

# EDDYSTONE

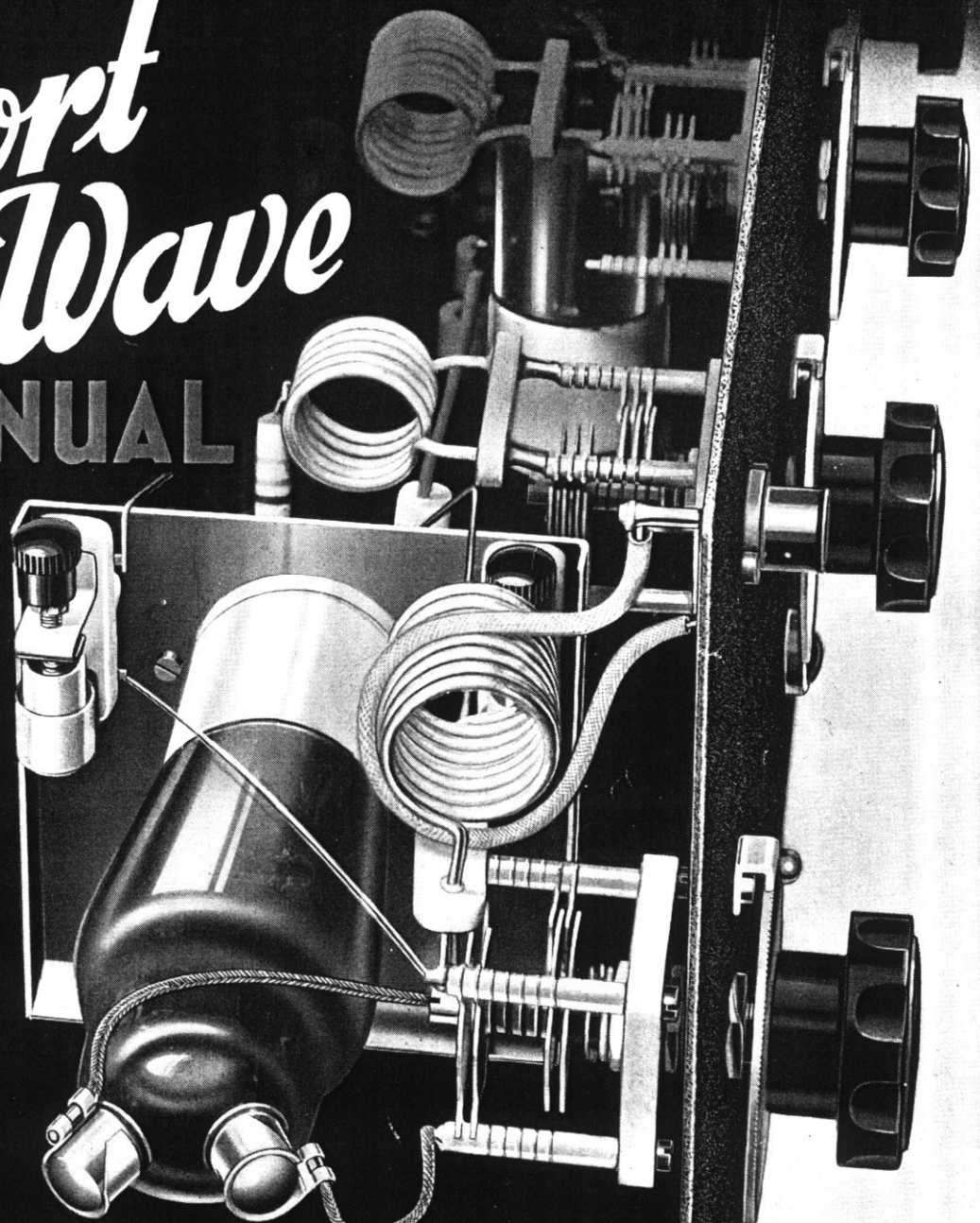
## *Short Wave*

MANUAL

2/6

CONSTRUCTIONAL  
ARTICLES *for* ~

SHORT WAVE RECEIVERS AND TRANSMITTERS



IN this, our second post-war Manual we have, as far as circumstances permit, reverted to the style of our earlier editions. We have gone to some elaboration with the layout drawings and with specially prepared guidance photographs.

To cater for the needs of the many grades of Amateur Radio enthusiasts is never an easy task and the still acute shortage of paper necessarily limits us in the number of articles. Nevertheless, we do sincerely hope that this sixth edition of the ever popular Manual will appeal to the majority.

Interest in the very high frequencies is rapidly increasing and is likely to continue—hence, a good proportion of our space has been devoted to V.H.F. equipment. As we go to press, doubts are being expressed regarding the retention by amateurs of the 60 Mc/s band. We believe that even if the present band is eventually withdrawn, another, not far removed, will be allocated in its stead. This has been borne in mind and the equipment described will require little, if any, modification for a new band. Should a change of bands come about, the V.H.F. Frequency Meter will be found particularly useful.

We hope that this Manual will be of real service. Suggestions for future issues will always be welcome.

## CONTENTS

	Page
V.F.H. Circuitry - - - - -	1
Short Wave Two Battery Receiver - - - - -	3
Single Valve V.H.F. Preselector - - - - -	7
Three Valve V.H.F. Straight Receiver - - - - -	10
60 Mc/s Crystal Controlled Transmitter - - - - -	14
Valve Base Data - - - - -	19
Heterodyne Frequency Meter - - - - -	20
Aerial Systems - - - - -	24

# V. H. F. Circuitry

It will probably be noticed that the design of the radio frequency circuits in some of the equipment described later is somewhat unusual. There are good reasons for this fact, and the following explanation of the various points which call for special attention will, it is hoped, prove both interesting and helpful.

## EFFECT OF STRAY CAPACITIES.

At very high frequencies, it is difficult to obtain results equivalent to those secured on frequencies below about 20 megacycles. One reason is that the valve input and output capacities, the tuning condenser minimum capacity and the stray capacities associated with other components and with the wiring, all add up to a value high in comparison with the total tuning capacity normally employed to bring the circuit as a whole into resonance at the operating frequency. It follows that the small inductance which must then be used results in a circuit with a low L/C ratio. The "Q" or goodness of the circuit is poor, and the voltage magnification and selectivity low.

Again, at very high frequencies, the input impedance of all types of valve drops to a comparatively low figure, although some special valves (*e.g.*, Acorns, which are relatively expensive) are better in this respect than those of normal construction. This low impedance, placed across the whole of the grid circuit, causes heavy damping and results in a further loss of magnification.

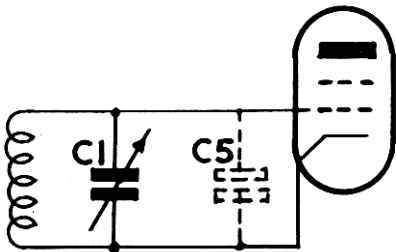


Fig. 1. Single-ended input circuit. C5 represents stray capacities.

