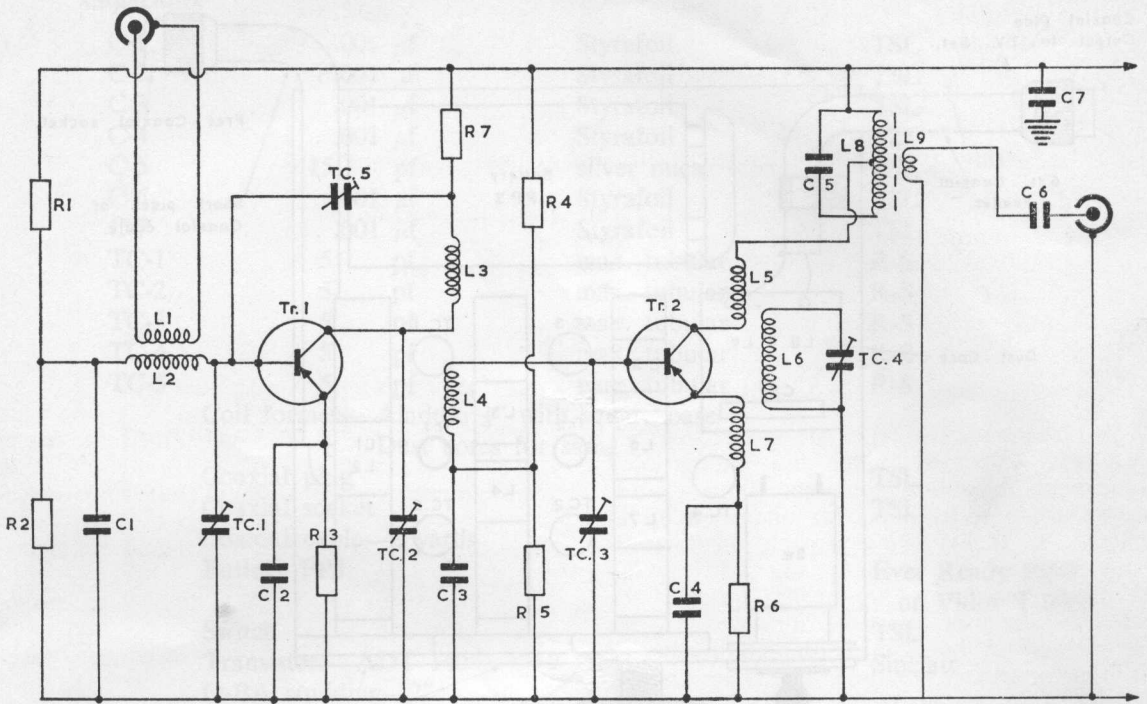
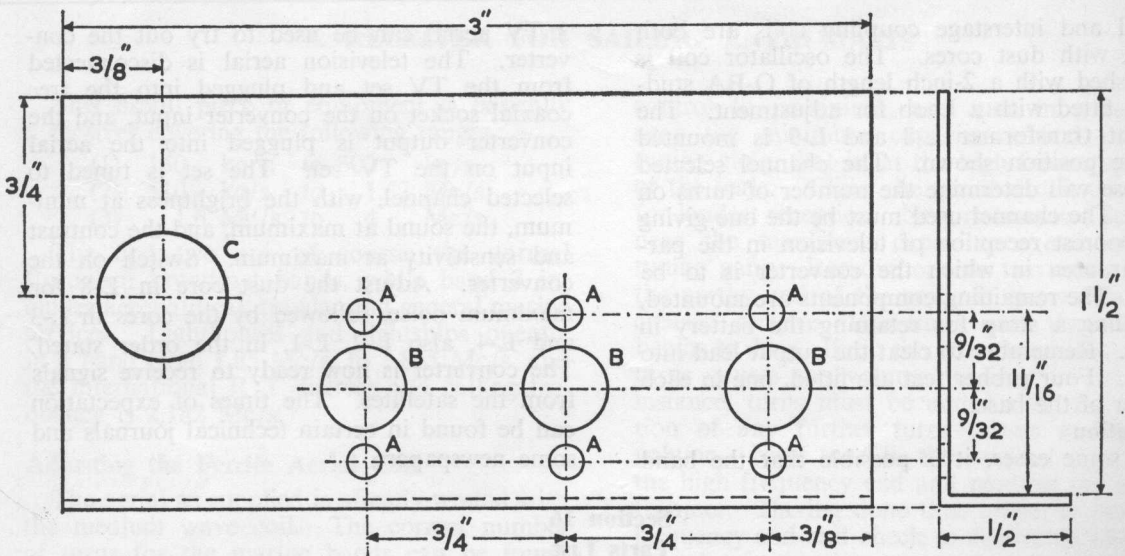


Fig. 16.1 Circuit of 136-137 Mc/s. Converter.



'A' 6BA. Clearance 32 MDG ($1/8$)
 'B' $5/16$ Dia.
 'C' $15/32$ Dia.

Coil mounting Bracket, 1off.
 Mat. 20 S.W.G. Aluminium

Satellite Receiver.

