

No.

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**TESTED SHORT WAVE
RECEIVER CIRCUITS
USING
MICRO ALLOY TRANSISTORS
(MAT's)**

Every circuit has been tested by a panel of amateur constructors.

Constructional hints and tips.

Receivers covering the 1.8, 3.5, 7, 14, 21, 28 Megacycle Amateur bands.

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BERNARD'S RADIO MANUALS

TESTED SHORT WAVE RECEIVER CIRCUITS USING MICRO ALLOY TRANSISTORS (MAT's)

BERNARDS (PUBLISHERS) LTD.
THE GRAMPIANS
WESTERN GATE
LONDON, W.6

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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We invite all authors, whether new or well established, to submit manuscripts for publication. The manuscripts may deal with any facet of electronics but should always be practical. Any circuit diagrams that may be included should have been thoroughly checked by the author. If you are considering trying your hand at writing this type of book we suggest that you let us have a short summary of the subject you intend to cover. We will then be able to let you know the size of book required and perhaps give you some advice on presentation.

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INTRODUCTION

In this book are described nine all transistor radio receivers, ranging from a simple single transistor-diode combination to a six transistor short-wave receiver. In addition, circuits are given enabling the construction of other receivers, each having specific uses, to be undertaken.

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 having only a novelty appeal, but is aimed at the more serious short wave enthusiast. It must also be pointed out that the object of the first six sections is to familiarise the constructor with the broad principles of transistor work, and to illustrate the general technique of construction.

Short wave listening offers great enjoyment and a sense of achievement, even more enhanced by the knowledge that the equipment has been made by the listener.

SECTION 1

SINGLE TRANSISTOR REFLEX

The ingenuity required to extract from a handful of components the extreme limit of their capabilities in order to receive distant stations has long presented a challenge which the true amateur has always been eager to accept.

This little receiver, using one transistor filling the dual role of an R.F. amplifier and an A.F. amplifier at the same time, together with one diode, enables the challenge to be met.

Circuit Description

Referring to the circuit diagram, Fig. 1-1, it will be seen that the aerial is coupled aperiodically to the base of Tr-1 via C-1. The choke coil RFC presents a high impedance to all frequencies in the received range. Base bias for Tr-1 is tapped off the 9 volt rail by means of R-1 and R-2. The emitter current of Tr-1 is stabilised by means of R-3, which is bypassed by C-4. The collector load of Tr-1 is a tuned circuit formed of L-1 and VC-1. In the interests of selectivity and gain, the collector is tapped down the coil. The diode D-1 is capacitance coupled to the collector circuit by means of C-5, and the audio signal is developed across R-5. The audio signal is then applied to the base of Tr-1 via R-4 and the blocking capacitor C-3. Any RF which may be present in the detector output is prevented from reaching the base of Tr-1 by a filter formed by RFC and C-2.

After amplification by Tr-1, the audio signal appears as current in the phones. C-6 provides the return path for the RF and also keeps out RF from the phones.

Construction

The receiver is built upon a piece of paxolin, 1/16th inch thick and four inches square. The components are mounted in the positions shown in Fig. 1-2 using small 6-BA solder tags secured in place by 6-BA screws and nuts. The valve-holder for the coil requires a $\frac{3}{4}$ inch diameter hole, and is held in place by two 6-BA screws and nuts.

Mounted on the front panel (see Fig. 1-3) are the dial, drive and phone jack. The paxolin panel on which the receiver is constructed is stood off the back of the front panel by means of four pillars or long spacers.

Coil Data (See Fig. 1-4)

All coils are wound on Denco miniature dual purpose formers.

Broadcast Bands

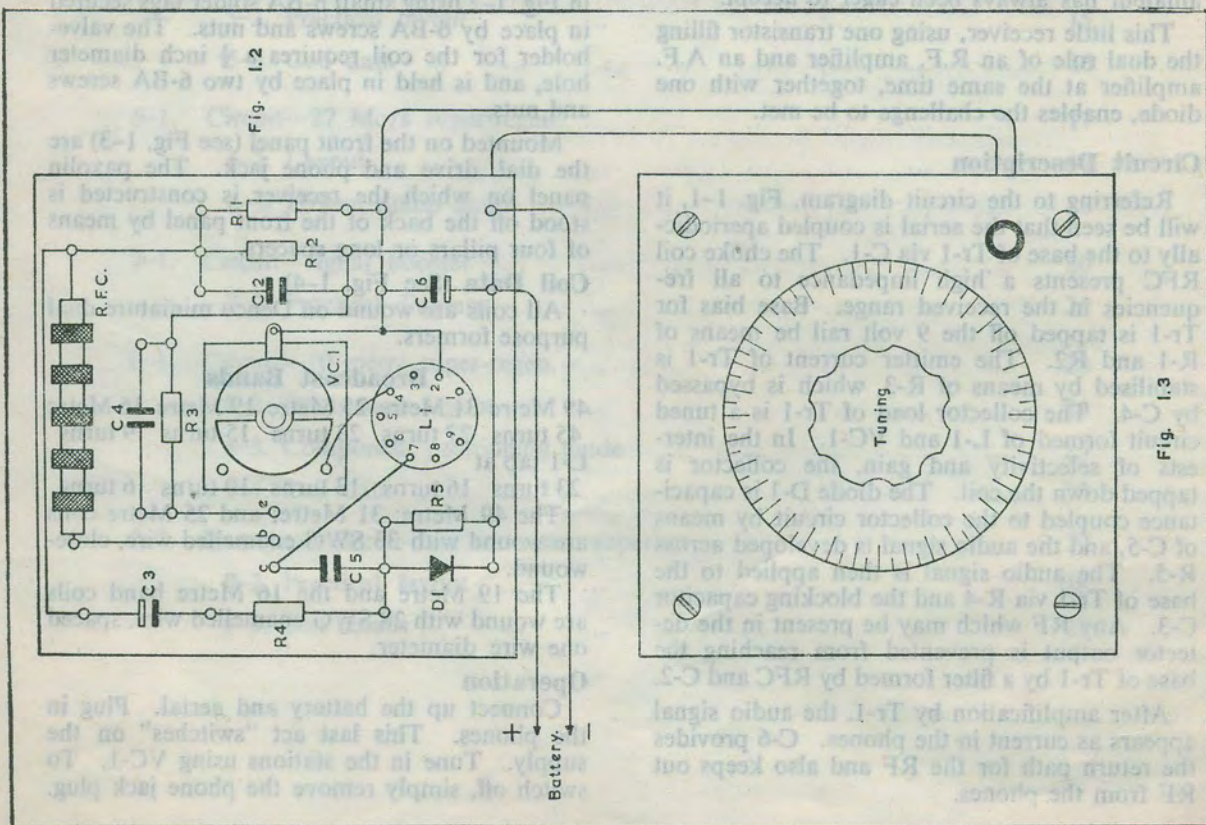
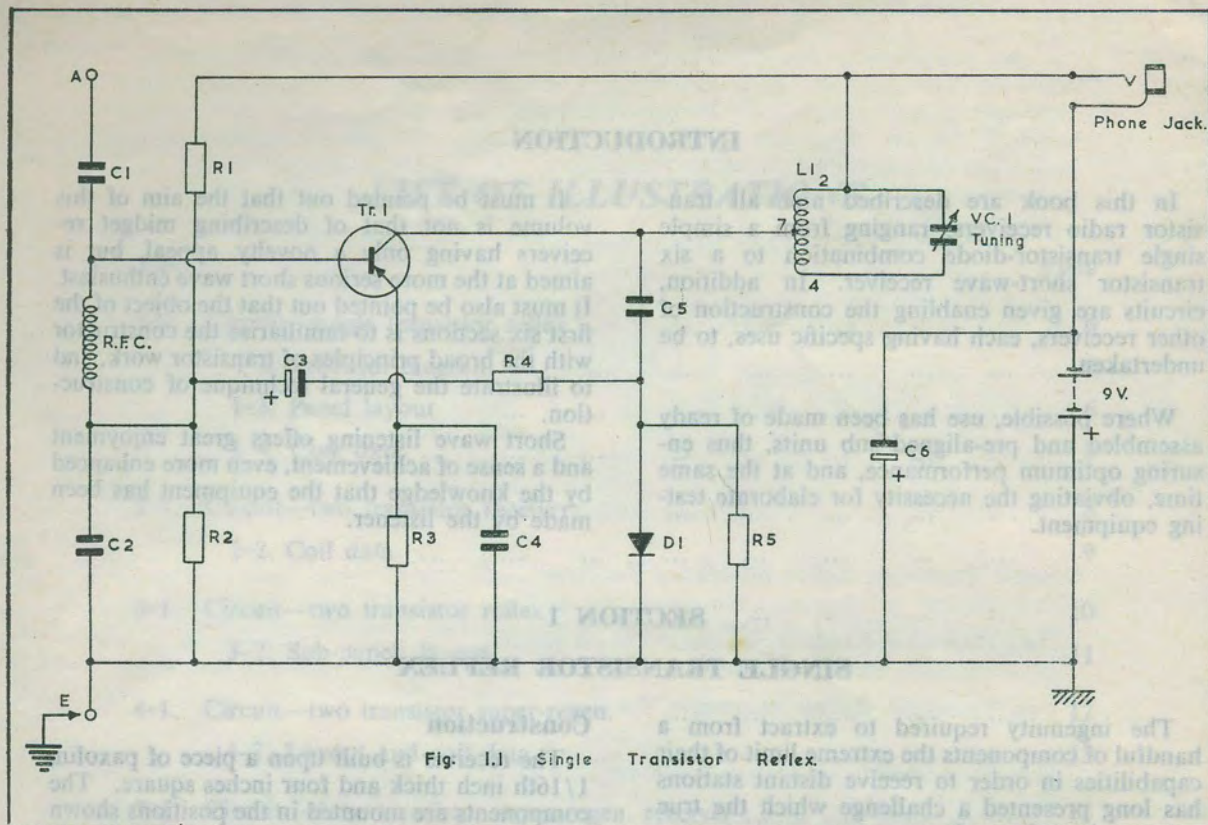
49 Metre 31 Metre 25 Metre 19 Metre 16 Metre
45 turns 27 turns 23 turns 15 turns 9 turns
L-1 tap at

23 turns 16 turns 13 turns 10 turns 6 turns
The 49 Metre; 31 Metre; and 25 Metre coils are wound with 33 SWG enamelled wire, close-wound.

The 19 Metre and the 16 Metre band coils are wound with 28 SWG enamelled wire, spaced one wire diameter.

Operation

Connect up the battery and aerial. Plug in the phones. This last act "switches" on the supply. Tune in the stations using VC-1. To switch off, simply remove the phone jack plug.



Parts List Section 1

Resistors

R-1	22,000 ohms	1/4 watt	20%	TSL
R-2	8,200 ohms	1/4 watt	20%	TSL
R-3	1,500 ohms	1/4 watt	20%	TSL
R-4	47,000 ohms	1/4 watt	20%	TSL
R-5	100,000 ohms	1/4 watt	20%	TSL

Capacitors

C-1	0.01 μ F	125 volt	TSL	20%
C-2	0.001 μ F	125 volt	TSL	20%
C-3	2.0 μ F	12/15 volt	TSL	—
C-4	0.01 μ F	125 volt	TSL	20%
C-5	75 pF		TSL	
C-6	100 μ F	12/15 volt	TSL	—

Tr-1 ADT140

D-1 D-100

diode

Sinclair

TSL

Transistor holder

TSL

Phone jack 3.5 mm.

TSL

Battery PP3

Ever Ready

Battery press stud connectors

TSL

Wander plug socket (Red)

TSL

Wander plug socket (Black)

TSL

Wander plug (Red)

TSL

Wander plug (Black)

TSL

RF choke 2.6 mH

TSL

B-9A valveholder

McMurdo

VC1 100 pF Variable

TSL

Coil Formers, with dust core

Denco dual purpose polystyrene plug in

4" Slow motion drive with

knob and scale

Jackson 4489

Paxolin panel 4" square 1/16" thick.

Miscellaneous Hardware

6 BA x 1/4" rh or ch screws.

6 BA nuts.

4 BA x 5/16" or 3/8" rh or ch screws.

6 BA solder tags.

1 1/2" spacers, tapped 4 BA.

Spindle coupler.

1/4" diameter extension spindle.

Front panel, 4 1/2" square, 18 SWG aluminium.

SECTION 2

A TWO TRANSISTOR RECEIVER FOR USE UP TO 88 Mc/s.