## CIRCUIT EXPLANATIONS.

Fig. 1 shows a typical circuit with the normal tuning condenser, inductance and valve grid input all in parallel. The minimum capacity across such a circuit will rarely be less than 20pF—a relatively large value at frequencies above 50 megacycles.

By re-arranging the circuit, it is possible to improve it considerably. Fig. 2 is another input circuit, but this time a split-stator tuning condenser is employed, with the rotor plates earthed. The coil is connected across the stator plates, both ends being at R.F. potential. The valve and other stray capacities are now effectively across half the tuned circuit and in consequence, the amount of inductance can be increased appreciably.

Further, the valve input impedance is also across only half the tuned circuit, which quadruples

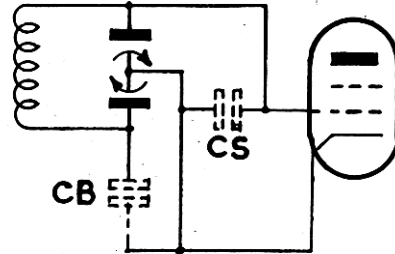


Fig. 2. Balanced input circuit. C5 represents stray capacity and CB balancing capacity.

its value as regards its effect on the whole circuit—for example, in a typical case, an input impedance of 10,000 ohms would be "seen" by the circuit as 40,000 ohms. The damping is then obviously much less and the magnification and selectivity of the circuit increase. Although only a proportion of the voltage developed across the circuit is applied to the grid of the valve, there is an overall gain.

The circuit in Fig. 2 is of the balanced type, and for balance to be complete, there should be connected, between the free end and chassis, a condenser of a capacity equal to the valve input capacity. If the centre of the coil is earthed (directly or capacitatively) such a condenser is desirable. It should, of course, be of the small low loss ceramic type. If the coil is allowed to "float" and find its own point of zero R.F. potential, the condenser may be omitted, with no appreciable effect on performance.

## INTERVALVE COUPLING.

Similar advantages accrue when the principle outlined is used in an output circuit or in an intervalve coupling circuit. Fig. 3 shows the usual type of single-ended R.F. amplifier, employing capacitive coupling to the following stage—in this case, a leaky grid detector. (If transformer coupling is employed, a certain amount of capacitive loading is placed on the secondary circuit). It will be appreciated at once that the numerous stray capacities, indicated by dotted lines, are in parallel

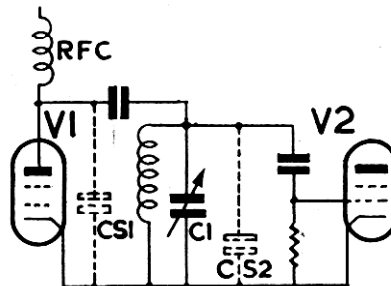


Fig. 3. Normal inter-valve coupling circuit. Output and input stray capacities, shown as CS1 and CS2, are effectively in parallel.

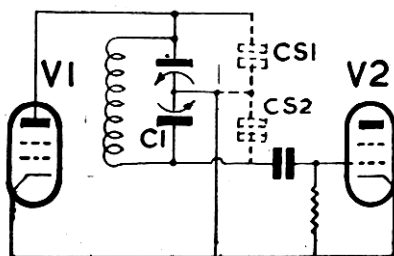


Fig. 4. Balanced inter-valve coupling circuit, with the stray capacities (CS1 and CS2) in series.

with the circuit, the inductance in which must necessarily be small. The balanced circuit recommended is given in Fig. 4. The stray capacities, including the anode-earth capacity of V1, and the grid-earth capacity of V2, are now in series across the coil, the size of which will require increasing, resulting in an all round improvement in gain and selectivity.

### TRANSMITTING CIRCUITS.

The output tank circuit of a transmitter is usually of the balanced type, while the early stages—crystal oscillator and first frequency doubler—work at a comparatively low frequency, in which cases the circuit described does not apply. Frequency doubling stages should have as little capacity as possible across the anode circuit and the balanced circuit is particularly recommended. Its use will result in sharper tuning, greater available driving power, and a general increase in efficiency at frequencies of 14 Mc/s and upwards. The circuit is quite effective at lower frequencies but the stray capacities are then relatively unimportant, whilst, with small tuning condensers, experiment will be necessary with the size of coil, since the tuning range will be more than usually restricted.

The balanced circuit should *not* be used in frequency trebling (anode) stages—this is the only exception in which the single-ended circuit is more efficient.

### OTHER ADVANTAGES.

In addition to giving improved results, the balanced circuit bestows other advantages. It will usually be found possible to achieve a better lay-out with short connecting leads. By-pass condensers are not required and the circuit is, if anything, more simple than its single-ended counterpart.

If plug-in coils are used, the high tension or grid return leads may be taken off one end of the coil through a good low capacity R.F. choke or resistor (see "Precautions" paragraph later). In a receiver or transmitter covering a restricted frequency range, where coil changing is not called for, it is better to take the connections off an approximate centre tap on the coil, possibly through a decoupling resistor or choke.

### COIL SIZES.

When building equipment incorporating the balanced circuit, it will be found that one's ideas of coil sizes suitable for any particular frequency will

have to be revised. For example, whereas one might otherwise employ a five turn VHF coil (Cat No. 603) for tuning to 60 Mc/s, it becomes possible to use an eight turn coil (Cat. No. 604). This ratio of five to eight will be found about right generally.

### CHOICE OF VALVES.

Another reason for flat tuning and low gain in VHF tuned circuits is the degenerative effect of the cathode lead inductance. This inductance is common to the control grid, screen grid and anode circuits, as illustrated in Fig. 5, and results in negative feed-back taking place. In a valve with a single cathode lead, nothing can be done to minimise it.

A few special valves are available, however, with two or more separate cathode leads, the Mullard EF50 and EF54 being examples. The inductance of each cathode lead is the same as that of a single lead but the R.F. currents are now forced

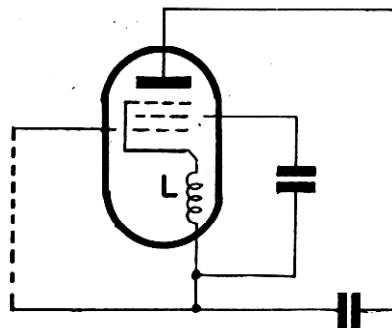


Fig. 5. The inductance of a common cathode lead results in negative feed-back.

to take separate return paths to the cathode. The negative feed-back effect is thereby eliminated with a consequent increase in effective gain. The circuit then becomes as shown in Fig. 6. Note that decoupling resistors or R.F. chokes are necessary in each of the grid, screen and anode circuits.