Fig. 16.2

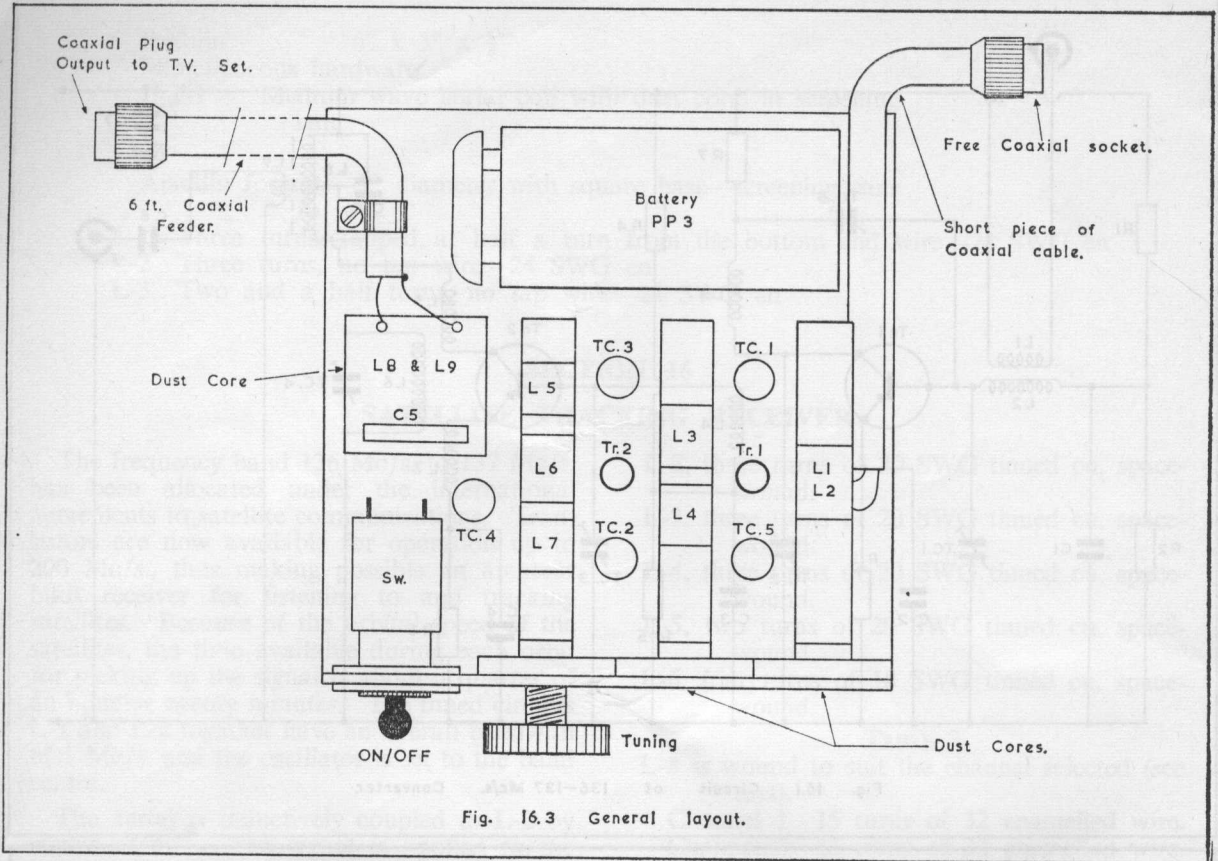


Fig. 16.3 General layout.

aerial and interstage coupling coils are both fitted with dust cores. The oscillator coil is furnished with a 2-inch length of O-BA studing, fitted with a knob for adjustment. The output transformer L-8 and L-9 is mounted in the position shown. The channel selected for use will determine the number of turns on L-8. The channel used must be the one giving the poorest reception of television in the particular area in which the converter is to be used. The remaining components are mounted, including a strap for retaining the battery in place. Remember to cleat the output lead into place. Four rubber feet are fitted, one in each corner of the base.

Operation

In some cases, it is possible that the band

3 TV aerial can be used to try out the converter. The television aerial is disconnected from the TV set and plugged into the free coaxial socket on the converter input, and the converter output is plugged into the aerial input on the TV set. The set is tuned to selected channel, with the brightness at minimum, the sound at maximum, and the contrast and sensitivity at maximum. Switch on the converter. Adjust the dust core in L-8 for maximum noise, followed by the cores in L-3 and L-4, also L-2, L-1, in the order stated. The converter is now ready to receive signals from the satellites. The times of expectation can be found in certain technical journals and some newspapers.

Section 16 Parts List

Resistors

R-1	4,700 ohms	1/4 watt	TSL
R-2	33,000 ohms	1/4 watt	TSL
R-3	1,000 ohms	1/4 watt	TSL
R-4	12,000 ohms	1/4 watt	TSL
R-5	12,000 ohms	1/4 watt	TSL
R-6	680 ohms	1/4 watt	TSL
R-7	100 ohms	1/4 watt	TSL

Capacitors

C-1	.001 μ f	Styrafoil	TSL
C-2	.001 μ f	Styrafoil	TSL
C-3	.001 μ f	Styrafoil	TSL
C-4	.001 μ f	Styrafoil	TSL
C-5	15 pf	silver mica	TSL
C-6	.001 μ f	Styrafoil	TSL
C-7	.001 μ f	Styrafoil	TSL
TC-1	5 pf	max. tubular	R-S
TC-2	5 pf	max. tubular	R-S
TC-3	5 pf	max. tubular	R-S
TC-4	5 pf	max. tubular	R-S
TC-5	5 pf	max. tubular	R-S

Coil formers—Aladdin $\frac{1}{4}$ " with square base
Dust cores for same

Coaxial plug TSL
Coaxial socket TSL

Coaxial cable—2 yards

Battery PP3

Ever Ready PP-3
or Vidor T-6003

Switch

TSL

Transistors—ADT 140 2 OFF

Sinclair

O-BA studding—2"

Miscellaneous hardware

SECTION 17**A RECEIVER FOR SAILING ENTHUSIASTS**

This useful piece of equipment is basically a receiver covering the following ranges:—

- (1) 150 kc/s. to 300 kc/s.
- (2) 510 kc/s. to 1.62 Mc/s.
- (3) 1.6 Mc/s. to 4 Mc/s.