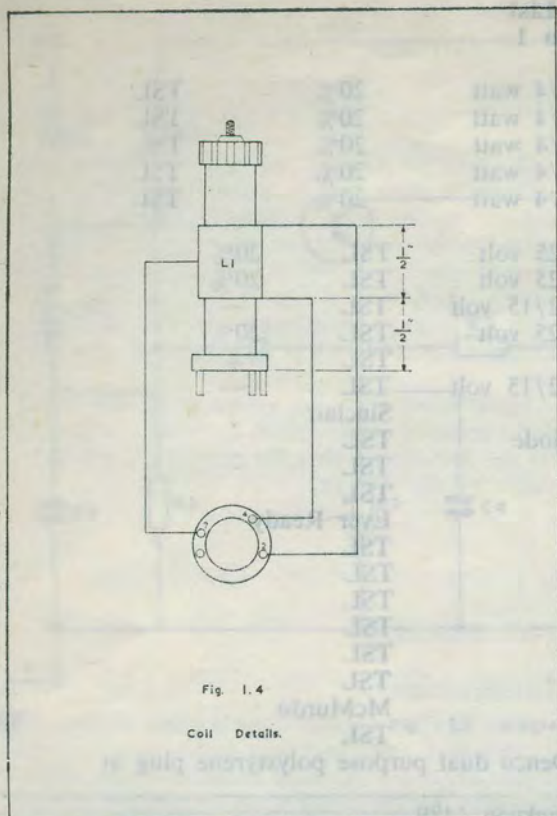
This is a two transistor regenerative receiver, roughly the equivalent of a two valve receiver having leaky grid detection with reaction and an audio output stage. Plug in coils are used and the upper frequency limit is set largely by the transistor characteristics. The set is designed around the ADT 140 transistor, which is intended for use up to 400 Mc/s.

Circuit Description (See Fig. 2-1)

The aerial is coupled to the tuned circuit L-2, C-2 by the primary winding L-1. The signal is applied to the base of Tr-1 from a tap on L-2, thus preventing loading of the tuned circuit by the base input resistance of Tr-1.

Feedback from the collector circuit into the base circuit is provided by an inductive coupling between L-3 and L-2, and regeneration is controlled by VR-1, which varies the potential applied to the base of Tr-1.

The audio signal is developed across the primary of the audio transformer AFT-1, and the voltage developed across the secondary is applied to the base of Tr-2 via C-6. Bias for Tr-2 is provided by the potential divider R-3 and R-4. The emitter current is stabilised by R-5, which is by-passed by C-7. Although phones are shown in the diagram, this little set will operate a loud speaker on signals of reasonable strength.



Construction

The RF and Audio sections of this set are built on a paxolin panel 6 inches by 4 inches by one eighth thick, which is stood off the front panel by means of four two inch spacers. The regeneration control with switch is mounted on the front panel, as is also the dial and drive for the main tuning capacitor. The coils are wound on Denco formers, intended to plug into a B9A valveholder.

Coil Data (See Fig. 2-2).

For 66 to 88 Mc/s.

L-1 Two turns, interwound with L-2 of 33 S.S.C.

L-2 Five turns of 22 bare copper, spaced to cover $\frac{1}{2}$ ".

L-3 Three turns, closewound of 33 S.S.C. spaced $\frac{1}{4}$ " from earthy end of L-2.

L-2 is tapped at $2\frac{1}{2}$ turns from the earthy end. For the 10 and 20 Metre bands.

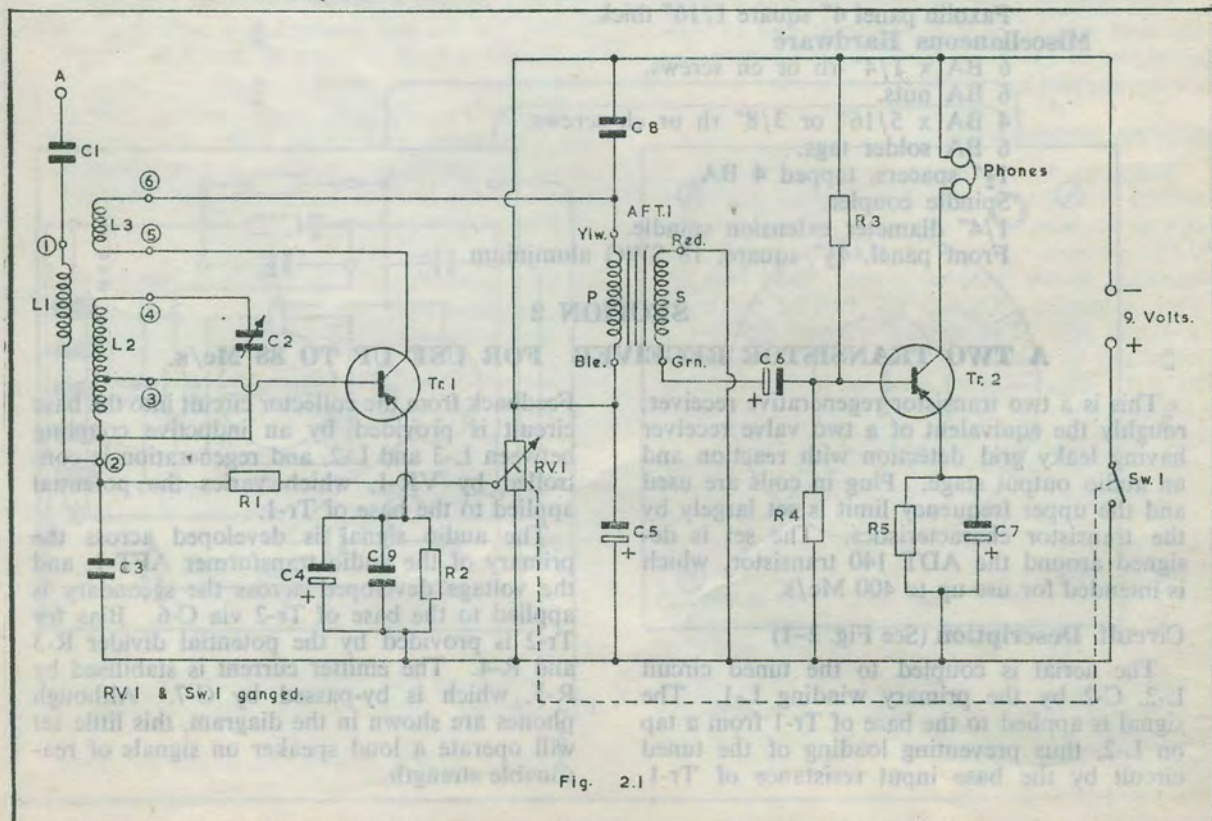
	10 Metre	20 Metre
L-1	4t	6t
L-2	8t	19t
tap on L-2	3t	7t
L-3	5t	7t

(spaced from L-2 $\frac{1}{4}$ inch.)

Wire sizes.

L-1 33 S.S.C.—interwound with L-2.

L-2 33 S.S.C.—spaced to occupy $\frac{1}{4}$ inch.



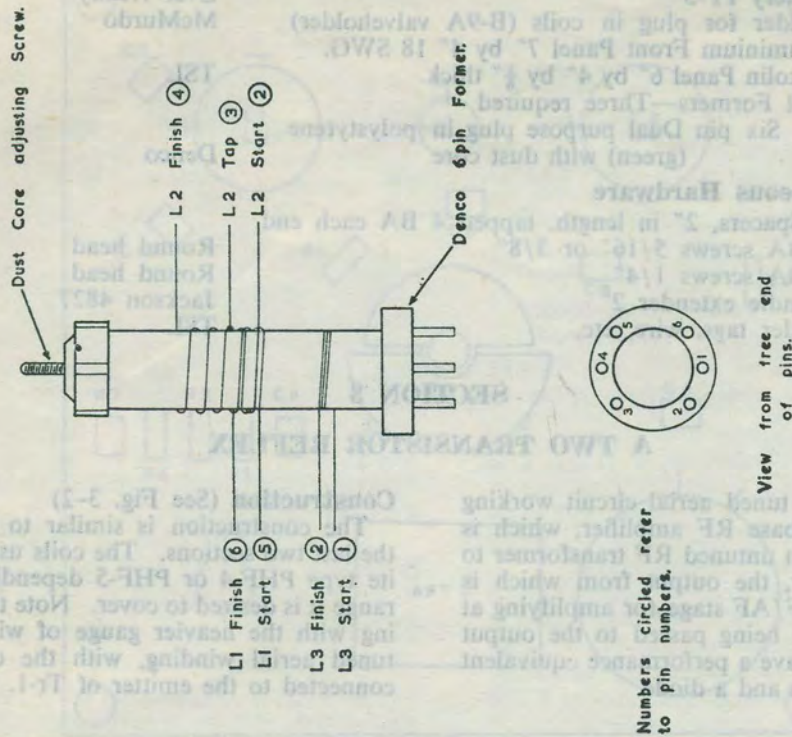


Fig. 2.2 Coil winding details.

Section 2

Parts List

Resistors

R-1	5,600 ohms	1/4 watt	20%	TSL
R-2	1,000 ohms	1/4 watt	20%	TSL
R-3	56,000 ohms	1/4 watt	20%	TSL
R-4	10,000 ohms	1/4 watt	20%	TSL
R-5	4,700 ohms	1/4 watt	20%	TSL
RV-1	50,000 ohms potentiometer with switch			TSL

Capacitors

C-1	68 pF	20%	125 volt	TSL
C-2	25 pF	variable		TSL
C-3	0.002 μ F		125 volt	TSL
C-4	5.0 μ F	electrolytic	12/15 volt	TSL
C-5	5.0 μ F	electrolytic	12/15 volt	TSL
C-6	2.0 μ F	electrolytic	12/15 volt	TSL
C-7	5.0 μ F	electrolytic	12/15 volt	TSL
C-8	0.01 μ F		125 volt	TSL
C-9	0.01 μ F		125 volt	TSL

Transformer

AFT-1	Interstage 4.5/1	TSL
-------	------------------	-----

Transistors

Tr-1	ADT140	Sinclair
Tr-2	MAT120	Sinclair
Transistor holders (two required)		TSL
Headphones 2000 ohms		TSL
Dial, drive and knob		Eddystone 843

Knob for RV-1
 Battery PP-3
 Holder for plug in coils (B-9A valveholder)
 Aluminium Front Panel 7" by 4" 18 SWG.
 Paxolin Panel 6" by 4" by $\frac{1}{8}$ " thick.
 Coil Formers—Three required
 Six pin Dual purpose plug in polystyrene
 (green) with dust core

TSL
 Ever Ready
 McMurdo

TSL

Denco

Miscellaneous Hardware

6 Spacers, 2" in length, tapped 4 BA each end.
 4 BA screws $\frac{5}{16}$ " or $\frac{3}{8}$ "
 6 BA screws $\frac{1}{4}$ "
 Spindle extender 2"
 Solder tags, wire, etc.

Round head
 Round head
 Jackson 4827
 TSL

SECTION 3

A TWO TRANSISTOR REFLEX

This set uses a tuned aerial circuit working into a grounded base RF amplifier, which is then coupled by an untuned RF transformer to the diode rectifier, the output from which is returned to the RF/AF stage for amplifying at audio level before being passed to the output stage. Thus we have a performance equivalent to three transistors and a diode.

Construction (See Fig. 3-2)

The construction is similar to that used in the last two sections. The coils used are Wearite type PHF-4 or PHF-5 depending upon the range it is desired to cover. Note that the winding with the heavier gauge of wire forms the tuned aerial winding, with the coupling coil connected to the emitter of Tr-1. Using these