### PRECAUTIONS.

A symmetrical circuit is liable to generate parasitic oscillations, particularly when the valve

*Continued on page 6*

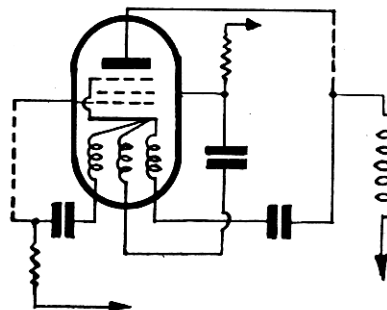


Fig. 6. Separate cathode leads and decoupled circuits remove the degeneration.

# Short Wave Two Battery Receiver

This receiver has been designed to meet the need for a set of a moderately simple type, easy to build and relatively inexpensive. Excellent results are assured through the use of efficient circuits and modern valves, one acting as a sensitive detector and the other as high gain audio amplifier. The receiver is intended for battery operation from a 2 volt accumulator and a 120 volt H.T. battery, the current consumption, both L.T. and H.T. being low. It will bring in, on telephones, signals from all over the world and being physically small, it is equally suitable for use at home or for portable operation.

The use of plug-in coils enables a wide range of frequencies to be covered and the bandspread arrangement incorporated in the receiver will be found most effective, both for separating stations in the well occupied amateur bands, and for ease of tuning in weak short wave broadcast stations.

## CIRCUIT.

The complete circuit diagram of the receiver is given in Fig. 1. The detector valve is an R.F. pentode, the Mullard KF35 being very suitable for the position. Two tuning condensers are used in parallel. The larger bandset condenser (C2) is mounted beneath the chassis, and indications of the setting of the condenser are read off the small dial. It is a simple matter to return to any given setting and frequency band. Above the chassis is the smaller bandspread condenser (C3). It is used in



conjunction with the open scale slow motion drive, a combination which is ideal for fine tuning. The ratio of the two condensers is such that adequate bandspread results on the amateur bands—and, of course, on other bands, such as short wave broadcast—without the possibility of stations being missed.

Reaction is obtained in the normal way from a coupling winding on the coil and is controlled by the potentiometer R2, which varies the screen potential.

Initial adjustment of the semi-variable reaction condenser C6 assists in securing smooth control.

The detector valve handles both radio and audio frequencies and, to ensure maximum efficiency and stability, as well as noiseless reaction control, two bypass condensers are connected between the screen grid and chassis. C7, a mica type, bypasses radio frequency currents and C8, a tubular paper condenser, looks after audio frequency currents.

The on-off switch should preferably be of the three point toggle type but difficulty may be experienced in obtaining one. A double pole switch will also be suitable, two of the contacts (one of each pole) being connected together to form one arm, the two remaining contacts forming the others, as shewn diagrammatically in Fig. 4.

The aerial coupling will require initial adjustment to arrive at adequate loading, elimination of blind spots and to give smooth reaction control, and a trimmer type condenser (C1) is therefore placed in series with the aerial terminal.

The detector valve is resistance/capacity coupled to the following stage and precautions are taken to ensure that no R.F. voltage reaches the grid of the audio amplifying valve, which is a Mullard KL35. The resistor in the screen circuit is inserted to prevent the screen voltage being higher than that applied to the anode. The anode current is low and the telephones are inserted directly in the anode circuit. As shewn, a telephone jack is used, this being the most convenient method of connecting the telephones but, if desired, a terminal strip may be fitted instead.

Grid bias for the output valve is obtained automatically from a resistor inserted in the H.T. negative lead.

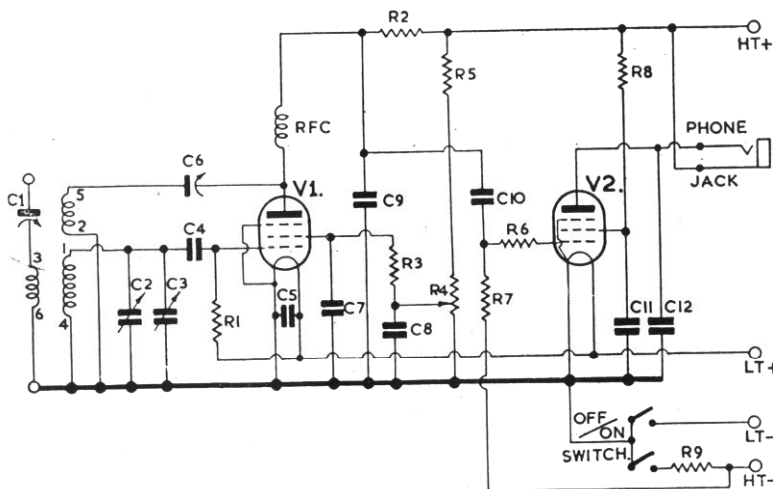


Fig. 1. Circuit diagram of the receiver.

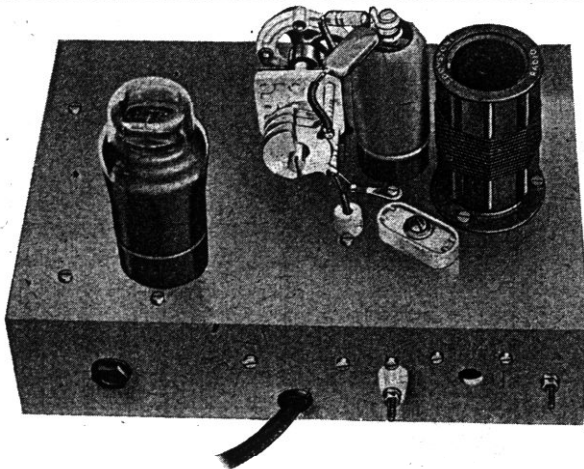


Fig. 2. Top view (from rear) of the receiver chassis, removed from its cabinet.

### CONSTRUCTION.

The receiver is built on a diecast aluminium chassis and enclosed in a metal cabinet. An illustration of the receiver, removed from its cabinet, appears at Fig. 2, and a drawing of the chassis layout is given in Fig. 3. The bracket used for mounting the bandspread condenser is identical with the one used in the V.H.F. receiver and dimensions will be found on page 13.

The components mounted on the front of the chassis (the bandset condenser C2, the on/off switch and the reaction potentiometer) are fixed centrally, i.e.,  $1\frac{3}{8}$  inches from the lower edge. The same applies to the aerial trimmer condenser, the standoff insulator and the telephone jack mounted at the rear of the chassis.

To ensure that the holes in the front of the chassis match up with the holes made in the cabinet, the latter should be drilled first ( $\frac{3}{8}$ -inch holes for the condenser and potentiometer,  $\frac{1}{2}$ -inch hole for the switch). The cabinet is then used as a template to mark accurately the locations for the holes in the front of the chassis, the fixing nuts of the three components being used to bolt together the cabinet and chassis. The scale of the bandset condenser is secured beneath the fixing nut, ensuring that the condenser vanes are fully meshed. The pointer knob is then fixed with the white engraved line pointing to "10."