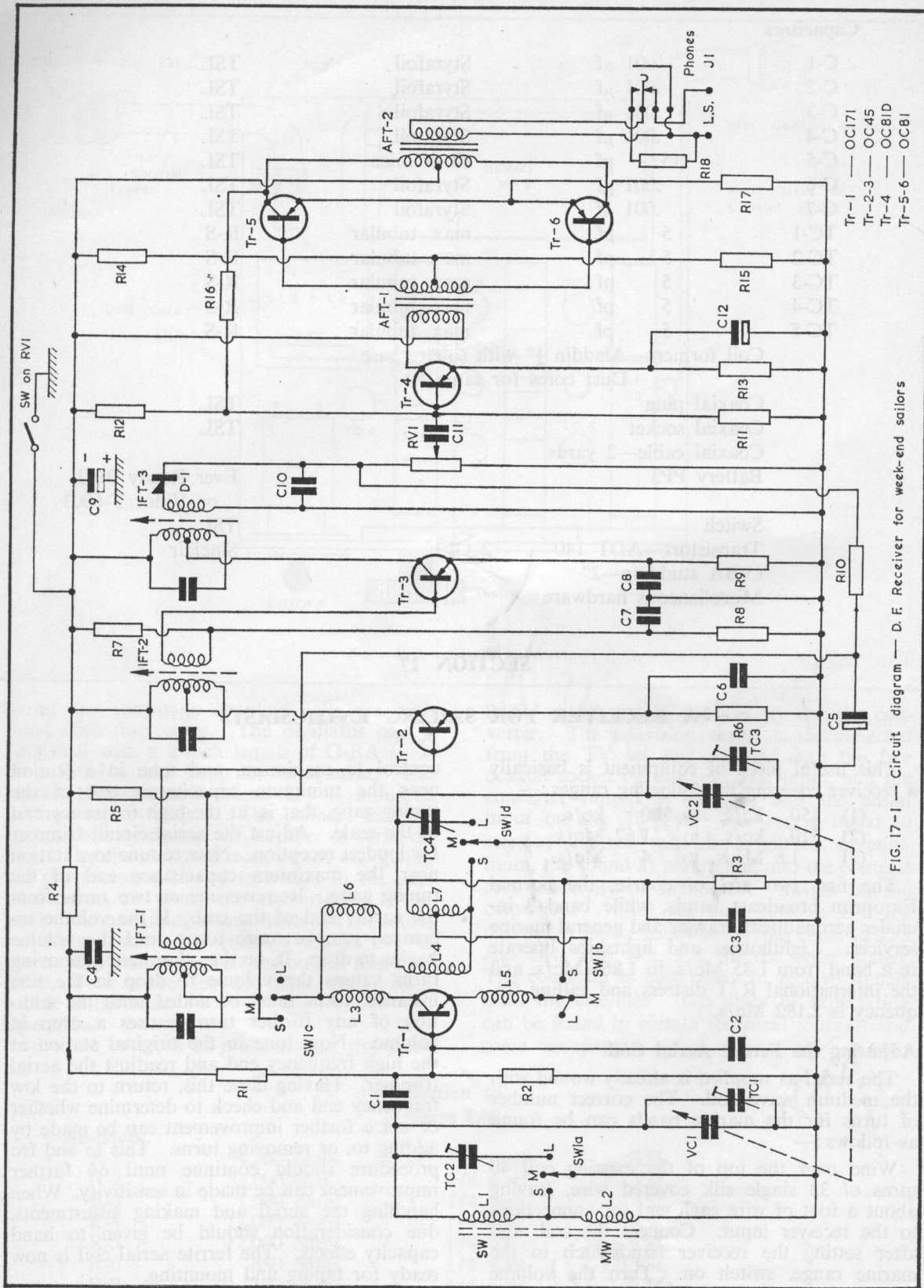
The first two are, of course, the normal European broadcast bands, while band 3 includes aeronautical, trawler and general marine services. Lighthouses and lightships operate in a band from 1.85 Mc/s. to 1.865 Mc/s. and the international R/T distress and calling frequency is 2.182 Mc/s.

Adjusting the Ferrite Aerial Coil

The aerial as supplied is already wound with the medium wave coil. The correct number of turns for the marine bands can be found as follows:—

Wind over the top of the existing coil 40 turns of 33 single silk covered wire, leaving about a foot of wire each end for connections to the receiver input. Connect the coil, and after setting the receiver bandswitch to the marine range, switch on. Turn the volume

control to maximum, and tune in a station near the minimum capacitance end of the tuning gang, that is, at the high frequency end of the scale. Adjust the aerial circuit trimmer for loudest reception. Now re-tune to a station near the maximum capacitance end of the tuning gang. Remove one or two turns from the earthy end of the coil. If the volume increases, remove more turns until the volume begins to drop. If, on the other hand, removing turns causes the volume to drop in the first instance, turns must be added until the addition of any further turns causes a drop in volume. Now tune in the original station at the high frequency end and readjust the aerial trimmer. Having done this, return to the low frequency end and check to determine whether or not a further improvement can be made by adding to, or removing turns. This to and fro procedure should continue until no further improvement can be made in sensitivity. When handling the aerial and making adjustments, due consideration should be given to hand capacity effects. The ferrite aerial coil is now ready for taping and mounting.