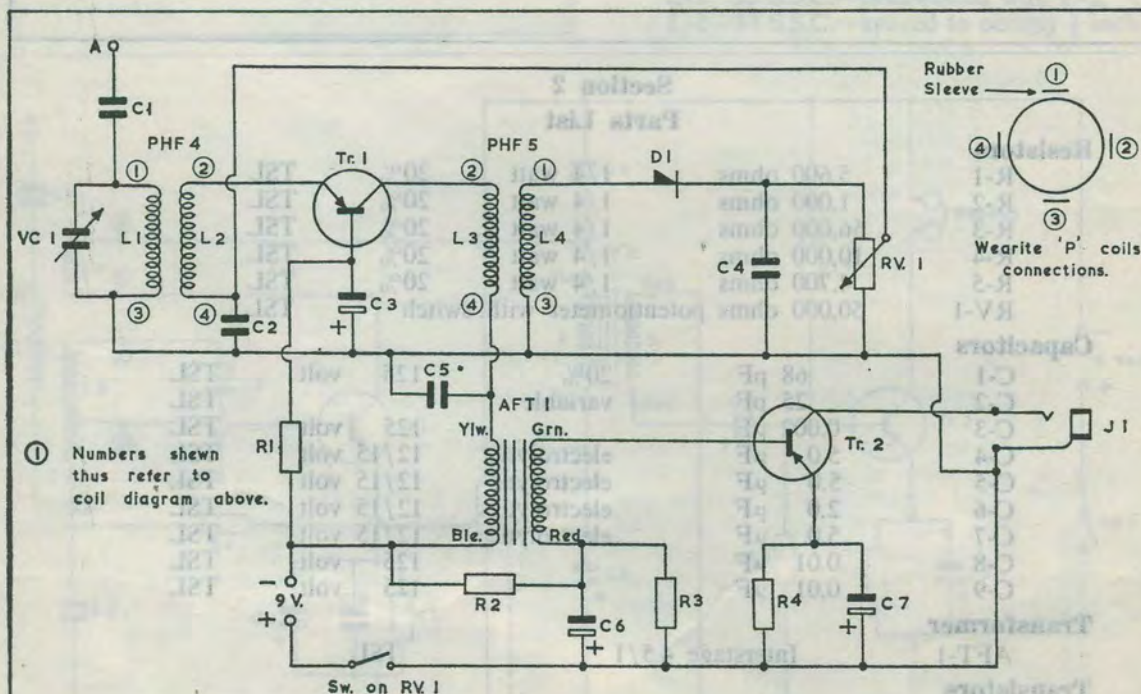


Fig. 3.1

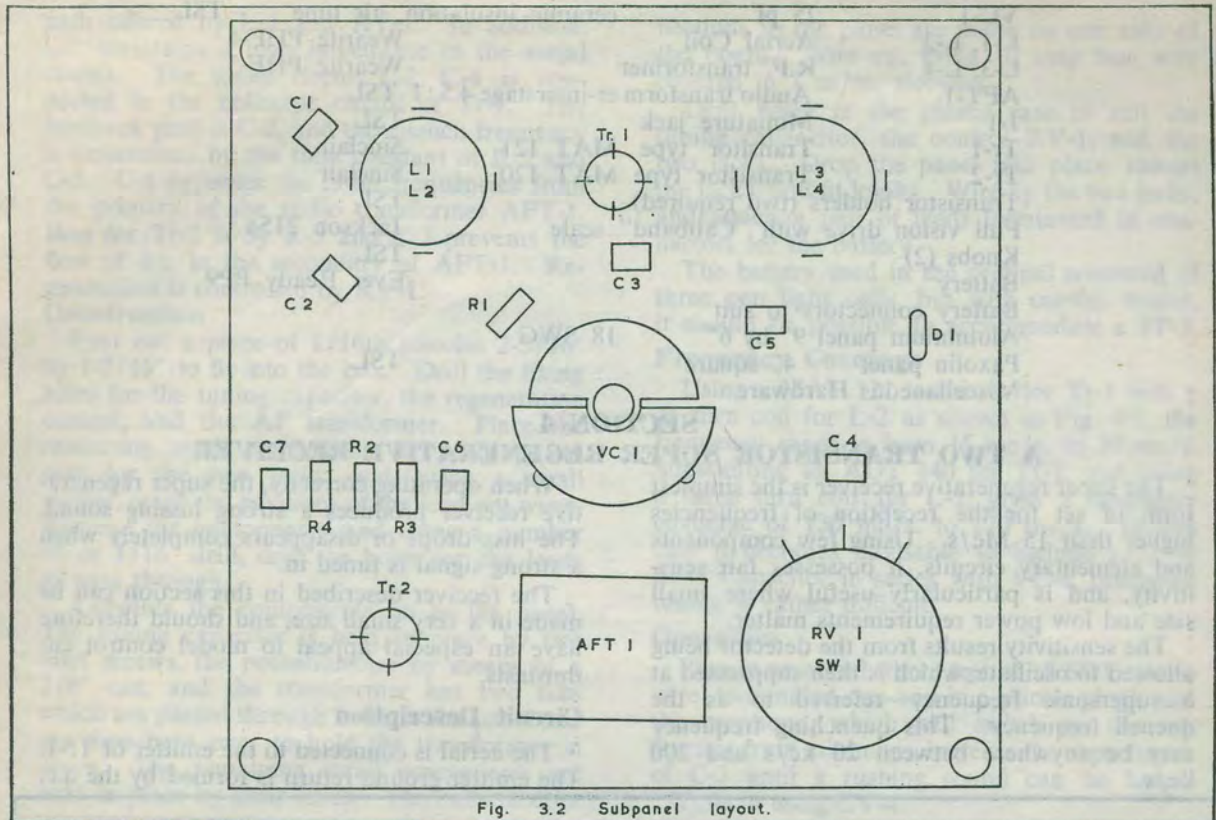


Fig. 3.2 Subpanel layout.

coils in this set gives a wider coverage than that stated by the makers. This is because these coils were designed in the first instance for use in multi range valve receivers, where the minimum capacitance of the tuning gang, range switching, wiring and the valve input capacitance adds up to something not less than 30 or 40 pf in even a well designed receiver. Since the coil is connected directly into the tuning circuit, we have only the stray capacitance of the coil itself in parallel with the capacitance

loading due to the aerial, which is less than 10 pf. This means that using a tuning capacitance with a swing of 25 pf, a frequency coverage having a ratio of 1.8:1 between the highest and lowest frequencies may be obtained.

The RF transformer for coupling the RF and diode stages is a Wearite type "P" coil, for the next lower frequency range than the one in use in the aerial circuit, e.g., when using a PHF-4 in the aerial position, use a PHF-5 for coupling.

Section 3 Parts List

Resistors

R-1	1 M Ω ohms	1/4 watt	20%	TSL
R-2	56,000 ohms	1/4 watt	20%	TSL
R-3	12,000 ohms	1/4 watt	20%	TSL
R-4	3,300 ohms	1/4 watt	20%	TSL
R-5	2,200 ohms	1/4 watt	20%	TSL
RV-1	5,000 ohms potentiometer with switch	20%		TSL

Capacitors

C-1	68 pf		125 volt	TSL
C-2	0.001 μ F		125 volt	TSL
C-3	2.0 μ F	Electrolytic	12/15 volt	TSL
C-4	0.01 μ F		125 volt	TSL
C-5	0.01 μ F		125 volt	TSL
C-6	2.0 μ F	Electrolytic	12/15 volt	TSL
C-7	10.0 μ F	Electrolytic	12/15 volt	TSL

VC-1	25 pf	ceramic insulation, air tune	TSL
L-1, L-2	Aerial Coil	Wearite PHF-4	
L-3, L-4	R.F. transformer	Wearite PHF-5	
AFT-1	Audio transformer-interstage 4.5:1	TSL	
J-1	Miniature jack	TSL	
Tr-1	Transistor type MAT 121	Sinclair	
Tr-2	Transistor type MAT 120	Sinclair	
Transistor holders (two required)		TSL	
Full vision drive with "Caliband" scale		Jackson 2154	
Knobs (2)		TSL	
Battery		Ever Ready PP9	
Battery connectors to suit			
Aluminium panel 9" by 6"	18 SWG		
Paxolin panel 4" square		TSL	
Miscellaneous Hardware			

SECTION 4

A TWO TRANSISTOR SUPER REGENERATIVE RECEIVER

The super regenerative receiver is the simplest form of set for the reception of frequencies higher than 15 Mc/s. Using few components and elementary circuits, it possesses fair sensitivity, and is particularly useful where small size and low power requirements matter.

The sensitivity results from the detector being allowed to oscillate, which is then suppressed at a supersonic frequency—referred to as the quench frequency. This quenching frequency may be anywhere between 20 kc/s and 200 kc/s.

When operating correctly, the super regenerative receiver produces a strong hissing sound. The hiss drops or disappears completely when a strong signal is tuned in.

The receiver described in this section can be made in a very small size, and should therefore have an especial appeal to model control enthusiasts.

Circuit Description

The aerial is connected to the emitter of Tr-1. The emitter ground return is formed by the d.c.

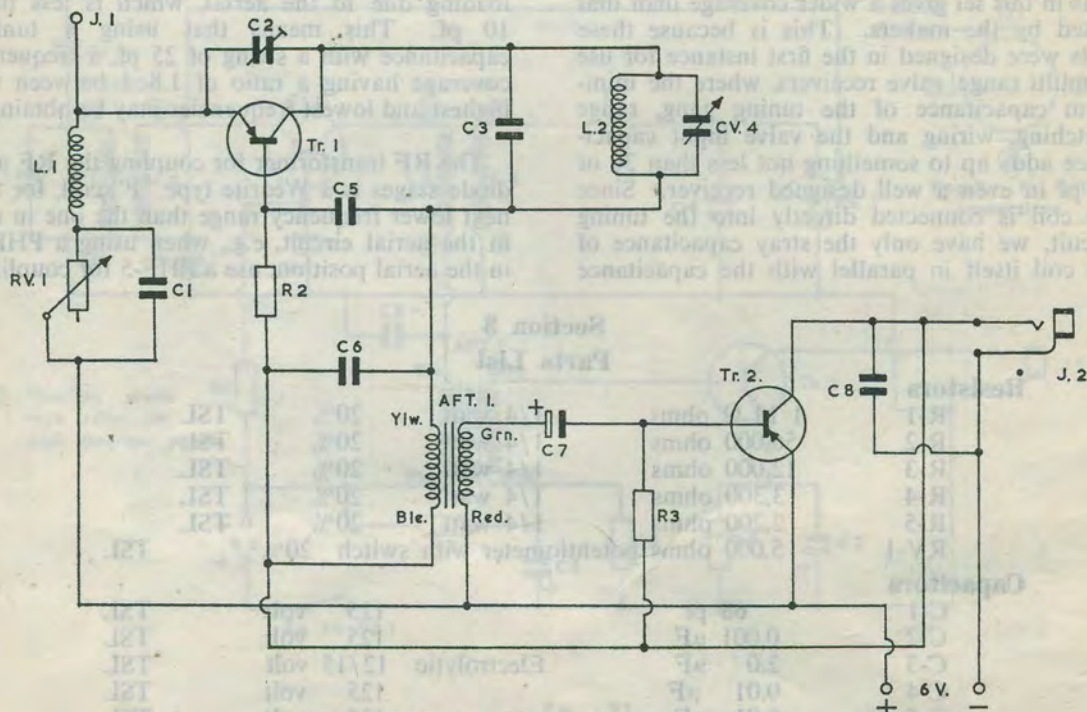


Fig. 4.1 Two Transistor Super-Regenerative.

path offered by L-1 and RV-1. In addition, L-1 maintains a high impedance in the aerial circuit. The tuned circuit L-2, C-4 is connected in the collector circuit of Tr-1. The feedback path is C-2, and the quench frequency is determined by the time constant of R-2 and C-5. C-6 bypasses the radio frequencies from the primary of the audio transformer AFT-1. Bias for Tr-2 is by R-3 and C-7 prevents the flow of d.c. in the secondary of AFT-1. Regeneration is controlled by RV-1.

Construction

First cut a piece of 1/16th paxolin 2-3/16" by 1-7/16" to fit into the box. Drill the fixing holes for the tuning capacitor, the regeneration control, and the AF transformer. Place the remaining small components in position, except for the two jacks, and, using a small scribe, mark the positions of the lead out wires. Remove the components and using a number 53 or 1/16" drill, drill the holes for the leads to pass through.

Assemble the components on to the panel. The tuning capacitor is held in place by two 6BA screws, the potentiometer by means of a 3/8" nut, and the transformer has two tabs which are passed through holes in the panel and are then bent over to hold the transformer in place. The remaining small components are held in place by their leads. Thus all the con-

nections to the panel are made on one side of the board. Wire up, using 10 amp fuse wire covered in 1 m/m. sleeving.

Drill holes in the plastic case to suit the tuning capacitor, the control RV-1, and the two jacks. Drop the panel into place, mount the jacks, and fit knobs. Wire up the two jacks, and attach a pair of leads terminated in connectors for the battery.

The battery used in the original consisted of three pen light cells, but with careful layout, it should be possible to accommodate a PP-3.

Frequency Coverage

Using a MAT 121 transistor for Tr-1 with a 25 turn coil for L-2 as shown in Fig. 4-2, the frequency range is from 15 mc/s. to 30 mc/s. Substituting an ADT 140 for Tr-1, and using a three turn coil for L-2, gives a frequency coverage of 130 mc/s. to 170 mc/s. In this case it becomes advisable to include a 22 pf fixed Capacitor in series with VC-4, otherwise tuning is rather difficult.

Operation

Plug in an aerial (three feet of 18 SWG piano wire, terminated one end in a phono plug), and the earphone, which will switch on the set. Starting from minimum, increase the capacitance of C-2 until a rushing sound can be heard.

Tune in using CV-4.

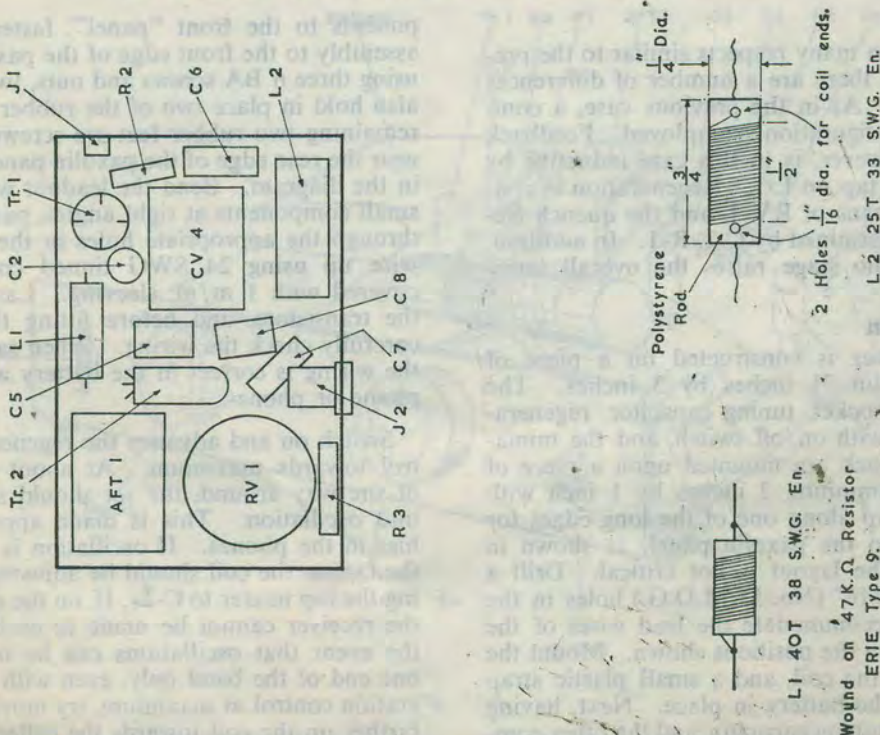


Fig. 4.2 Layout & Coil details.