The location of the  $\frac{1}{8}$ -inch hole required for the slow motion dial should be ascertained with the chassis bolted to the cabinet.

The reaction condenser (C6) is a compression type on a ceramic base, as generally used for oscillator padding in superheterodyne receivers but any other similar type may be employed provided it can be

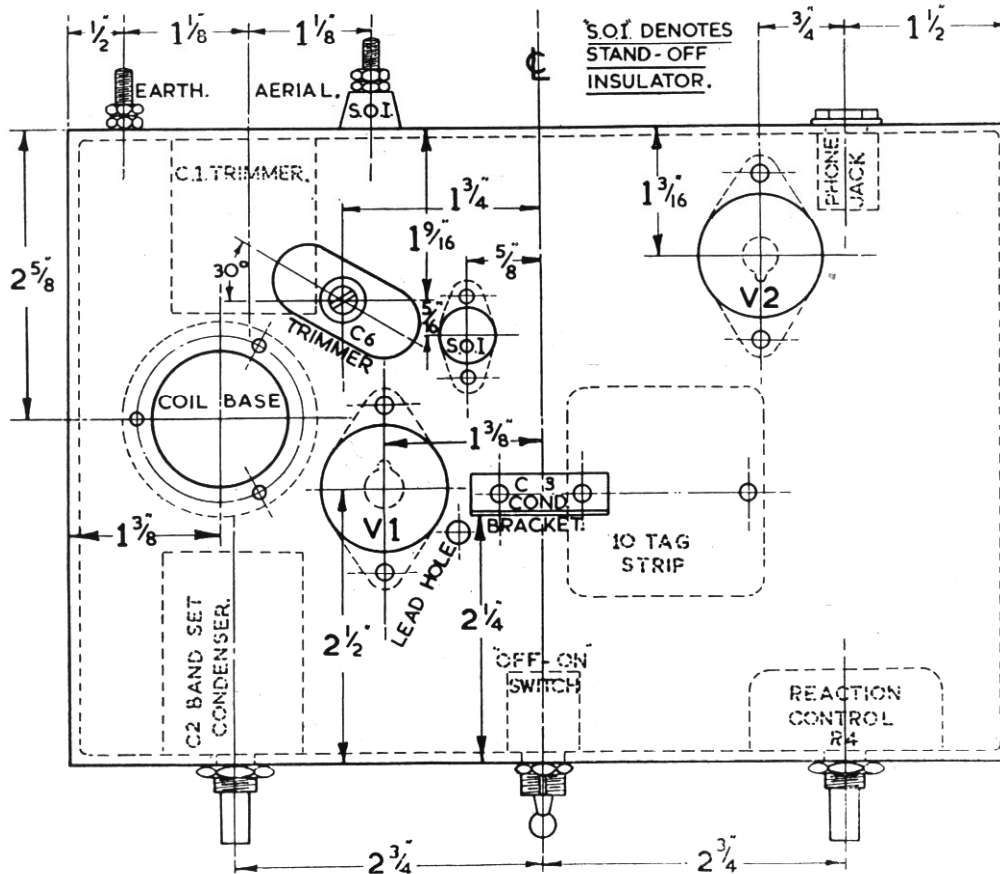


Fig. 3. Plan of receiver chassis.

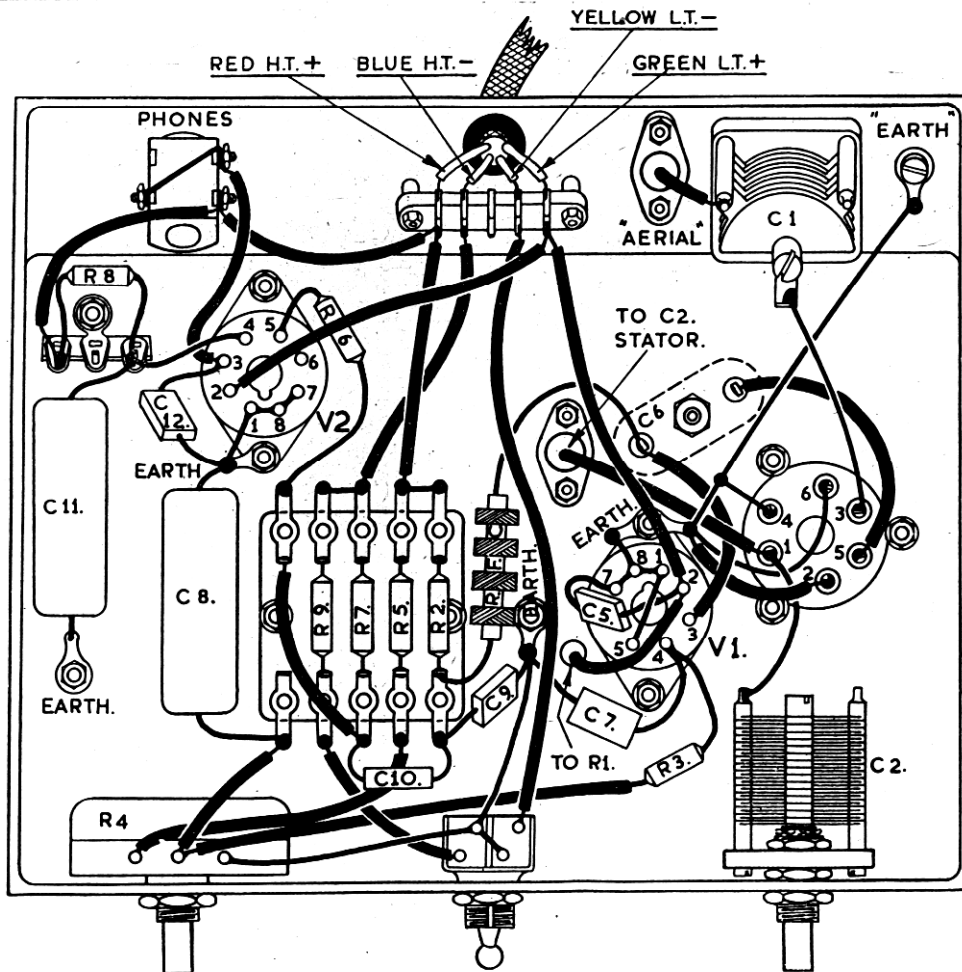


Fig. 4. Point-to-point wiring diagram of the receiver.

mounted to allow of adjustment from above the chassis, and has both ends insulated.