- Tr-1 — OC171
- Tr-2-3 — OC45
- Tr-4 — OC81D
- Tr-5-6 — OC81

FIG. 17-1 — Circuit diagram — D. F. Receiver for week-end sailors

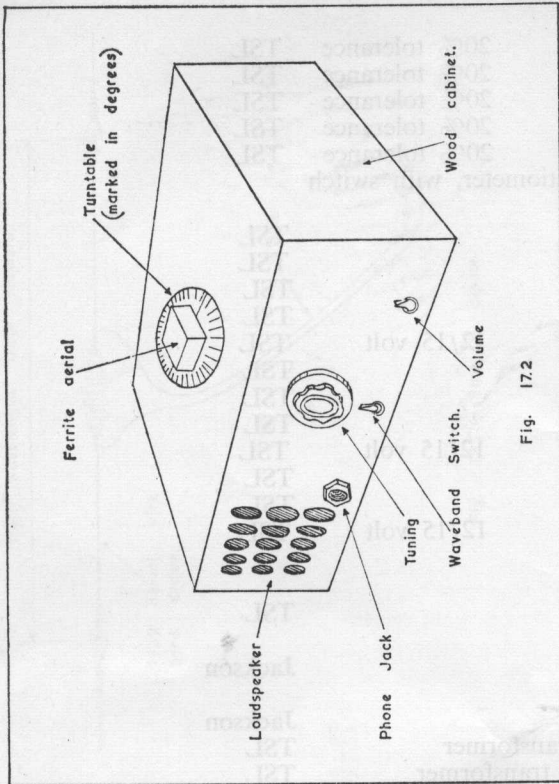


Fig. 17.2

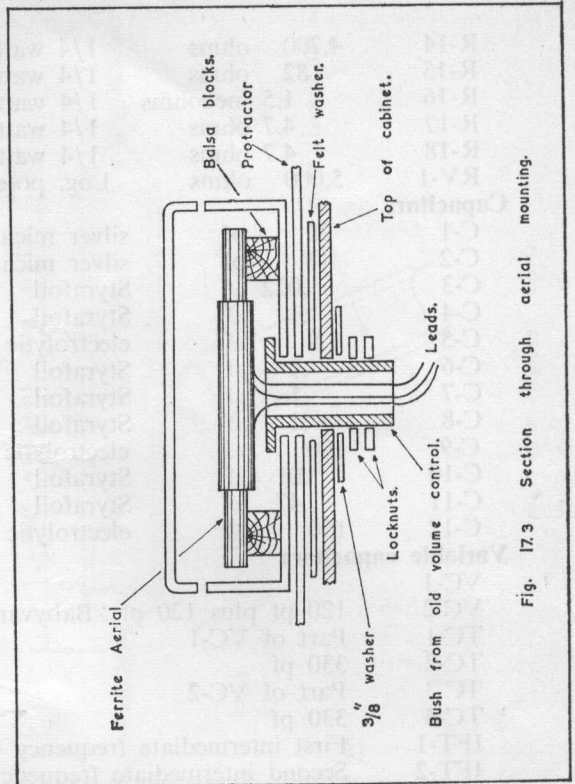


Fig. 17.3 Section through aerial mounting.

Mounting the Aerial (see Fig. 17-3)

The moulded box for protecting the aerial is fixed in the centre of the protractor, which should be of the 360° variety. A 3/8-inch diameter hole is drilled through the centre of the box and the protractor. In this hole is mounted a bush taken from a discarded volume control, using a thin nut. Pass the bush through a hole in the cabinet top, large enough to allow the bush to turn freely. Two thin volume control nuts with a large diameter

washer are used to hold the assembly on the cabinet top. The assembly must be free to rotate. Between the underside of the protractor and the top of the cabinet, a piece of felt, circular in shape, and 6 inches in diameter, prevents the underside of the protractor being scratched as it is rotated.

The ferrite aerial is mounted in the box, using two pieces of balsa wood as spacers, as shown in the diagram. Pass the leads from the coil through the hole in the centre of the bush and fasten the lid in place.

Section 17

Parts List

Resistors

R-1	33,000	ohms	1/4 watt	20% tolerance	TSL
R-2	6,800	ohms	1/4 watt	20% tolerance	TSL
R-3	1,000	ohms	1/4 watt	20% tolerance	TSL
R-4	100	ohms	1/4 watt	20% tolerance	TSL
R-5	56,000	ohms	1/4 watt	20% tolerance	TSL
R-6	680	ohms	1/4 watt	20% tolerance	TSL
R-7	22,000	ohms	1/4 watt	20% tolerance	TSL
R-8	4,700	ohms	1/4 watt	20% tolerance	TSL
R-9	1,000	ohms	1/4 watt	20% tolerance	TSL
R-10	8,200	ohms	1/4 watt	20% tolerance	TSL
R-11	22,000	ohms	1/4 watt	20% tolerance	TSL
R-12	68,000	ohms	1/4 watt	20% tolerance	TSL
R-13	1,000	ohms	1/4 watt	20% tolerance	TSL

R-14	4,700	ohms	1/4 watt	20% tolerance	TSL
R-15	82	ohms	1/4 watt	20% tolerance	TSL
R-16	1.5	megohms	1/4 watt	20% tolerance	TSL
R-17	4.7	ohms	1/4 watt	20% tolerance	TSL
R-18	4.7	ohms	1/4 watt	20% tolerance	TSL
RV-1	5,000	ohms	Log. potentiometer, with switch		
Capacitors					
C-1	22	pf	silver mica		TSL
C-2	47	pf	silver mica		TSL
C-3	.022	μ f	Styrafoil		TSL
C-4	.1	μ f	Styrafoil		TSL
C-5	8	μ f	electrolytic	12/15 volt	TSL
C-6	.1	μ f	Styrafoil		TSL
C-7	.1	μ f	Styrafoil		TSL
C-8	.1	μ f	Styrafoil		TSL
C-9	100	μ f	electrolytic	12/15 volt	TSL
C-10	.01	μ f	Styrafoil		TSL
C-11	.47	μ f	Styrafoil		TSL
C-12	100	μ f	electrolytic	12/15 volt	TSL
Variable capacitors					
VC-1					
VC-2	120 pf plus 120 pf	'Babyvar'			TSL
TC-1	Part of VC-1				
TC-2	330 pf				Jackson
TC-3	Part of VC-2				
TC-4	330 pf				Jackson
IFT-1	First intermediate frequency transformer				TSL
IFT-2	Second intermediate frequency transformer				TSL
IFT-3	Third intermediate frequency transformer				TSL
AFT-1	Audio driver transformer				TSL
AFT-2	Audio output transformer				TSL
Tr-1	Transistor MAT 121				Sinclair
Tr-2	MAT 120				Sinclair
Tr-3	MAT 120				Sinclair
Tr-4	OC-81-D				Mullard
Tr-5	OC-81				Mullard
Tr-6	OC-81				Mullard
D-1	Diode OA70				Mullard
SW-1	Four pole, three way wafer switch				AB or NSF
J-1	Telephone jack—two circuit change over				Bulgin J-13
L.S.	3 Ω				TSL
Coils					
L-1; L-2	Ferrite aerial modified (see text)				TSL
L-3; L-4; L-5	Oscillator coil MW and LW				TSL
L-6; L-7	Oscillator coil for 1.6 to 4 Mc/s. band				Denco Range 3