Section 4

Parts List

Resistors

RV-1	25,000 ohm	miniature control		TSL
R-2	120,000 ohms	1/4 watt	20%	TSL
R-3	680,000 ohms	1/4 watt	20%	TSL

Capacitors

C-1	0.0047 μ F	Styrafoil	20%	125 volt	TSL
C-2	5 pF	tubular trimmer			TSL
C-3	6.8 pF	silver mica			TSL
CV-4	50 pF	miniature tuning			TSL
C-5	0.001 μ F	Styrafoil	20%	125 volt	TSL
C-6	0.0047 μ F	Styrafoil	20%	125 volt	TSL
C-7	5.0 μ F	electrolytic		12/15 volt	TSL
C-8	0.001 μ F	Styrafoil		125 volt	TSL

Transistors

Tr-1	MAT 121 or ADT 140	Sinclair
Tr-2	MAT 120	Sinclair

Transformer

AFT-1	Interstage 4.5:1	TSL
J-1	Phonoplug and socket	TSL
J-2	Miniature jack plug and socket	TSL
Small plastic case		TSL
Earpiece	High impedance Magnetic	TSL
Battery(ies) see text		Ever Ready or Vidor
Battery connectors		TSL
L-1, L-2 see text)		

SECTION 5

THREE TRANSISTOR SUPER-REGENERATIVE

Description

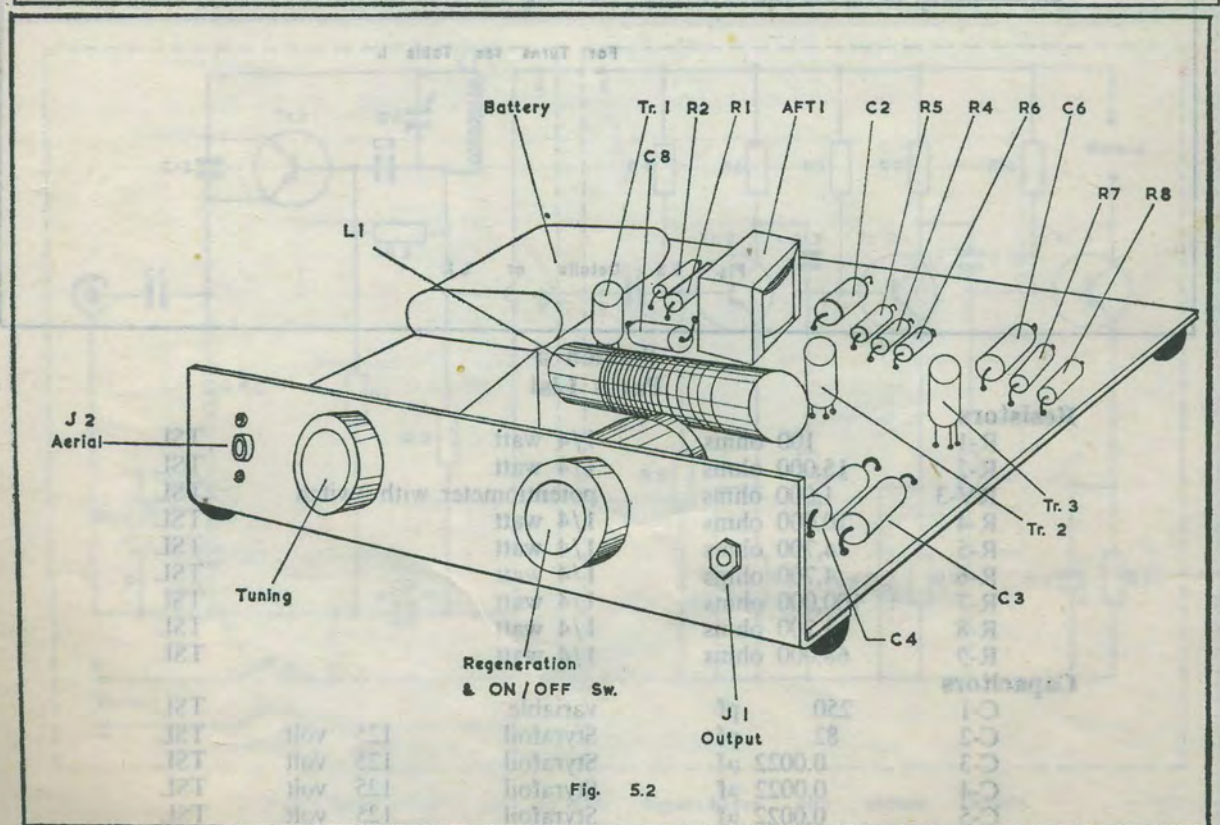
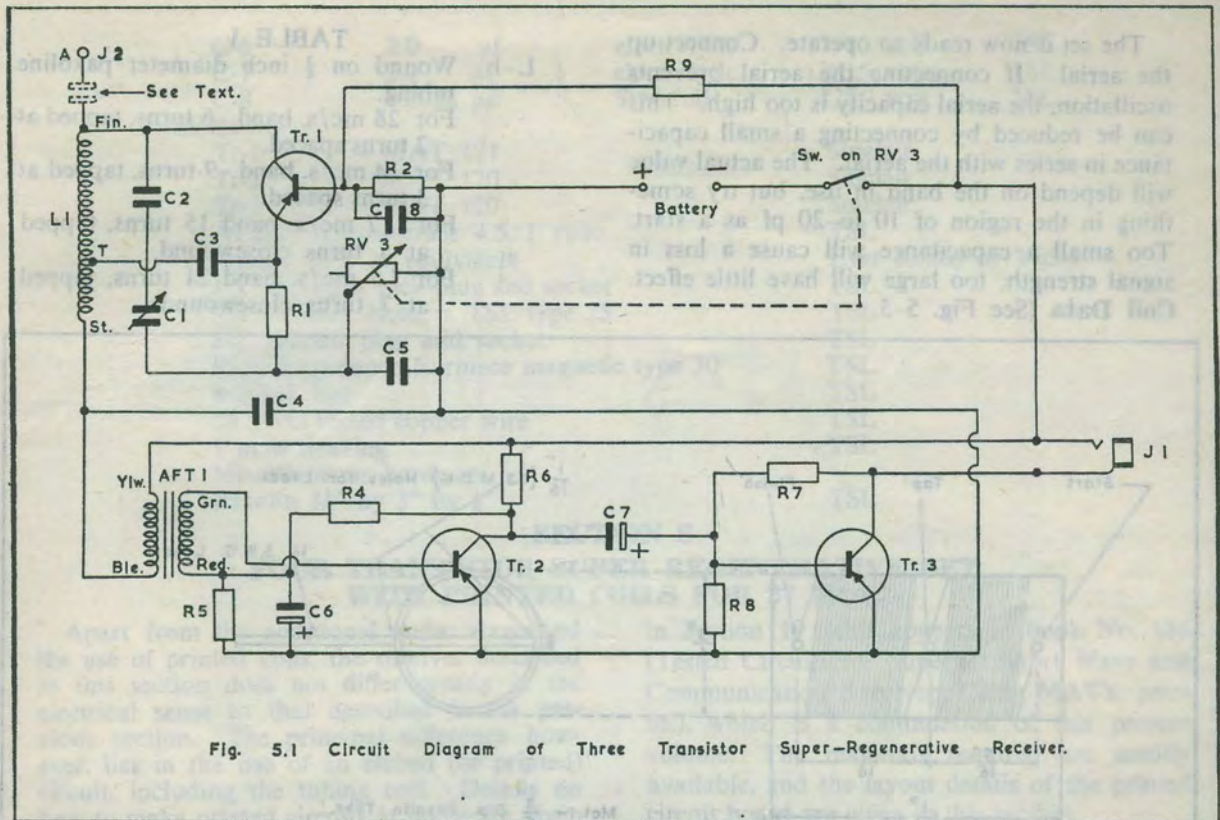
Although in many respects similar to the previous circuit, there are a number of differences to be noted. As in the previous case, a common base configuration is employed. Feedback coupling, however, is in this case inductive by virtue of the tap on L-1. Regeneration is controlled by means of RV-3, and the quench frequency is determined by C-2, R-1. In addition, an extra audio stage raises the overall sensitivity.

Construction

The receiver is constructed on a piece of 1/16th paxolin 3 1/4 inches by 3 inches. The aerial input socket, tuning capacitor, regeneration control with on/off switch, and the miniature output jack are mounted upon a piece of 22 SWG aluminium, 3 inches by 1 inch with a half inch lip along one of the long edges for attachment to the paxolin panel, as shown in Fig. 5-2. The layout is not critical. Drill a number of 1/16" (No. 53 M.D.G.) holes in the paxolin to accommodate the lead wires of the components in the positions shown. Mount the transformer, the coil, and a small plastic strap for holding the battery in place. Next, having attached the tuning capacitor and the other com-

ponents to the front "panel", fasten this sub assembly to the front edge of the paxolin panel, using three 6 BA screws and nuts, two of which also hold in place two of the rubber feet. The remaining two rubber feet are screwed in place near the rear edge of the paxolin panel as shown in the diagram. Bend the leadout wires on the small components at right angles, pass the leads through the appropriate holes in the panel and wire up using 24 SWG tinned copper wire, covered with 1 m/m. sleeving. Lastly, mount the transistors, and before fitting the battery, carefully check the wiring. When satisfied that the wiring is correct fit the battery and plug in phone or phones.

Switch on and advance the regeneration control towards maximum. At about two thirds of the way around, the set should slide gently into oscillation. This is made apparent by a hiss in the phones. If oscillation is too fierce, the tap on the coil should be adjusted, by making the tap nearer to C-3. If, on the other hand, the receiver cannot be made to oscillate, or in the event that oscillations can be obtained at one end of the band only, even with the regeneration control at maximum, try moving the tap farther up the coil towards the collector end.

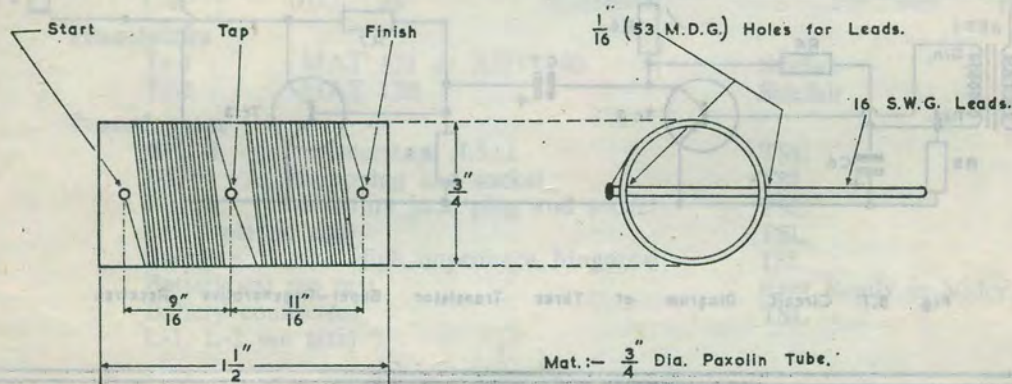


The set is now ready to operate. Connect up the aerial. If connecting the aerial prevents oscillation, the aerial capacity is too high. This can be reduced by connecting a small capacitance in series with the aerial. The actual value will depend on the band in use, but try something in the region of 10 to 20 pf as a start. Too small a capacitance will cause a loss in signal strength, too large will have little effect.

Coil Data (See Fig. 5-3).

TABLE 1.

L-1	Wound on $\frac{3}{4}$ inch diameter paxoline tubing.
	For 28 mc/s. band -6 turns, tapped at 2 turns spaced.
	For 14 mc/s. band -9 turns, tapped at 3 turns spaced.
	For 7 mc/s. band 15 turns, tapped at 5 turns closewound.
	For 3.5 mc/s. band 21 turns, tapped at 7 turns closewound.



For Turns see Table I.

Fig. 5.3 Details of L-1.