The air dielectric condenser (C1) conveniently permits a fine adjustment to be made of aerial loading but, if desired, a small mica dielectric type trimmer (3/30 pF) may be used in lieu. In the latter case, the condenser should be mounted externally, to allow of easy access, and a second standoff insulator will enable this to be done. The lead from pin 3 of the coil base will then go direct to one insulator and the trimmer condenser held in position across the two insulators.

When the Cat. No. 581 condenser is used, it should be spaced away from the chassis with  $\frac{1}{2}$ -inch pillars and a  $\frac{3}{8}$ -inch hole cut in the rear of the chassis to allow of adjustment by means of a screwdriver.

The group board should be mounted in place after the resistors fitted to it have been soldered in position. Spacing washers will be required to hold the group board off the chassis.

#### WIRING.

The layout has been designed to keep the R.F. wiring reasonably short and well separated from other wiring. The pictorial diagram Fig. 4 indicates

both the positions of the various components and the under-chassis wiring, which may be carried out with 20 S.W.G. tinned copper wire enclosed in insulating sleeving. The only wiring above the chassis is to the stator of the bandspread condenser and to the valve top cap. The grid condenser (C4) and leak (R1) should be connected as close as possible to the top cap of the detector valve. The grid leak is returned to L.T. positive, to secure better detector efficiency.

A length of four-way cable makes a convenient means of connecting the receiver to its associated batteries — alternatively, two separate pieces of twin flexible wire may be used, but, in either case, the colours should be easily distinguishable, to prevent any possibility of the H.T. and L.T. connections being reversed. A careful check should be made after completion of the wiring, to make quite sure that no errors have been made.

#### PRELIMINARY ADJUSTMENTS.

The results obtained from a receiver of this type will depend to a considerable extent on the efficiency of the aerial with which it is used. An indoor aerial is usually anything but efficient and

effort expended in erecting a good outdoor aerial will be well repaid in improved reception. The aerial need not necessarily be long but it should be as high as possible and well clear of other objects. A good average length for all round reception is sixty feet.

Two preliminary adjustments are necessary — one to the preset reaction condenser and one to the aerial trimming condenser — and, to some extent, these adjustments affect each other. The greater the aerial loading, the more the reaction capacity necessary, particularly on the higher frequencies and a certain amount of experiment with different settings will be desirable to achieve smooth control over a wide range of frequencies.

To begin with, the reaction potentiometer should be rotated somewhat beyond half its full travel, with the aerial connected and the aerial condenser partially meshed. The preset reaction condenser should then be adjusted to a point at which the detector valve is just oscillating, as indicated by a slight hissing noise in the telephones. On rotating the bandset condenser, signals should be heard, except possibly at certain positions of the tuning condenser where the receiver goes out of oscillation. If this occurs, the aerial trimmer capacity should be reduced until the blind spot disappears. The positions at which blind spots are found may also be shifted to a relatively unimportant part of the tuning range by altering the length of the aerial. The latter factor will have a marked effect on the amount of aerial trimmer capacity it is possible to employ — the condenser will be near maximum with a very short aerial and near minimum with a long aerial. The aim is to use as much aerial

trimmer capacity as possible whilst still maintaining freedom from blind spots.

It is desirable to connect the receiver to a good earth by as short a lead as possible. Other factors which will also affect performance include the use of really sensitive telephones and keeping the L.T. accumulator well charged.

#### FREQUENCY COVERAGE.

The following ranges may be expected from the coils specified:—

COIL TYPE.	MIN. FREQ. Mc/s.	MAX. FREQ. Mc/s.
6BB	17.0	29.8
6LB	12.0	23.0
6Y	6.0	13.0
6R	3.2	6.5
6W	1.7	4.0

It will be seen that all the normal high frequency amateur bands are covered. The 28 Mc/s. band is just covered and to maintain oscillation on this frequency, it will probably be necessary to reduce the aerial loading. To avoid upsetting the adjustment of the aerial trimmer, it is advisable, on 28 Mc/s. only, to include a further small condenser in the aerial lead, near the terminal. The value of this condenser will depend on the aerial characteristics but a value of between 5 and 10 pF will usually prove effective.

From the figures given above, the constructor will be able to choose coils to suit his own particular requirements — for instance, if the 7 and 14 Mc/s. amateur bands are the main interest, coils type 6LB and 6Y will be suitable. The majority of the long distance short wave broadcast stations are receivable on the 6LB coil.

#### LIST OF COMPONENTS.

EDDYSTONE.	Cat. No.	
1 Diecast Chassis	643	
1 Metal Cabinet	644	
1 Bandset Condenser (C <sub>2</sub> )	586	
1 Variable Condenser (C <sub>3</sub> )	580	
1 Variable Condenser (C <sub>1</sub> )	581	
1 Full Vision Dial	598	
1 Coil type 6BB		
1 Coil type 6LB		
1 Coil type 6Y	959	(see text)
1 6 pin Coil Base		
1 Flexible Coupler, large	964	
1 R.F. Choke	50	
3 Miniature Insulators	1010	
1 Knob and Dial	1019	
1 Skirt Knob	425	
1 Skirt Knob	2416P	
MISCELLANEOUS		
1 Valve type KF35		Mullard
1 Valve type KL35		Mullard
2 Octal Valveholders.		
1 Telephone Jack (Insulated).		
1 Switch 3 point Toggle, type S287 (see text).		
1 Preset Trimmer Condenser, 250 pF (C <sub>6</sub> ).		
2 Moulded Mica Condensers, .002 mF (C <sub>5</sub> , 7).		
2 Moulded Mica Condensers, .0003 mF (C <sub>9</sub> , 12).		
1 Condenser, 100 pF, Silvered Mica or Ceramic (C <sub>4</sub> ).		
2 Tubular Paper Condensers, .5 mF (C <sub>8</sub> , 11).		
1 Tubular Paper Condenser, .01 mF (C <sub>10</sub> ).		
2 Resistors, 1000 ohms, ½ watt (R <sub>3</sub> , 9).		
1 Resistor, 10,000 ohms, ½ watt (R <sub>8</sub> ).		
1 Resistor, 30,000 ohms, ½ watt (R <sub>2</sub> ).		
2 Resistors, 47,000 ohms, ½ watt (R <sub>5</sub> , 6).		
1 Resistor, 470,000 ohms, ½ watt (R <sub>7</sub> ).		
1 Resistor, 2 megohms, ½ watt (R <sub>1</sub> ).		
1 Potentiometer, 100,000 ohms (R <sub>4</sub> ).		

#### V.H.F. Circuitry (continued from page 2)

has a high mutual conductance. Such parasitic oscillations may be of a frequency much higher than normal and may therefore be difficult to detect. Whistles from harmonic beats will indicate their presence and, in any case, the stage gain will be abnormally low, because grid current will be present. Small resistors, of a value between 15 and 25 ohms, connected directly to the grid and anode contacts, completely eliminate U.H.F. parasitic oscillations. It will be noticed that such resistors are included in practically all the circuits described elsewhere.