SECTION 18

AERIALS SUITABLE FOR USE WITH RECEIVERS DESCRIBED

The aerial system of a receiving station is an integral part of the receiver. It is composed basically of two parts:—

- (a) The aerial proper.
- (b) The means employed for transferring the signal voltages generated in the aerial to the input circuits of the receiver.

This section aims at setting out some of the various types of aerial, together with the types of transmission lines normally employed for the

purpose of coupling the input circuits of the receiver to the aerial with the minimum loss of energy.

Except for VHF working, the choice of aerial system is, as far as the majority of enthusiasts go, determined largely by the space available. For the lower frequency bands, the choice is generally restricted to a straight piece of wire, mounted as high as possible, and as far away from earthed objects as is possible. As the frequency of operation increases, how-

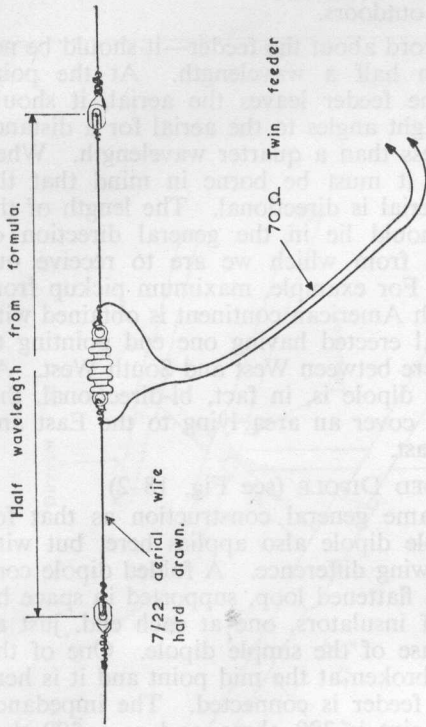


Fig. 18.1 Simple dipole.

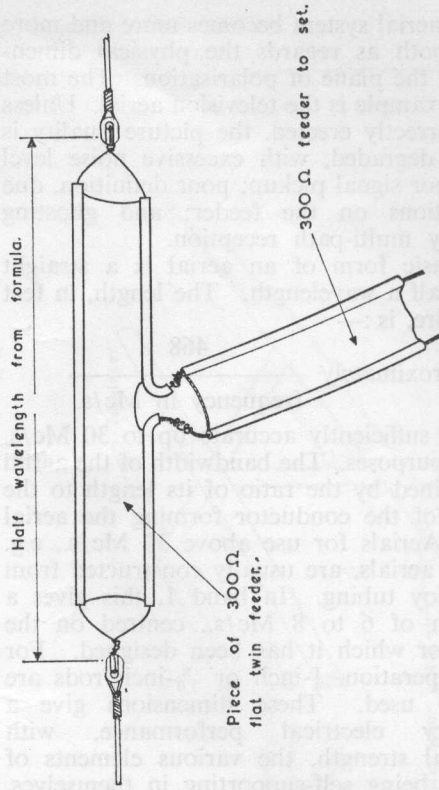


Fig. 18.2 Folded dipole.

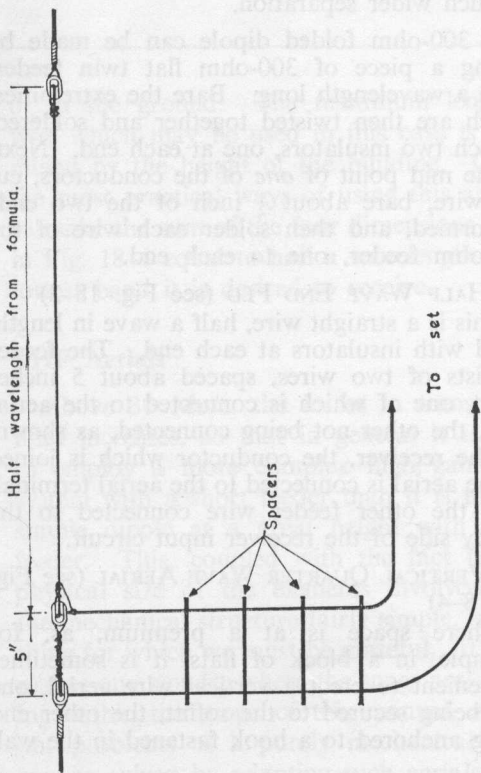


Fig. 18.3 Half wave end fed aerial.

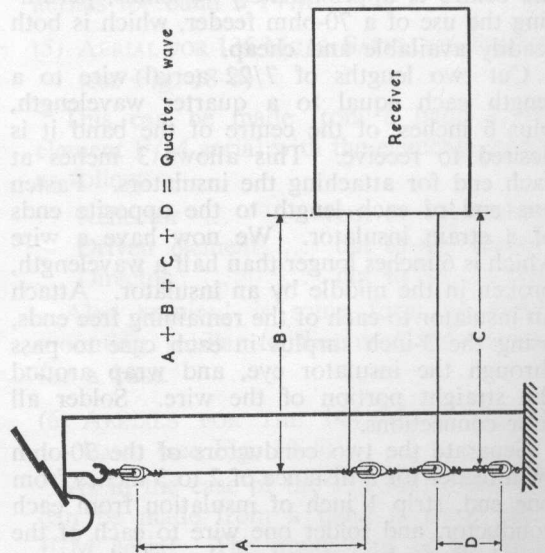


Fig. 18.4 Vertical quarter wave aerial.

ever, the aerial system becomes more and more critical, both as regards the physical dimensions and the plane of polarisation. The most obvious example is the television aerial. Unless this is correctly erected, the picture quality is seriously degraded, with excessive noise level due to poor signal pickup; poor definition, due to reflections on the feeder; and ghosting caused by multi-path reception.