Section 5 Parts List

Resistors

R-1	100 ohms	1/4 watt	TSL
R-2	15,000 ohms	1/4 watt	TSL
RV-3	1,000 ohms	potentiometer with switch	TSL
R-4	10,000 ohms	1/4 watt	TSL
R-5	4,700 ohms	1/4 watt	TSL
R-6	4,700 ohms	1/4 watt	TSL
R-7	100,000 ohms	1/4 watt	TSL
R-8	4,700 ohms	1/4 watt	TSL
R-9	68,000 ohms	1/4 watt	TSL

Capacitors

C-1	250 pf	variable	TSL
C-2	82 pf	Styrafoil	125 volt TSL
C-3	0.0022 μ f	Styrafoil	125 volt TSL
C-4	0.0022 μ f	Styrafoil	125 volt TSL
C-5	0.0022 μ f	Styrafoil	125 volt TSL

C-6	2.0 μ f	electrolytic	12/15 volt	TSL
C-7	2.0 μ f	electrolytic	12/15 volt	TSL
C-8	0.0022 μ F	Styrafoil	125 volt	TSL
Transistors				
Tr-1	MAT 121		Sinclair	
Tr-2	MAT 120		Sinclair	
Tr-3	MAT 120		Sinclair	
AFT-1	Transformer 4.5:1 ratio		TSL	
Battery	PP3 or equivalent		Ever Ready or Vidor	
J-1	3.5 m.m. jack plug and socket		TSL	
3 Transistor Holders	TSL type 25		TSL	
J-2	Phono plug and socket		TSL	
High Impedance Earpiece	magnetic type 30		TSL	
Rubber feet			TSL	
24 SWG tinned copper wire			TSL	
1 m.m sleeving			TSL	
Miscellaneous hardware				
Paxolin 3½" by 3" by ⅛"			TSL	

SECTION 6

FOUR TRANSISTOR SUPER REGENERATIVE SET WITH PRINTED COILS FOR 27 Mc/s.

Apart from the additional audio stage and the use of printed coils, the receiver described in this section does not differ greatly in the electrical sense to that described in the previous section. The principal difference however, lies in the use of an etched (or printed) circuit, including the tuning coil. Details on how to make printed circuits at home are given

in Section 19: this appears in book No. 186 (Tested Circuits for Superhet Short Wave and Communication Receivers Using MAT's, price 6s.), which is a continuation of this present volume. The materials required are readily available, and the layout details of the printed circuit board are given in this section.

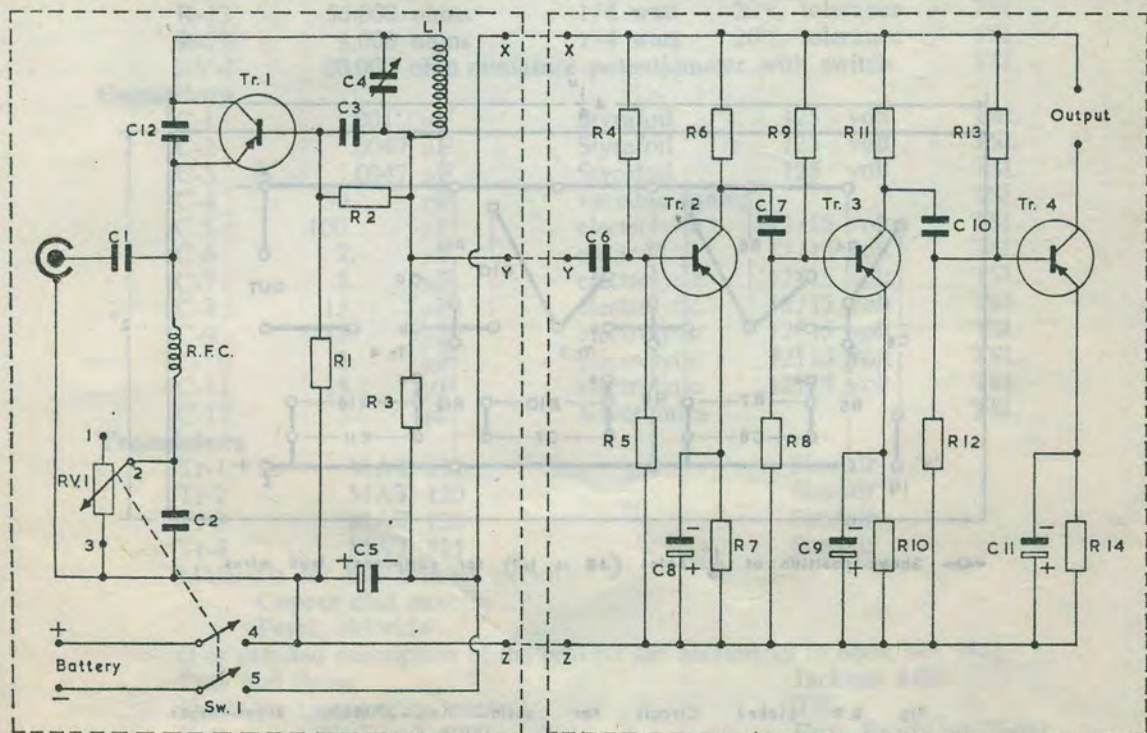
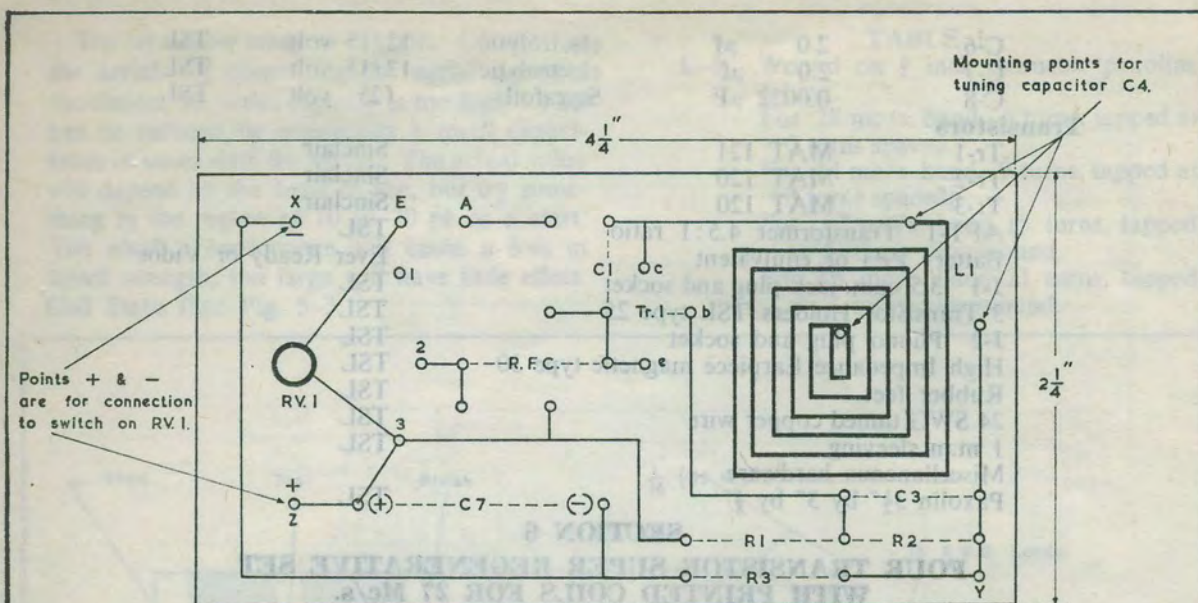


Fig. 6.1 Circuit of 27 Mc/s Super-Regen with etched circuits.



Numbers 1, 2, 3 & X, Y, Z correspond to connections on RV.1; Sw.1 on circuit diagram.

Fig. 6.2 Layout of Etched Circuit Board-Tuner.

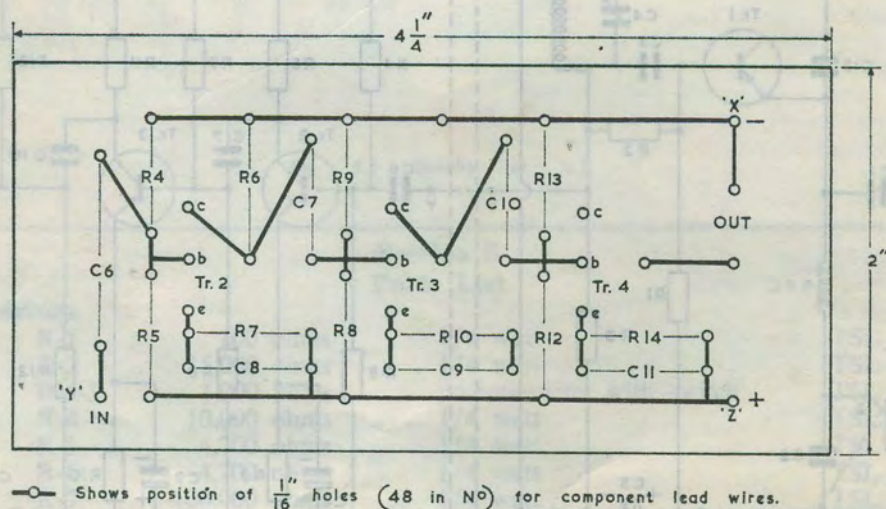


Fig. 6.3 Etched Circuit for audio Amp-27 Mc/s. Super-Regen.

Circuit Description

The aerial is capacitively coupled by C-1 to the emitter of Tr-1. The collector load is the inductance L-1, tuned by C-4. The 5 pf capacitor C-12 is the feedback path. Regeneration is controlled by RV-1, which is ganged with the on/off switch. Base bias for Tr-1 is taken from the junction of R-1 and R-2. The audio load is R-3.

The first two audio stages each use MAT 120 transistors, resistance coupled, and the output stage is an MAT 121.

Construction (See Figs. 6-2 & 6-3)

The tuner section is sufficiently light in weight to be supported directly upon the tuning capacitor C-4. The regeneration control is mounted

on the printed circuit board, and if necessary, an extension spindle is used through the front panel. The various component references are shown on the layout diagrams, and these should be marked on the P.C.B. The two boards should be mounted as close together as possible, using short leads. Apart from this, the mechanical layout is entirely up to the constructor.

Operation

Having carefully checked the wiring, connect up the battery, aerial and phones. Switch on, and turn the regeneration control slowly clockwise until a rushing sound is heard in the phones. Tune in a station with C-4. On strong stations the rushing sound disappears when in tune.

Section 6 Parts List

Resistors

R-1	2,700 ohms	1/4 watt	20% tolerance	TSL
R-2	18,000 ohms	1/4 watt	20% tolerance	TSL
R-3	1,000 ohms	1/4 watt	20% tolerance	TSL
R-4	56,000 ohms	1/4 watt	20% tolerance	TSL
R-5	10,000 ohms	1/4 watt	20% tolerance	TSL
R-6	2,200 ohms	1/4 watt	20% tolerance	TSL
R-7	1,000 ohms	1/4 watt	20% tolerance	TSL
R-8	10,000 ohms	1/4 watt	20% tolerance	TSL
R-9	56,000 ohms	1/4 watt	20% tolerance	TSL
R-10	1,000 ohms	1/4 watt	20% tolerance	TSL
R-11	2,200 ohms	1/4 watt	20% tolerance	TSL
R-12	10,000 ohms	1/4 watt	20% tolerance	TSL
R-13	56,000 ohms	1/4 watt	20% tolerance	TSL
R-14	1,000 ohms	1/4 watt	20% tolerance	TSL
RV-1	10,000 ohm miniature potentiometer with switch			TSL

Capacitors

C-1	.001 μ F	Styrafoil	125 volt	TSL
C-2	.0047 μ F	Styrafoil	125 volt	TSL
C-3	.0047 μ F	Styrafoil	125 volt	TSL
C-4	30. pF	variable tuning		TSL
C-5	100. μ F	electrolytic	12/15 volt	TSL
C-6	2. μ F	electrolytic	12/15 volt	TSL
C-7	2. μ F	electrolytic	12/15 volt	TSL
C-8	15. μ F	electrolytic	12/15 volt	TSL
C-9	15. μ F	electrolytic	12/15 volt	TSL
C-10	2. μ F	electrolytic	12/15 volt	TSL
C-11	15. μ F	electrolytic	12/15 volt	TSL
C-12	5. pf	Silver mica		TSL

Transistors

Tr-1	MAT 121	Sinclair
Tr-2	MAT 120	Sinclair
Tr-3	MAT 120	Sinclair
Tr-4	MAT 121	Sinclair

Materials for the printed circuit:

Copper clad paxolin

Ferric chloride

(For detailed description of the process see Section 19 in book No. 186)

Dial and drive

Jackson 4489

Knob for regeneration control

TSL

Battery PP-7 or T-6007

Ever Ready or Vidor

Connector for battery

TSL

Phones 2,000 Ω

TSL

SECTION 7

A TRANSISTORISED SIGNAL BOOSTER FOR 20 TO 50 METRES

The performance of any receiver is greatly improved by the addition of an RF stage of amplification ahead of the mixer. The signal to noise ratio is improved, and the response to images, or double tuning points together with the attendant whistles is reduced tremendously. The signal booster here described is an additional RF stage which can be used in front of any shortwave receiver, valve or transistor without making any changes whatever in the receiver. Being transistorised, the minute power requirements are easily met from a small self-contained battery, which is switched on or off by the range switch.

Circuit Description

The aerial is switched to L-1, L-2 by SW-1; or straight through to the receiver by SW-1 and

SW-2. In the latter case, the converter power is switched off. The appropriate tuning coil, either L-3 or L-4 is tuned by the 175 pf capacitor VC-1. The base input resistance of Tr-1 is matched to the input circuit by the capacitive tap formed by C-1 and C-2. Bias for Tr-1 is taken from the junction of R-1 and R-2. The emitter is stabilised by R-3, which is bypassed for RF by C-3.

The output circuit inductances, L-5 or L-6 are tuned by the second 175 pf section of the ganged tuning capacitor. The 3.3 pf capacitor C-5, and the 27 ohm resistor R-4 are the neutralising circuit. The power supply rail is bypassed for RF by means of C-4.