Low frequency parasitic oscillation is also

possible if radio frequency chokes of similar characteristics are inserted in both grid and anode circuits. The cure is to use either chokes having inductances which differ widely or preferably, to use a decoupling resistor of a moderately high value in the grid circuit and an R.F. choke or a lower value resistor in the anode circuit.

The rotor of the split stator condenser used in a balanced circuit must be earthed by a path of low resistance and low inductance. A short, wide strip of heavy gauge brass is suitable, and at the same time forms the mounting.



## Single Valve V.H.F. Preselector

The function of a pre-selector for use on very high frequencies is mainly to give increased sensitivity, in order satisfactorily to receive weak signals. Careful design is called for, to achieve fairly high gain without an undue increase in noise level. The unit described incorporates the balanced circuits explained earlier and definitely gives a worth while increase in sensitivity, to an extent which brings up a very weak telephony signal to readable strength.

The preselector will be found most useful to those whose interest is the reception of long distance signals in the 50 and 60 Mc/s. amateur bands. By substituting larger coils for those specified, lower frequencies, including television, can be covered. The unit is directly suitable for amplification of the sound programme but slight modification may be necessary to increase the bandwidth in the case of vision signals. In the latter connection, the unit will prove of definite assistance where the synchronising signals are too weak to lock the picture properly.

The preselector will also give a worth while increase in selectivity, a feature which will prove advantageous to those in areas where amateur transmitters are numerous. Tuning is quite sharp and hence, if placed before a superheterodyne receiver, the preselector will much reduce image interference.

### CIRCUIT.

Only one valve is employed, a Mullard type EF54. The complete circuit is given in Fig. 1. The two tuning condensers are ganged and, it being assumed that the R.F. gain can be controlled in the receiver proper, no gain control is fitted. A single direct drive dial controls the condensers and the instrument is therefore very simple to operate.

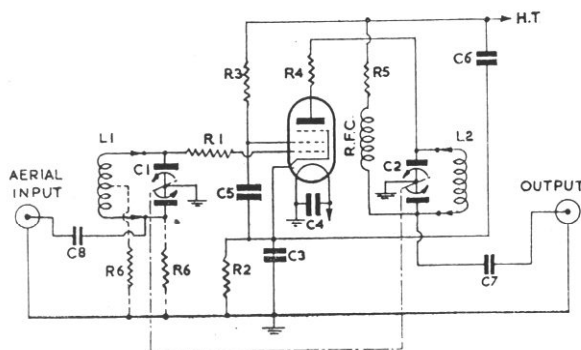


Fig. 1. Circuit diagram of the Preselector.



The input circuit is arranged to match into a low impedance feeder (of 72 ohms or thereabouts) although a long wire aerial may also be used. The output is fed by a length of coaxial feeder to the normal receiver which may be either a straight type or a superheterodyne.

The power requirements are low — 6.3 volts 3 amp. and 200/250 volts 12 mA. — and it should be possible to take these from the receiver power supply.

The metal cabinet enhances the appearance of the finished instrument and provides a measure of screening. It is interesting to note that strong signals can be received on the coils and wiring alone if the unit is not enclosed in the cabinet.

### CONSTRUCTION.

The unit is built upon a diecast chassis, the components being laid out in a manner which allows good separation of the anode and grid circuits, at the same time keeping all R.F. connections short. Fig. 4 shows the general arrangement and gives details also of the metal brackets required for mounting the variable condensers and coaxial sockets.

The bracket holding C1 acts also as a screen between the two tuned circuits and the preselector is quite stable without further screening. For ease of construction, C2 is also fitted to a bracket, which, for convenience, is shown identical to the other although, as no screening properties are called for, it may be reduced in size if desired.

In Fig. 4 (a) coil bases are indicated, to enable various sizes of coils to be plugged in. If it is intended to use the preselector solely on one particular band, the coils may be soldered directly to the stators of the tuning condensers, the opposing lugs being arranged uppermost in either case.

Beneath the chassis (Fig. 2) are the other small components, secured to tag strips where necessary. A three-way tag strip takes the H.T. and L.T. connections, which are completed through a cable passing through a hole in the rear of the chassis.

The chassis is fixed to the cabinet by means of two 2BA bolts. Holes should be made first in the cabinet, then the chassis drilled and tapped. If tapping facilities are not available, self-tapping screws can be used, care being taken to make the holes in the chassis on the small side.

### WIRING.

Although the wiring is relatively simple, care is necessary that the valveholder is wired up correctly. The pictorial diagram Fig. 2 will make

matters clear. Pins 4, 5, 7 and 8 of the EF54 are all internally connected to the cathode, internal screen and suppressor grid and, for reasons given earlier, each pin takes one R.F. connection only. The screen bypass condenser (C5) is soldered across pins 3 and 7; the cathode condenser (C3) between pin 5 and a soldering tag bolted to the chassis; and C6 between an H.T. point and pin 8. Condenser C4 is directly across pins 9 and 1 and resistors R1 and R4 are soldered very close to pins 2 and 6.

### COILS AND COUPLINGS.

It is important that the output of the preselector is fed properly into the normal receiver, otherwise losses at this point may nullify the gain of the pre-selector. A convenient length of low impedance coaxial cable (the narrow diameter type is quite suitable) should be made up and fitted with the Belling-Lee plug at one end. The other end may be connected direct to the receiver aerial terminals or another plug fitted if required. The outer screen of the cable must, in any case, be well bonded to the receiver chassis, to prevent any possibility of direct signal pick-up. The receiver input impedance should be low, to match into the cable. To achieve maximum results, it may be necessary to experiment with the coupling to the receiver.

Couplings inside the preselector are made through small ceramic condensers, as shewn in

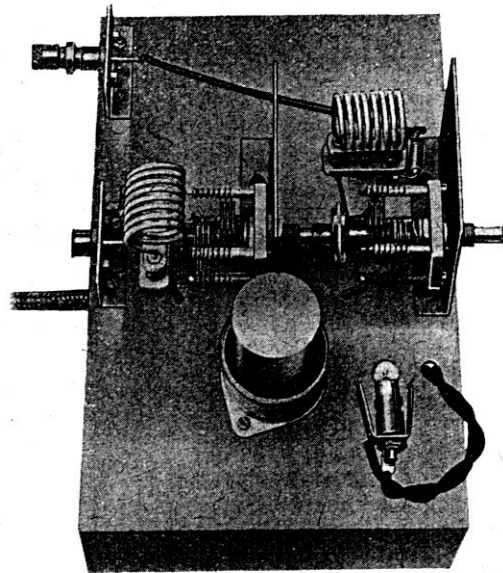


Fig. 3. Top view of the Preselector, removed from cabinet.