The basic form of an aerial is a straight wire of half a wavelength. The length, in feet of this wire, is:—

$$\text{approximately } \frac{468}{\text{frequency in Mc/s.}}$$

This is sufficiently accurate up to 30 Mc/s. for most purposes. The bandwidth of the aerial is determined by the ratio of its length to the diameter of the conductor forming the aerial proper. Aerials for use above 30 Mc/s., e.g. television aerials, are usually constructed from $\frac{1}{2}$ -inch alloy tubing. In band 1, this gives a bandwidth of 6 to 8 Mc/s., centred on the channel for which it has been designed. For band 3 operation, $\frac{1}{4}$ -inch or $\frac{5}{16}$ -inch rods are frequently used. These dimensions give a satisfactory electrical performance, with mechanical strength, the various elements of the array being self-supporting in themselves, needing support only for the structure as a whole.

Practical Aerials

(1) CENTRE FED DIPOLE (see Fig. 18-1)

Space permitting, the centre fed, half wave dipole is the first choice. The impedance at the centre is approximately 70 ohms, permitting the use of a 70-ohm feeder, which is both readily available and cheap.

Cut two lengths of 7/22 aerial wire to a length each equal to a quarter wavelength, plus 6 inches, of the centre of the band it is desired to receive. This allows 3 inches at each end for attaching the insulators. Fasten one end of each length to the opposite ends of a strain insulator. We now have a wire which is 6 inches longer than half a wavelength, broken in the middle by an insulator. Attach an insulator to each of the remaining free ends, using the 3-inch surplus in each case to pass through the insulator eye, and wrap around the straight portion of the wire. Solder all four connections.

Separate the two conductors of the 70-ohm twin feeder for a distance of 2 to 3 inches from one end, strip 1 inch of insulation from each conductor, and solder one wire to each of the aerial wires where they pass through the centre insulator. Attach support lines to each end insulator (nylon parachute lines are excellent

for this purpose), and the aerial is ready for erection outdoors.

One word about the feeder—it should be not less than half a wavelength. At the point where the feeder leaves the aerial, it should run at right angles to the aerial for a distance of not less than a quarter wavelength. When erecting, it must be borne in mind that the dipole aerial is directional. The length of the aerial should lie in the general direction of the area from which we are to receive our signals. For example, maximum pickup from the North American continent is obtained with the aerial erected having one end pointing to somewhere between West and South West. As a simple dipole is, in fact, bi-directional, this will also cover an area lying to the East and North East.

(2) FOLDED DIPOLE (see Fig. 18-2)

The same general construction as that for the simple dipole also applies here, but with the following difference. A folded dipole consists of a flattened loop, supported in space by means of insulators, one at each end, just as in the case of the simple dipole. One of the wires is broken at the mid point and it is here that the feeder is connected. The impedance at this point is 300 ohms, and so a 300-ohm feeder must be used. This is readily distinguishable from the 70-ohm feeder by the spacing of the conductors, the 300 ohm having a much wider separation.

A 300-ohm folded dipole can be made by taking a piece of 300-ohm flat twin feeder, have a wavelength long. Bare the extremities, which are then twisted together and soldered. Attach two insulators, one at each end. Next, in the mid point of one of the conductors, cut the wire, bare about $\frac{1}{2}$ inch of the two ends so formed, and then solder each wire of the 300-ohm feeder, one to each end.

(3) HALF WAVE END FED (see Fig. 18-3)

This is a straight wire, half a wave in length, fitted with insulators at each end. The feeder consists of two wires, spaced about 5 inches apart, one of which is connected to the aerial wire, the other not being connected, as shown. At the receiver, the conductor which is joined to the aerial is connected to the aerial terminal, with the other feeder wire connected to the earthy side of the receiver input circuit.

(4) VERTICAL QUARTER WAVE AERIAL (see Fig. 18-4)

Where space is at a premium, as, for example, in a block of flats, it is sometimes convenient to erect a vertical wire aerial, one end being secured to the soffitt, the other end being anchored to a hook fastened in the wall

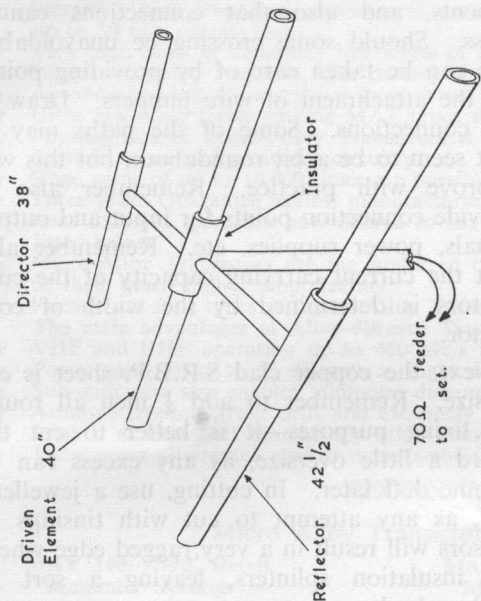


Fig. 18.5 136 Mc/s. aerial.