Compensation for aerial capacitance can be made from the front panel by a small trimmer, TC-1.

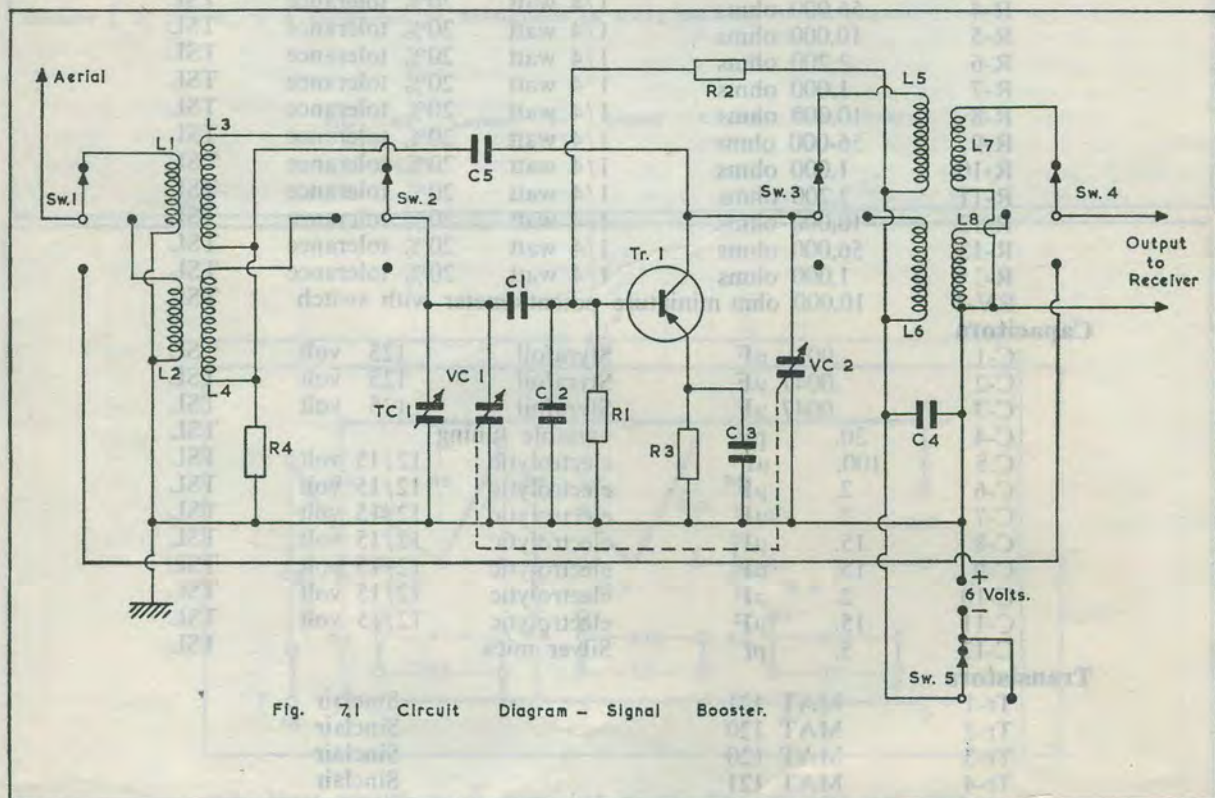


Fig. 7.1 Circuit Diagram - Signal Booster.

Section 7
Parts List

Resistors

R-1	12,000 ohms	1/4 watt	20% tolerance	TSL
R-2	39,000 ohms	1/4 watt	20% tolerance	TSL
R-3	1,000 ohms	1/4 watt	20% tolerance	TSL
R-4	27 ohms	1/4 watt	20% tolerance	TSL

Capacitors

C-1	22	pf	Styrafoil	125 volt	TSL
C-2	47	pf	Styrafoil	125 volt	TSL
C-3	1,000	pf	Styrafoil	125 volt	TSL
C-4	10,000	pf	Styrafoil	125 volt	TSL
C-5	3.3	pf	Silver Mica		TSL
VC-1; VC-2	Tuning gang 175 pf + 175 pf				Jackson 00
TC-1	Aerial trimmer 15 pf				TSL
Coils PHF-4					Wearite type 'P'
PHF-5					Wearite type 'P'
PA -4					Wearite type 'P'
PA -5					Wearite type 'P'
SW-1 to SW-5	Miniature Oak 2 wafers one—3 pole 3 way one—2 pole 3 way				AB-OAK Type 'H'
Tag board	Miniature type (5 way)				TSL
Chassis 7" by 4" by 2" deep					TSL
Dial and drive					Eddystone 843
Knobs -2 off					TSL
Front panel 16 SWG Aluminium					TSL
Two way tag strip					TSL
Miscellaneous hardware, screws and wire					
Battery					Ever Ready PP-3
Battery connector					or Vidor T-6003
Tr-1	MAT 121 or ADT 140				

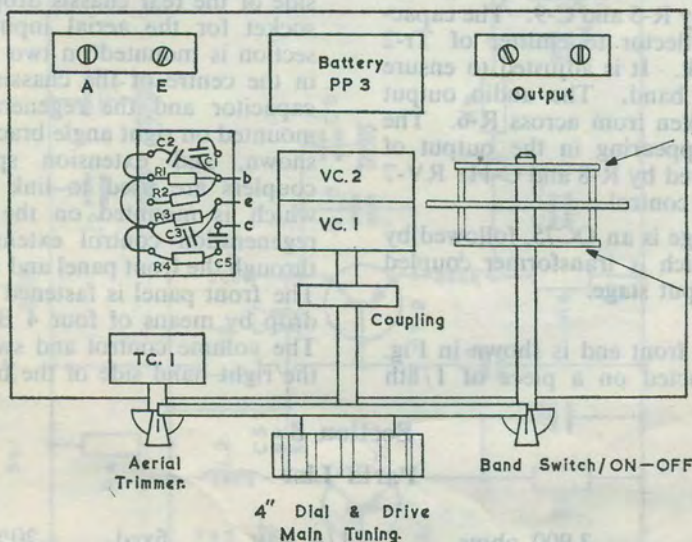


Fig. 7.2 Signal-Booster

SECTION 8

10 METRE TRF USING SIX TRANSISTORS

This section describes a ten metre receiver that uses low priced transistors which are readily available. Sensitivity is good, a signal in the 10 μ V region can be heard, and because of the super regenerative action of the detector, a form of AGC operates which automatically adjusts the sensitivity of the set according to the strength of the incoming signal.

Circuit Description

Looking at the circuit diagram (Fig. 8-1), it will be seen that the RF stage uses an MAT 121 (Tr-1) micro-alloy transistor in a grounded emitter circuit. L-1, the aerial input coil is tuned by C-3. The aerial input is tapped down the coil. The input circuit L-1, C-3 has shunted across it the input resistance of Tr-1. This, combined with the damping imposed by the aerial, gives the input circuit a wide bandwidth. This circuit is tuned to the centre of the band.

The base bias of Tr-1 is determined by R-1 and R-3. The collector circuit of Tr-1 is composed of L-2, tuned by C-5, while that of Tr-2 is L-3 and C-7. C-6 is common to both circuits, and forms the coupling impedance. Tr-2 is the detector. Tuning is by C-8. The circuit is a grounded base oscillator with the quench frequency determined by R-5 and C-9. The capacitor (C-15) from collector to emitter of Tr-2 controls the feedback. It is adjusted to ensure oscillation over the band. The audio output from this stage is taken from across R-6. The quench frequency appearing in the output of the detector is removed by R-8 and C-11. RV-7 is the audio volume control.

The first audio stage is an OC75, followed by an OC71 driver, which is transformer coupled to the push pull output stage.

Construction

The layout of the front end is shown in Fig. 8-2. This is constructed on a piece of 1/8th

paxolin, 6 inches by 3 inches. No. 53 MDC holes are drilled at each of the points shown, to take pieces of 16 SWG brass or copper wire. These wires, each $\frac{1}{2}$ inch in length, form the tags upon which the components are to be soldered. The Aladdin coil formers each require two 6 BA clearance holes in the paxolin for the mounting screws.

Coil Winding Data (See Fig. 8-4)

Wound on Aladdin $\frac{1}{4}$ " formers, with cans.

- L-1 10 turns 24 SWG enamelled wire, tapped at 5 turns.
- L-2 10 turns 24 SWG enamelled wire, no tap.
- L-3 10 turns 24 SWG enamelled wire, no tap.

The complete receiver is assembled on a metal chassis, 7" by 7" by 2" deep. The general layout is shown in Fig. 8-3. The GS 12005 audio amplifier is mounted in the position shown, using four 6 BA screws and spacers long enough to raise the unit clear of the chassis. Mounted on the left hand side of the rear chassis drop is a pair of sockets for wander plugs. These are for the loud-speaker. On the right hand side of the rear chassis drop is mounted a twin socket for the aerial input feeder. The RF section is mounted on two right angle brackets in the centre of the chassis. Both the tuning capacitor and the regeneration capacitor are mounted on right angle brackets in the positions shown, and extension spindles fitted with couplers are used to link up with the drive, which is mounted on the front panel. The regeneration control extension spindle passes through the front panel and is fitted with a knob. The front panel is fastened to the front chassis drop by means of four 4 BA screws and nuts. The volume control and switch is mounted on the right hand side of the front panel.

Section 8

Parts List

Resistors

R-1	3,900 ohms	1/4 watt	fixed	20%	TSL
R-2	1,000 ohms	1/4 watt	fixed	20%	TSL
R-3	22,000 ohms	1/4 watt	fixed	20%	TSL
R-4	1,000 ohms	1/4 watt	fixed	20%	TSL
R-5	220,000 ohms	1/4 watt	fixed	20%	TSL
R-6	1,000 ohms	1/4 watt	fixed	20%	TSL
RV-7	5,000 ohms		potentiometer		TSL
R-8	1,000 ohms	1/4 watt	fixed	20%	TSL

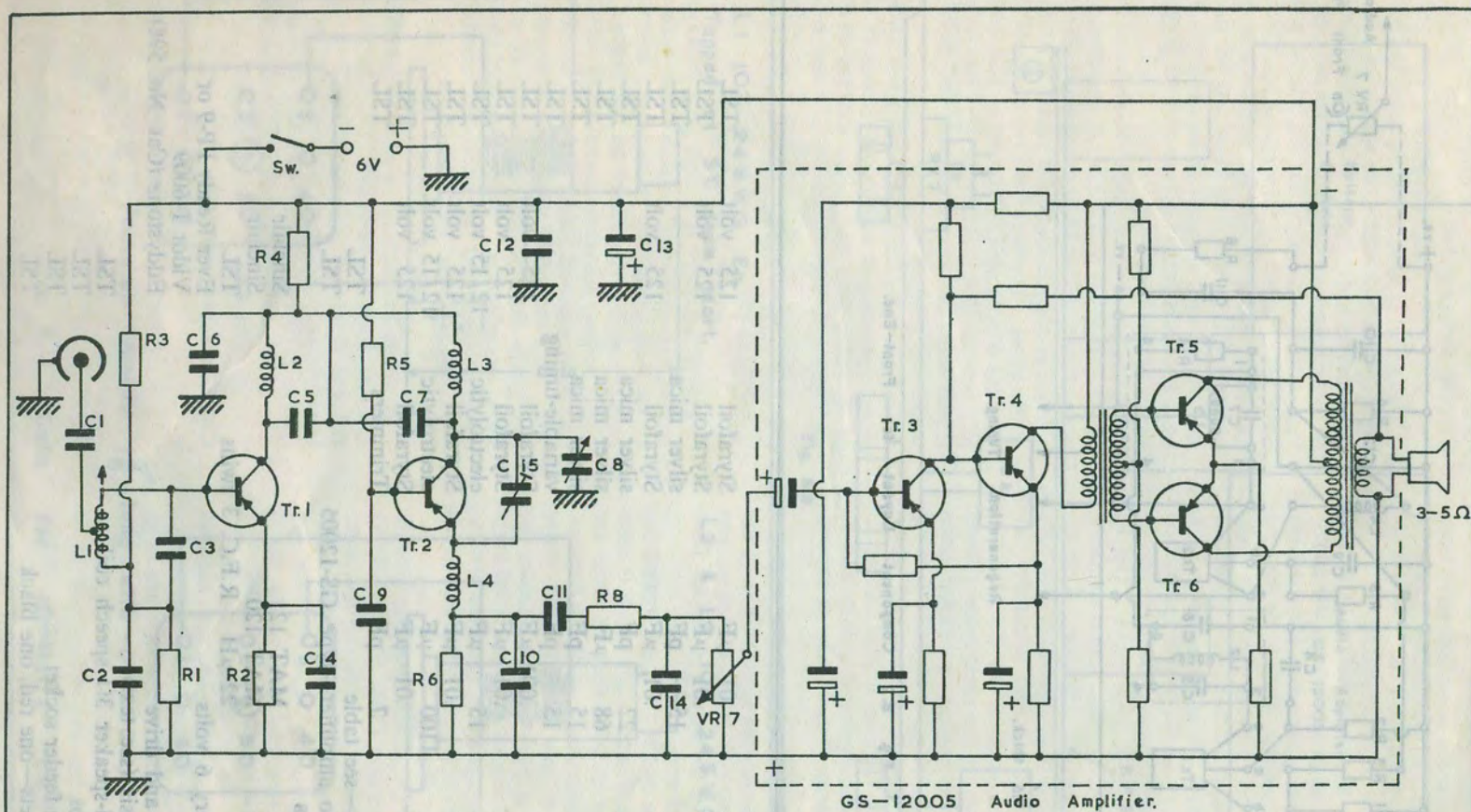


Fig. 8.1 Circuit Diagram for 10-Metre Super-Regen.