Fig. 1, but inductive single turn loops may be employed in lieu if desired, arranged around the centres of the coils. Both systems are equally effective—the former is more convenient when different frequency bands are covered, necessitating

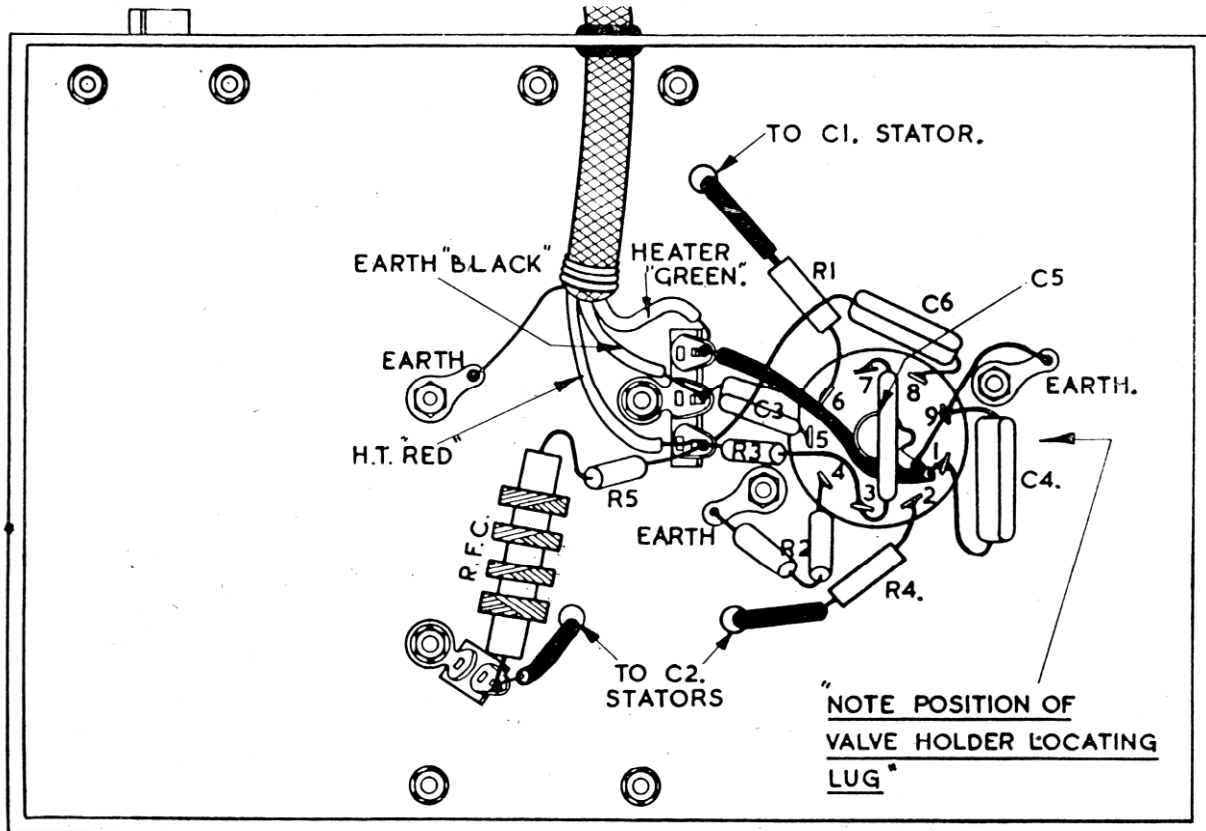


Fig. 2. Point-to-point wiring diagram.

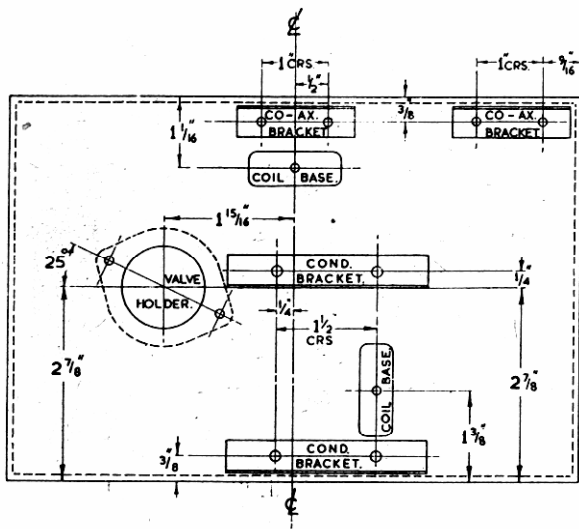
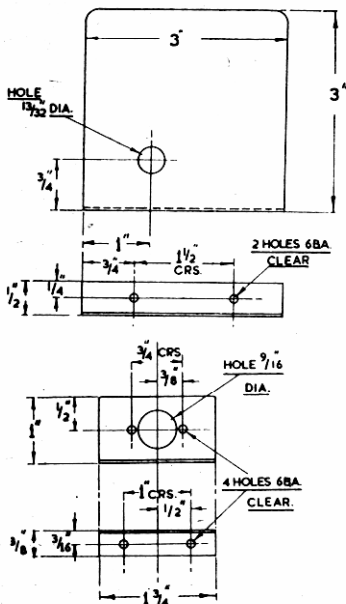


Fig 4 (a) Plan of chassis layout.



4 (b) Details of condenser brackets (top) and coaxial socket mounting (bottom).

change of coils. If the coils are soldered in place permanently, resistor R6 should preferably be soldered to an approximate centre tap on coil L1 instead of to one end. The alternative connections are indicated in Fig. 1.

For use on the 50 to 60 Mc/s. amateur band, eight turn coils are suitable — resonance at 60 Mc/s. occurs at approximately 50° on the dial. For the television frequencies, ten turn coils should be plugged in. The 10 metre band can be covered by using 10 turn coils, across which have been soldered small ceramic condensers of a value between 15 and 20 pF.

If used to boost the strength of vision signals, it will be desirable to increase the bandwidth of the preselector and this may be done by connecting 4,700 ohm 1/2 watt resistors directly across each of the two tuned stages. One result of doing so will

be a loss of gain, and in some cases, it may be necessary to compromise by increasing the value of the resistors to 10,000 ohms or more.

**OPERATION OF THE PRESELECTOR.**

After the aerial, output and power supply leads have been connected up, a check taken across the cathode resistor R2 should indicate a voltage between 1.6 and 1.8 volts. Resonance of the grid and anode circuits is shown by an increase in the noise level, whilst the strength of any particular signal receivable without the preselector will be found to increase considerably when the unit is placed in front of the receiver.

The input and output capacities of the valve are different and alignment of the two tuned circuits is advisable before the instrument is put into use permanently. This operation may be carried out on the noise level but it is more satisfactory to do it on an actual signal. With the condensers in mechanical alignment, first tune to resonance. Then slacken off the grub screws on one side of the flexible coupler and adjust each condenser separately for maximum signal strength, after which the grub screws should be finally tightened.