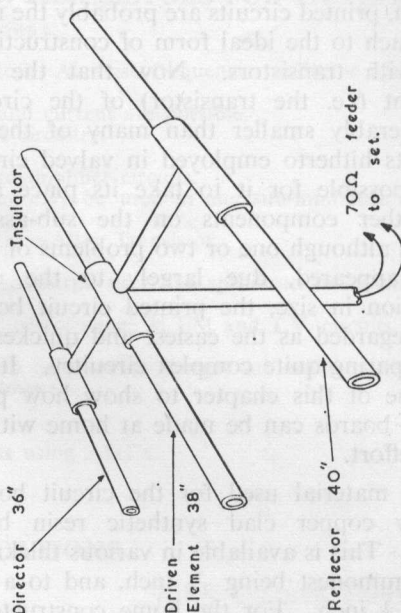


Fig. 18.6 144 Mc/s. amateur band aerial.

or in the ground. The maximum length of wire which may be used in this case is determined by the height of the building. One of the most practical ways of using this aerial is to make the sum of the four dimensions shown in Fig. 18-4 equal to half a wavelength of the lowest band it is desired to receive.

VHF Aerials

Above 30 Mc/s. the losses in transmission lines increases, so that in general it is better to employ a more complex high gain aerial system with a short feeder than it is to use a simple dipole at a great height with a long feeder. This, coupled with the fact that the physical size of the elements involved make the mechanical structure fairly simple, is something for which we must be grateful. It almost makes one wonder where the snags are. Keeping within the scope of this manual, most of our problems of a purely mechanical nature can be solved by adapting such aerials as are already available in the form of television

aerials for bands 1 and 3, together with VHF aerials for band 2 F/M.

(5) AERIAL FOR 136 MC/S. SATELLITE TRACKING (see Fig. 18-5)

This can be made from a band 2, three element F/M aerial with the elements modified as follows:—

- Reflector cut to 42½ inches
- Driven element ... cut to 40 inches
- Director cut to 38 inches

Also required is some form of movable mounting, similar to that used for telescopes, for a base.

(6) AERIALS FOR THE 144 MC/S. AMATEUR BAND (see Fig. 18-6)

As in the case of the 136 Mc/s. aerial, this can be made from a band 2, three element F/M aerial. The dimensions of the various elements are as follows:—

- Reflector cut to 40 inches
- Driven element ... cut to 38 inches
- Director cut to 36 inches

SECTION 19

ETCHED CIRCUITS—HOW TO PREPARE THEM

Etched, or as they are more popularly known, printed circuits are probably the nearest approach to the ideal form of construction for use with transistors. Now that the active element (i.e. the transistor) of the circuit is considerably smaller than many of the components hitherto employed in valved circuitry, it is possible for it to take its place among the other components on the sub-assembly board, although one or two problems of layout have appeared, due largely to the overall reduction in size, the printed circuit board is now regarded as the easiest and quickest way of preparing quite complex circuitry. It is the purpose of this chapter to show how printed circuit boards can be made at home with very little effort.

The material used for the circuit board is usually copper clad synthetic resin bonded paper. This is available in various thicknesses, the commonest being $\frac{1}{16}$ inch, and to a lesser extent $\frac{1}{8}$ inch. For the home constructor the most convenient material is the $\frac{1}{16}$ inch, coated on one side. It is manufactured coated on one side or on both sides with a deposit of copper of high purity, and to a thickness of either .001 inch or .0015 inch. This copper is etched away in the desired areas, leaving sufficient copper in the remaining areas to form the required circuit. Holes are then drilled through the copper and the board at the points where the lead wires for the various components are to be soldered.

Apparatus required :—

- Shallow photographer's dish, either porcelain or polyethylene will do.
- Small pencil brush, say a number 2.
- Medium size artist's brush, number 5 or 6.
- Razor blade, single edge.
- Straight edge, such as a 6-inch steel rule.

Materials required :—

- Ferric chloride—this is used by printers in the preparation of half-tone blocks.
- Small tin of quick drying lacquer, colour unimportant.
- 2 oz. acetone or paint thinners.

Method

First, the conventional circuit diagram must be prepared. It is possible sometimes to lay this out in a form almost identical with the

finally finished board. Next, decide upon the component layout, bearing in mind the possibility of interaction between critical components, and also that connections cannot cross. Should some crossing be unavoidable, this can be taken care of by providing points for the attachment of wire jumpers. Draw in the connections. Some of the paths may at first seem to be a bit roundabout, but this will improve with practice. Remember also to provide connection points for input and output signals, power supplies, etc. Remember also that the current carrying capacity of the conductors is determined by the width of conductor.

Next, the copper clad S.R.B.P. sheet is cut to size. Remember to add $\frac{1}{4}$ inch all round for fixing purposes—it is better to cut the board a little oversize, as any excess can be trimmed off later. In cutting, use a jeweller's saw, as any attempt to cut with tinsnips or scissors will result in a very ragged edge where the insulation splinters, leaving a sort of scalloped edge.

Copy the drawing on to the copper, using the pencil brush dipped in some of the lacquer which has been thinned just enough to allow it to flow fairly easily, but not to run. Set the board on one side to dry. When dry, the edges of the lacquer may be cleaned up by using the razor blade as a scraper with the straight edge for a guide. This helps to give a more professional look.

The board is now ready for etching, and should be placed in the dish. Next, pour over the board sufficient of the ferric chloride to cover the board to a depth of $\frac{1}{4}$ inch. Every few minutes pick up the dish and rotate it in such a manner as to circulate the ferric chloride. This is to ensure that the etchant in the immediate vicinity of the etched areas does not become saturated with copper. When all the areas not covered by the lacquer have been etched away, the board may be removed from the dish and wiped dry with a piece of clean rag. The lacquer is next removed by washing with another rag, this time soaked in thinners or acetone, and after finally cleaning up the edges with a fine file, the completed printed circuit board is now ready for assembly and wiring.