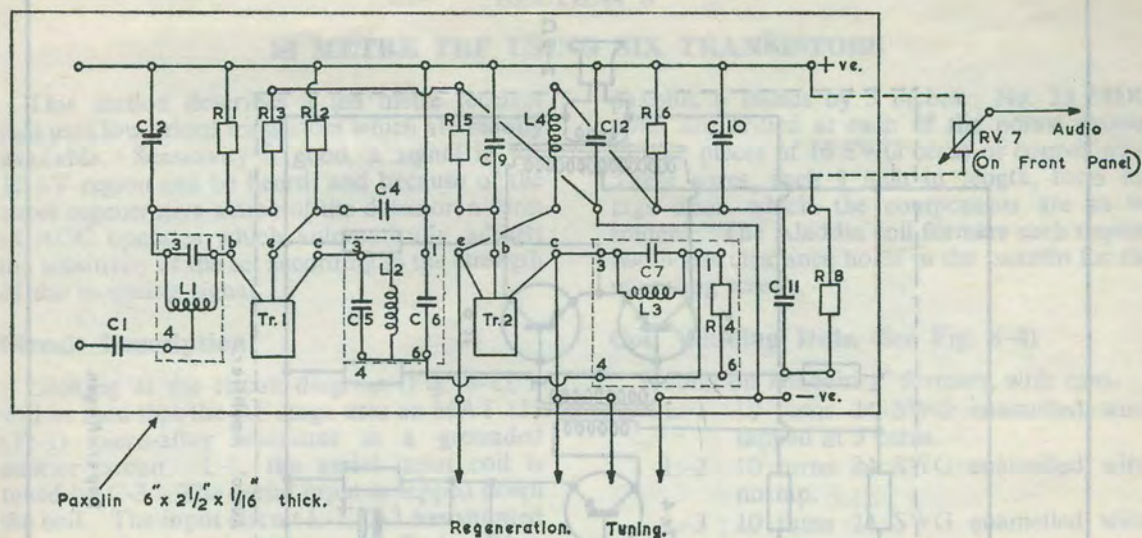


Fig. 8.2 Component Layout for Front-End.

Capacitors

C-1	.01	μF	Styrafoil	125	volt	TSL
C-2	.01	μF	Styrafoil	125	volt	TSL
C-3	15	pF	silver mica			TSL
C-4	.01	μF	Styrafoil	125	volt	TSL
C-5	22	pF	silver mica			TSL
C-6	68	μF	silver mica			TSL
C-7	15	pF	silver mica			TSL
C-8	15	pF	variable-tuning			TSL
C-9	.001	μF	Styrafoil	125	volt	TSL
C-10	.01	μF	Styrafoil	125	volt	TSL
C-11	15	μF	electrolytic	12/15	volt	TSL
C-12	.01	μF	Styrafoil	125	volt	TSL
C-13	100	μF	electrolytic	12/15	volt	TSL
C-14	.01	μF	Styrafoil	125	volt	TSL
C-15	7	pF	Trimmers			TSL

Coils—see table

Audio amplifier—type GS-12005

Transistors

Tr-1	MAT 121	Sinclair
Tr-2	MAT 120	Sinclair
L-4	22 μH R.F.C. 3 twins	TSL
Battery	6 volts	Ever Ready PP-9 or Vidor T-6009 Eddystone (Cat. No. 598)
Dial and drive		
Chassis (see text)		
Loud-speaker	3Ω speech coil	TSL
Knobs		TSL
Twin feeder socket		TSL
Sockets—one red, one black		TSL

SIX TRANSISTOR SUPERHET

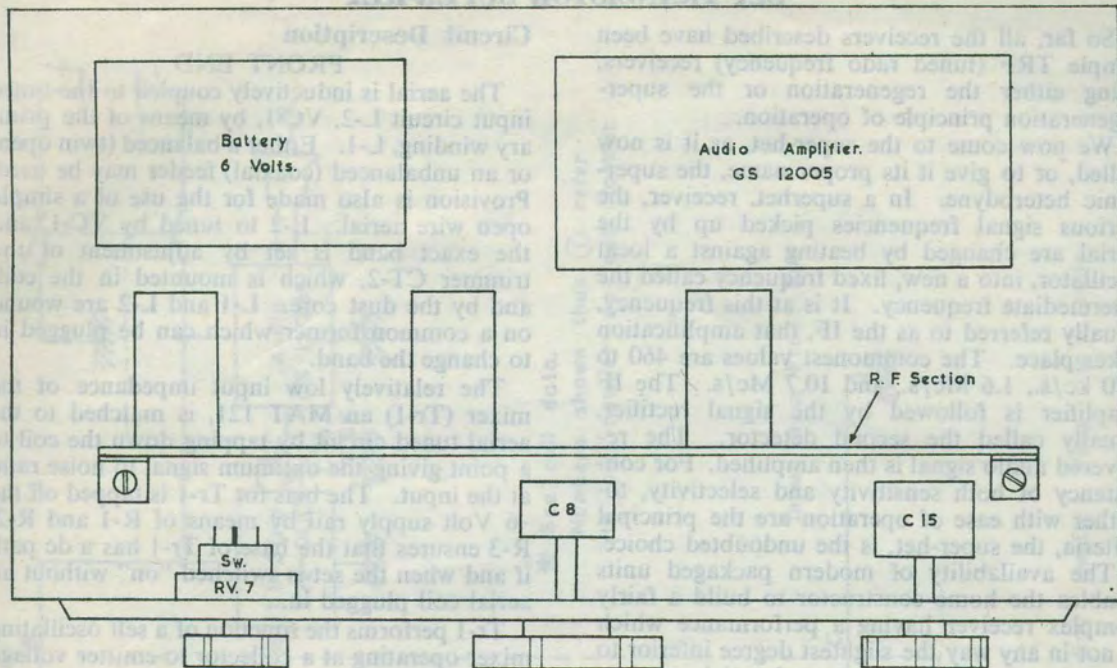
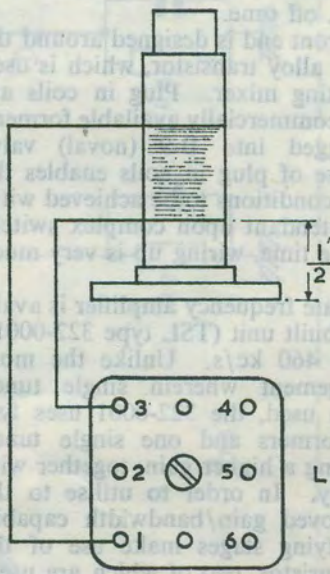
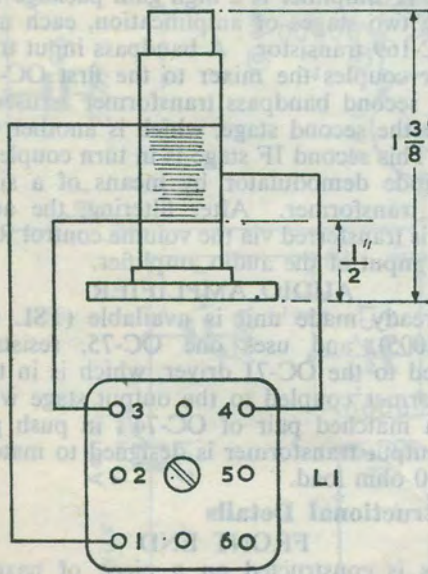


Fig. 8.3

L1 10T. 24 S.W.G. En.
Tapped at 5T. from start.

L2 & L3 10T. 24 S.W.G. En.



Formers: Aladdin 1 3/8" long with Dust Core & Can.

Fig. 8.4 Coils for 10-Metre T.R.F.

SECTION 9

SIX TRANSISTOR SUPER-HET

So far, all the receivers described have been simple TRF (tuned radio frequency) receivers, using either the regeneration or the super-regeneration principle of operation.

We now come to the super-het, as it is now called, or to give it its proper name, the super-sonic heterodyne. In a superhet. receiver, the various signal frequencies picked up by the aerial are changed by beating against a local oscillator, into a new, fixed frequency called the intermediate frequency. It is at this frequency, usually referred to as the IF, that amplification takes place. The commonest values are 460 to 470 kc/s., 1.6 Mc/s., and 10.7 Mc/s. The IF amplifier is followed by the signal rectifier, usually called the second detector. The recovered audio signal is then amplified. For consistency of both sensitivity and selectivity, together with ease of operation are the principal criteria, the super-het. is the undoubted choice.

The availability of modern packaged units enables the home constructor to build a fairly complex receiver having a performance which is not in any way the slightest degree inferior to the commercially manufactured article, and to accomplish this without a vast array of expensive test apparatus.

The receiver about to be described is just such a set. When completed, the sensitivity is of the order of $10 \mu\text{V}$ for 50 mW standard output, and the adjacent channel selectivity is better than 35 dB at 9 kc/s. off tune.

The receiver front end is designed around the MAT 121 micro alloy transistor, which is used as a self oscillating mixer. Plug in coils are used, wound on commercially available formers, which are plugged into B-9 (noval) valve holders. The use of plug in coils enables the optimum circuit conditions to be achieved without the losses attendant upon complex switching. At the same time, wiring up is very much simpler.

The intermediate frequency amplifier is available as a ready built unit (TSL type 322-0001), and operates at 460 kc/s. Unlike the more common arrangement wherein single tuned transformers are used, the 322-0001 uses two bandpass transformers and one single tuned transformer, giving a higher gain, together with greater selectivity. In order to utilise to the full, these improved gain/bandwidth capabilities, the amplifying stages make use of the OC-169 drift transistor, two of which are used.

As in the case of the IF strip, the audio section is available in package form (TSL GS-12005), which gives an undistorted output of 1 watt from an input signal of 5mV, using a six volt supply.

Circuit Description

FRONT END

The aerial is inductively coupled to the tuned input circuit L-2, VC-1, by means of the primary winding, L-1. Either a balanced (twin open) or an unbalanced (coaxial) feeder may be used. Provision is also made for the use of a simple open wire aerial. L-2 is tuned by VC-1, and the exact band is set by adjustment of the trimmer CT-2, which is mounted in the coil, and by the dust core. L-1 and L-2 are wound on a common former which can be plugged in to change the band.

The relatively low input impedance of the mixer (Tr-1) an MAT 121, is matched to the aerial tuned circuit by tapping down the coil to a point giving the optimum signal to noise ratio at the input. The bias for Tr-1 is tapped off the -6 Volt supply rail by means of R-1 and R-2. R-3 ensures that the base of Tr-1 has a dc path if and when the set is switched "on" without an aerial coil plugged in.

Tr-1 performs the function of a self oscillating mixer operating at a collector to emitter voltage of -6 volts, with an emitter current of 1 mA. Oscillation is maintained by L-3 and L-5, and the frequency of oscillation is determined by L-4 and VC-2. The input to the IF amplifier is taken from the top end of L-3.

IF AMPLIFIER

The IF amplifier is a high gain package unit, having two stages of amplification, each using an OC-169 transistor. A bandpass input transformer couples the mixer to the first OC-169, and a second bandpass transformer is used to couple the second stage, which is another OC-169. This second IF stage is in turn coupled to the diode demodulator by means of a single tuned transformer. After filtering, the audio signal is transferred via the volume control RV-1 to the input of the audio amplifier.

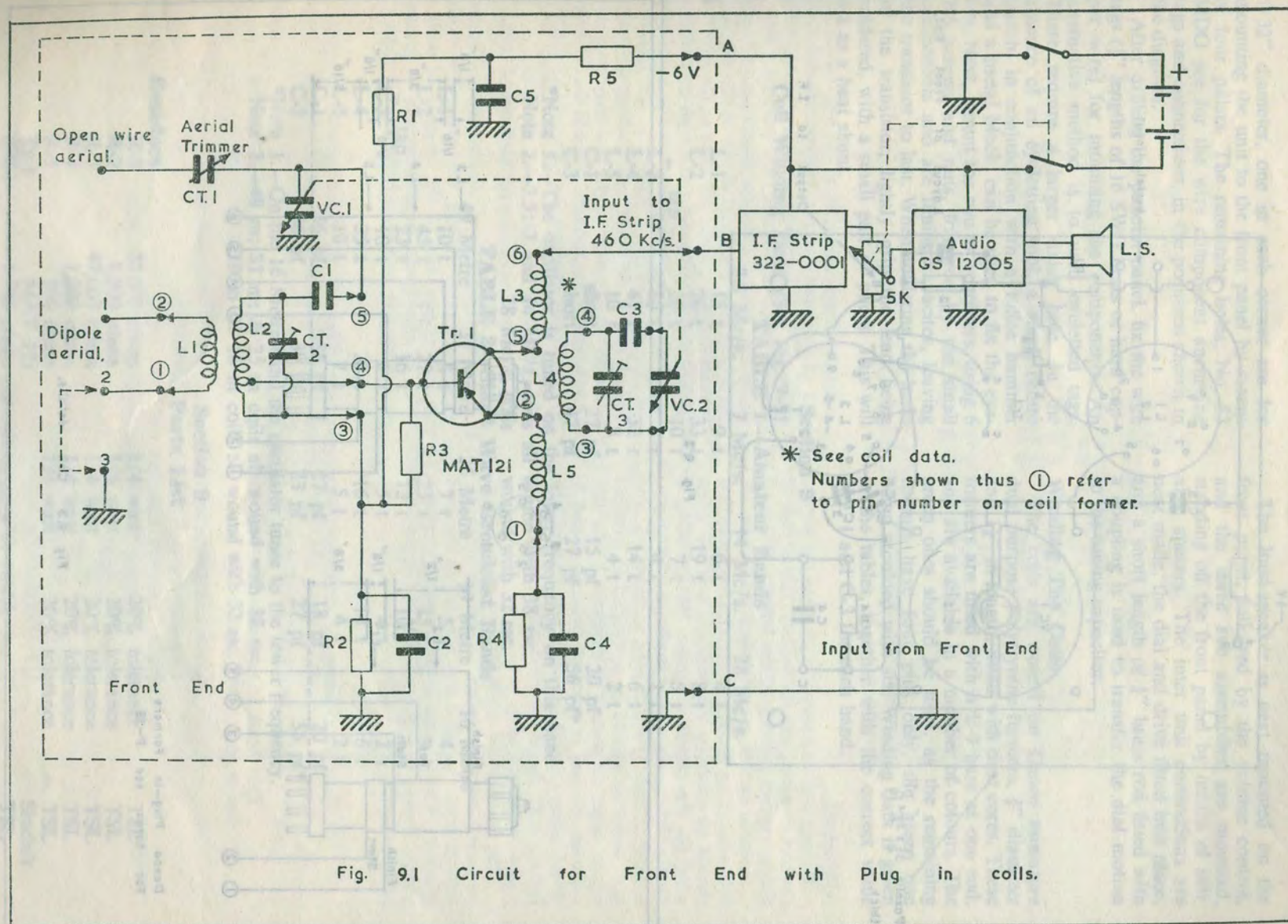
AUDIO AMPLIFIER

A ready made unit is available (TSL type GS-12005), and uses one OC-75, resistance coupled to the OC-71 driver, which is in turn, transformer coupled to the output stage which uses a matched pair of OC-74's in push pull. The output transformer is designed to match a 3 to 10 ohm load.

Constructional Details

FRONT END

This is constructed on a piece of paxolin, $3\frac{1}{2}$ inches by $3\frac{1}{2}$ inches by $1/16$ th. The tuning capacitor VC-1 and VC-2 requires a $3/8$ th diameter hole. The two B-9 valveholders for the coils each require a $\frac{3}{4}$ " hole with two $\frac{1}{8}$ " holes for the 6 BA fixing screws. Four holes,



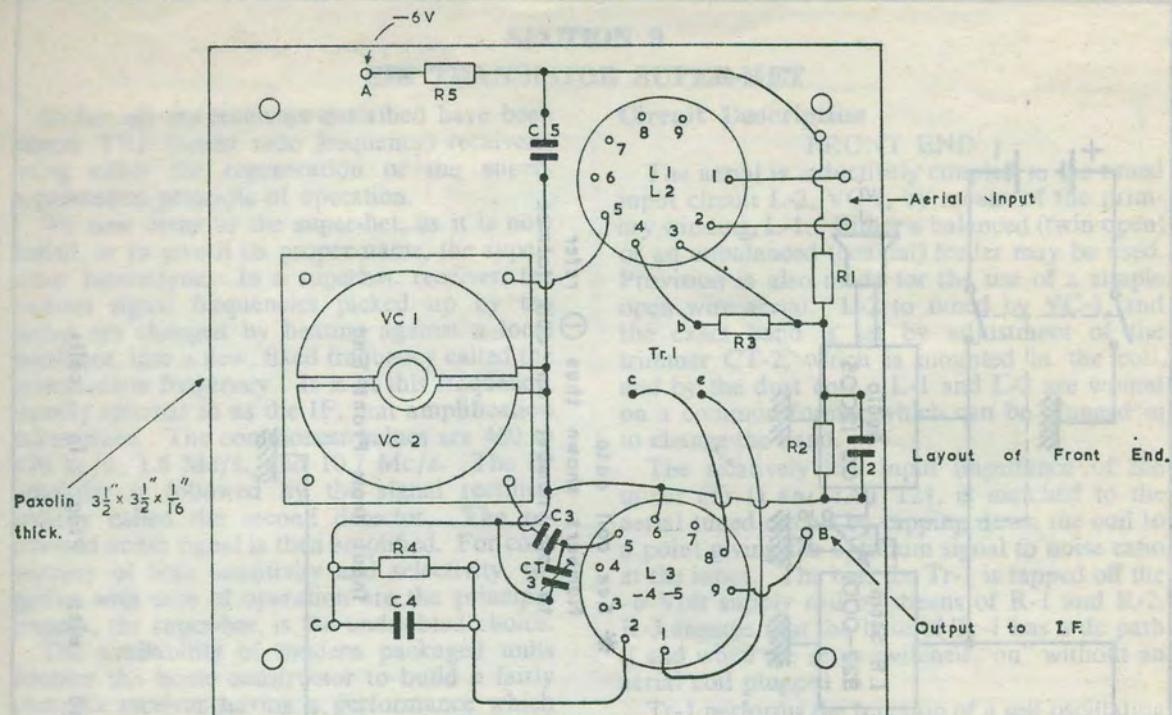
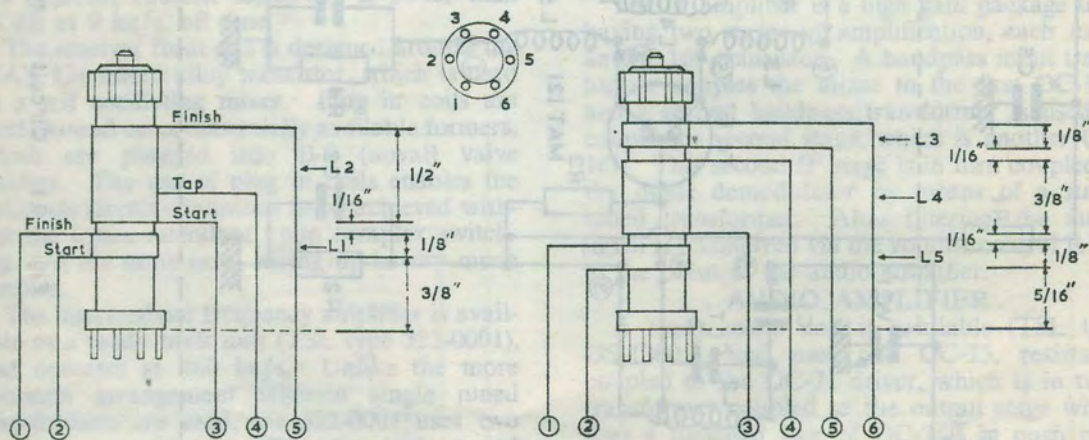


Fig. 9.2



Denco Plug-In Formers
For turns see P-58

Fig. 9.3 Coil details.

5/32" diameter, one in each corner are for mounting the unit to the front panel by means of four pillars. The remaining holes, No. 53 MDG are for the wire component anchoring tags and connections, in the positions shown in the diagram.

After drilling the paxolin panel, fix the wire tags ($\frac{1}{2}$ " lengths of 16 SWG brass or hard copper wire) for mounting the components. An alternative method is to use eyeletted tags. These require a larger fixing hole. In the absence of an eyeletting tool, a small centre punch, in conjunction with a toffee hammer and a metal block, can be used to fix the eyelets. Next, mount the two valveholders, using 6 BA screws and nuts, followed by the small components and the tuning capacitor, leaving the transistor to last. When soldering the leads of the transistor, lightly grip the lead being soldered, with a small pair of pliers. This will act as a heat shunt.

The loud-speaker is next mounted on the front panel, followed by the volume control, and the three sub assemblies are mounted, standing off the front panel by means of suitable spacers. The inter unit connections are next made, the dial and drive fitted into place, and a short length of $\frac{1}{4}$ " brass rod fitted with a coupling is used to transfer the dial motion to the tuning capacitor.

Winding The Coils

The coils are wound on Denco miniature dual purpose polystyrene formers, $\frac{3}{8}$ " diameter and $1\frac{1}{2}$ " in length, fitted with dust cores. These formers are fitted with a B-9 base at one end, and are available in a number of colours. The green ones should be used, as the remaining colours have four pins only, the green one being moulded with six. Winding data is given in the tables, together with the correct value of C-1 and C-3 for each band.

Section 9

Coil Winding Data (See Fig. 9-3)

TABLE 1—Amateur Bands

	3.5 Mc/s.	7 Mc/s.	14 Mc/s.	28 Mc/s.
L-1	15 t	9 t	6 t	4 t
L-2	76 t	33 t	19 t	8 t
" tap	20 t	10 t	7 t	5 t
L-3	10 t	8 t	4 t	2 t
L-4	47 t	32 t	14 t	6 t
L-5	10 t	8 t	4 t	2 t
C-1	short	27 pf	15 pf	20 pf
C-3	short	47 pf	27 pf	56 pf*

*Note 1.—The oscillator is tuned on the lower frequency on this band.

Note 2.—3.5; 7 and 14 Mc/s. coils all wound with 38 ssc.

28 Mc/s. coils wound with 32 ssc.

TABLE 2—Short Wave Broadcast Bands

	49 Metre	31 Metre	25 Metre	19 Metre	16 Metre
L-1	10 t	8 t	7 t	5 t	4 t
L-2	45 t	27 t	23 t	15 t	9 t
" tap	23 t	16 t	13 t	10 t	6 t
L-3	10 t	7 t	5 t	4 t	2 t
L-4	35 t	23 t	16 t	14 t	6 t
L-5	10 t	7 t	5 t	4 t	2 t
C-1	56 pf	33 pf	27 pf	18 pf	20 pf
C-3	56 pf	39 pf	33 pf	27 pf	56 pf*

*Note 1.—On the 16 Metre band the oscillator tunes to the lower frequency.

Note 2.—49 m; 31 m; & 25 m coils all wound with 38 ssc.

19 m & 16 m coils all wound with 32 ssc.

Section 9

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	47,000 ohms	1/4 watt	20% tolerance	TSL
R-4	1,000 ohms	1/4 watt	20% tolerance	TSL
R-5	100 ohms	1/4 watt	20% tolerance	TSL
Tr-1	MAT 121			Sinclair
RV-1	5,000 ohms potentiometer with switch			TSL

Capacitors

C-1	see coil data	silver mica	TSL
C-2	.01 μ F	Styrafoil	125 volt TSL
C-3	see coil data	silver mica	TSL
C-4	.022 μ F	Styrafoil	125 volt TSL
CT-1	miniature trimmer	15 pf	TSL
CT-2	miniature trimmer	15 pf	TSL
CT-3	miniature trimmer	45 pf	TSL
VC-1-2	25 pf x 25 pf split stator	Eddystone microdenser	type 551
C-5	.01 μ F	Styrafoil	125 volt TSL
Full vision drive and dial		Eddystone type 598	
IF unit		TSL 322-0001	
Audio amplifier		TSL GS-12005	
Loud-speaker unit	3 Ω speech	TSL	
Battery	6 volt	Ever Ready or Vidor	
Knobs		TSL	
Front panel			
Miscellaneous hardware			
Paxolin panel	3½" square by 1/16"	TSL	

Alignment

Having first very carefully checked the wiring, connect an aerial and the battery, taking care to ensure correct polarity of the latter.

Suitable aerials are described in Section 18. When using an open wire aerial, the connection should be made to the terminal marked 'open wire' on the circuit diagram. When using a dipole, either a twin open feeder can be used or coaxial cable. Twin feeder is balanced, and one conductor should be connected to terminal 1, the other conductor to terminal 2. In this instance, no link is required between 2 and 3. When using coaxial feeder, 2 and 3 should be linked, with the inner conductor connected to 1 and the screen to 2.

Plug in a set of coils for one of the lower frequency ranges, switch on and advance the volume control until a hiss is heard in the loud speaker. The IF strip has been pre-aligned and results should be obtained without further adjustment.

Set the tuning capacitor to the high frequency end of the band (i.e. the low capacitance end), and tune in a signal, using the trimmer mounted on the oscillator coil for this purpose. Next, adjust the aerial trimmer for maximum response. Having peaked the aerial circuit in this manner, tune in another signal, this time at the low frequency end of the band, (i.e. -high capacitance end), and adjust the dust core in the aerial core for maximum output. Retune to the high frequency end of the band, and readjust the aerial trimmer. Now retune to the low frequency end and check the bandspread. Should the coverage be insufficient, increase the value of C-3 slightly and retrim.

Repeat the procedure for each set of coils.

Having available a reasonably calibrated signal generator makes the procedure fairly straightforward, but in the absence of such a piece of equipment, frequencies can be located by listening to, and identifying transmissions.

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