TSL

MICRO ALLOY (MAT's) and ALLOY DIFFUSED (ADT's) TRANSISTORS FOR THE SPACE AGE

The main advantages of Micro-Alloy Transistors are as follows :

- ★ Exceptionally high levels of current gain are available.
 - ★ Extremely high frequency operation is possible up to 130 Mc/s. At these frequencies collector currents of up to 50 mA can be used.
 - ★ Very high gains at incredibly low levels of collector voltage and current are possible.
 - ★ Superb frequency response, thus making them ideal for Hi-Fi circuitry.
 - ★ Absolute freedom from drift or inconsistent performance.
 - ★ Ultra low noise levels making MAT types the preferred in pre-amplifier circuits.
 - ★ Physical size of Micro-Alloy Transistors is so small that they may be used in any sub-miniature circuitry apart from normal transistor circuitry.
 - ★ Stage gains of up to 10,000 times are possible with a single Micro-Alloy Transistor.
 - ★ Three years Guarantee against manufacturing faults.
 - ★ Four different types are now offered to the constructor and industrial user, the specifications of which are listed below.
 - ★ Micro-Alloy Transistors are the preferred types for superior performance in FM and T.V. circuits, because of their much higher amplification.
 - ★ Price of all four types of Micro-Alloy Transistors is very much below price charges for ordinary transistors.
- The main advantages of Alloy-diffused Transistors are as follows :
- ★ VHF and UHF operation up to 450 Mc/s is possible.
 - ★ Power gains of up to 55 dB with a single stage are possible.
 - ★ Sub-miniature size enables minimum dimensions for apparatus using ADT's.
 - ★ Absolute freedom from drift and extremely low noise levels.
 - ★ Price is at least half that of any other comparable type.
 - ★ Three years Guarantee against manufacturing faults.

TECHNICAL SPECIFICATIONS

Micro Alloy Transistors

Alloy Diffused Transistors

MAT 100—7/9d. Retail

MAT 101—8/6d. Retail

ADT 140—15/- Retail

Maximum Ratings:

Maximum Ratings:

Maximum Ratings :

Ic 50 mA.
VCE 9 V.
Pc 50 mW @ 25°C.

Ic 50 mA.
VCE 9 V.
Pc 50 mW @ 25°C.

Ic 25 mA.
VCE 9 V.
Pc 100 mW @ 25°C.

Specifications @ Ic=0.5 mA,
VCE=0.5 V:

Specifications @ Ic=0.5 mA,
VCE=0.5 V:

Alpha cut off frequency 400 Mc/s.
typical

Alpha cut off frequency 60 Mc/s.
Common Emitter current
gain 25 to 75

Alpha cut off frequency 60 Mc/s.
Common Emitter current
gain 75 to 200

Power gain at 100 Mc/s at 6 V,
1 mA=15 dB typical.

MAT 120—7/9d. Retail

MAT 121—8/6d. Retail

(Common Base circuit.)

Maximum Ratings:

Maximum Ratings:

A.F. output impedance in common
emitter circuit
at 6 V, 1 mA=100 KΩ min.

Ic 50 mA.
VCE 9 V.
Pc 50 mW @ 25°C.

Ic 50 mA.
VCE 9 V.
Pc 50 mW @ 25°C.

Cob Collector capacitance 2.3 pF
typical

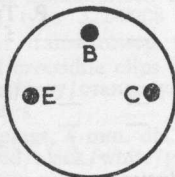
Specifications @ Ic=5 mA,
VCE=3 V:

Specifications @ Ic=5 mA,
VCE=3 V:

Collector-Base leakage current at
VCB= -6 V. is 1μA typical.

Alpha cut off frequency 120 Mc/s.
Common Emitter current
gain 25 to 75

Alpha cut off frequency 120 Mc/s.
Common Emitter current
gain 75 to 250



B = Base

E = Emitter

C = Collector

Sketch shewing base connections of
MAT 100, 101, 120, 121 and
ADT 140. Pins facing viewer.

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TSL INSTRUMENT GRADE "AAA1" COPPER WIRES FOR COILS AND ELECTRONIC WORK.

SWG	Enamelled on reels		Tinned on reels		Cotton covered on reels		Silk covered on reels		
	2-oz.	4-oz.	2-oz.	4-oz.	2-oz.	4-oz.	2-oz.	4-oz.	
16	...	2/6	4/-	...	2/6	4/-	...	2/8	4/3
18	...	2/7	4/2	...	2/7	4/2	...	2/9	4/4
20	...	2/8	4/3	...	2/8	4/3	...	2/11	4/6
22	...	2/9	4/5	...	2/9	4/5	...	3/1	4/9
24	...	2/10	4/7	...	2/10	4/7	...	3/3	5/-
26	...	3/-	4/9	...	3/-	4/9	...	3/4	5/2
28	...	3/1	4/10	...	3/2	4/11	...	3/6	5/4
30	...	3/2	5/-	...	3/3	5/1	...	3/8	5/6
32	...	3/3	5/1	...	3/5	5/3	...	3/10	5/11
34	...	3/4	5/2	...	3/7	5/6	...	4/1	6/6
36	...	3/6	5/5	...	3/9	6/2	...	4/3	6/10
38	...	3/8	5/9	...	3/11	6/9	...	4/9	8/9
40	...	3/10	6/2	...	4/1	7/3	...	5/8	10/6
42	...	5/6	11/-	...	6/6	13/-	...	8/6	14/-
44	...	8/6	16/-	...	8/9	17/-	...	10/3	19/-
46	...	12/-	24/-	...	12/6	25/-	...	16/-	29/6

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 - 0.015 mfd-0.1 mfd each 1/6
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- Type LPH65 tweeter. Plastic cone 17/11
- High-O Flexette enclosure P. Tax 3/1
- TSL-Lorenz LP312-2—12" plus two tweeters 28/6
- P. Tax 4/7
- 89/2
- P. Tax 15/1
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- M.1 microphone, dynamic moving coil with high/low input 84/-

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OC81, list 8/-. Our price	6/6
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