Tuning is fairly sharp, but not unduly critical. On the 60 Mc/s. band, five turn coils may be tried instead of eight turn coils, when it will be found that resonance will occur at near maximum capacity of the tuning condensers, tuning will be sharper and selectivity increased.

**LIST OF COMPONENTS.**

EDDYSTONE.		Cat. No.	
1	Diecast Chassis	643	
1	Metal Cabinet	644	
2	Var. Condensers, Split Stator, 25 x 25 pF (C1, 2)	583	
2	V.H.F. Coils, 8 turns (L1, 2) (see text)	604	
2	V.H.F. Coil Bases	606	
1	Flexibler Coupler, Medium	529	
1	Direct Drive Dial, Black, 2-inches	595	
1	R.F. Choke	1010	
<b>MISCELLANEOUS</b>			
1	Valve, type EF54		Mullard
1	Valveholder (B9G), L500/C, with Locking Ring, etc.		Belling-Lee
2	Coaxial Sockets (and plugs to match), L568, L604/S and L604/P		Belling-Lee
4	Fixed Condensers, Moulded or Silvered Mica, 300 pF (C3, 4, 5, 6).		
2	Ceramic Condensers, 3 pF (see text), (C7, 8).		
1	Resistor, 1/2 watt, 150 ohms (R2).		
2	Resistors, 1/2 watt, 22 ohms (R1, 4).		
2	Resistors, 1/2 watt, 10,000 ohms (R3, 6).		
1	Resistor, 1/2 watt, 330 ohms (R5).		

**AERIAL SYSTEMS—Continued from page 24**

From a third insulator, which also acts as the aerial terminal, a flexible lead terminating in a crocodile clip is provided with which to tap on to the coil. The circuit is earthed to the chassis only at the point where the condenser bush is fixed to the panel. A small direct drive dial (Cat. No. 595) and a coaxial socket complete the simple assembly. A single insulated loop of wire, connected to the coaxial socket, acts as coupling.

Similarly, the 60 megacycle model employs a 15 pF air dielectric trimmer condenser (Cat. No. 580) and a coil of 14 S.W.G. wire, four turns 1 1/4" outside diameter, spaced to occupy 1 1/2".

The aerial tuning unit is coupled to the transmitter by means of a short length of coaxial cable,

Continued on page 13

## 3 Valve V.H.F. Straight Receiver

This receiver is eminently suitable for newcomers to very high frequency work and for those who, for any reason, do not wish to adopt the more complicated superheterodyne type of receiver. Being fairly small, compact and well protected in its steel cabinet, it also lends itself to portable operation.

The receiver is moderately simple to construct, is free from the vices often met in V.H.F. receivers and it requires only modest power supplies. Whilst perhaps not equal to a good superheterodyne, the sensitivity of the receiver is excellent and the noise level low, due largely to the special valves and circuits embodied in it. Provided a good aerial system is used, signals can be received over comparatively long distances — during tests, a prototype receiver has brought in 60 Mc/s. signals from stations over 100 miles away, under average conditions. The receiver may also be used for reception of television sound signals.

The illustration at the heading of this article shows the handsome external appearance of the finished receiver.

### GENERAL DESCRIPTION.

The circuit, Fig. 1, comprises a tuned R.F. stage built up around a Mullard EF54 R.F. pentode a detector stage using an EF50 valve ; and a single high gain audio stage. A gain control (the left hand lower knob) varies the screen voltage of the R.F. amplifier, since strong signals will tend to overload the detector, making C.W. signals difficult to read.

The R.F. circuits are of the balanced type discussed earlier. For the sake of simplicity and optimum performance, they are separately tuned. It would be difficult to gang the two circuits since a comparatively large value of inductance is used in the R.F. stage, giving maximum gain, whilst a small one is employed in the detector stage, to give, in conjunction with the trimmer C20, a fair amount of bandspread, without which tuning would be unduly critical.

The detector circuit is a little unusual. Reaction is obtained via the screen grid of the EF50 and is



controlled by varying the screen potential. In any straight V.H.F. receiver it is difficult to prevent the reaction adjustment varying the frequency and this particular method affects the frequency only slightly, at the same time giving smooth control. The latter is very essential in a receiver of this type, depending on regeneration for its sensitivity.

The third valve is a non-microphonic R.F. pentode, giving, in this particular application, high audio gain. Coupling between it and the detector is by the medium of a parallel fed transformer. The type specified gives a high step-up ratio and has the advantage of small physical size. The audio stage gives ample output and consumes very little current. Coupling to the output jack is by the choke/capacity method and is suitable for high resistance telephones. The receiver is not intended for loud speaker use — for this purpose, a small additional amplifier is necessary.

Whilst the receiver is primarily intended for operation on the 60 Mc/s. amateur band, it is capable of covering frequencies over an approximate range of 70 to 25 Mc/s. by plugging in suitable V.H.F. coils from the Eddystone range.

If used in conjunction with a transmitter, it will be necessary to mute the receiver during

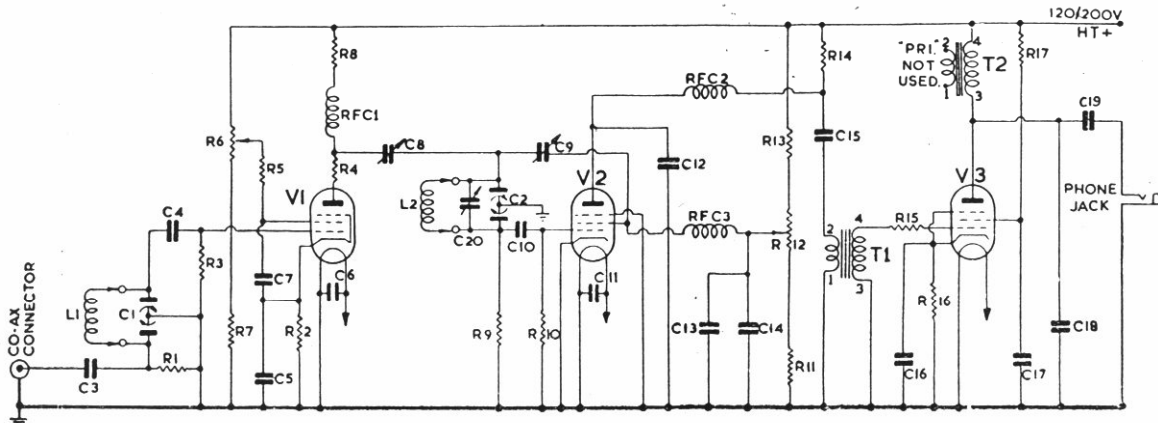


Fig. 1. Circuit diagram of the V.H.F. Receiver.

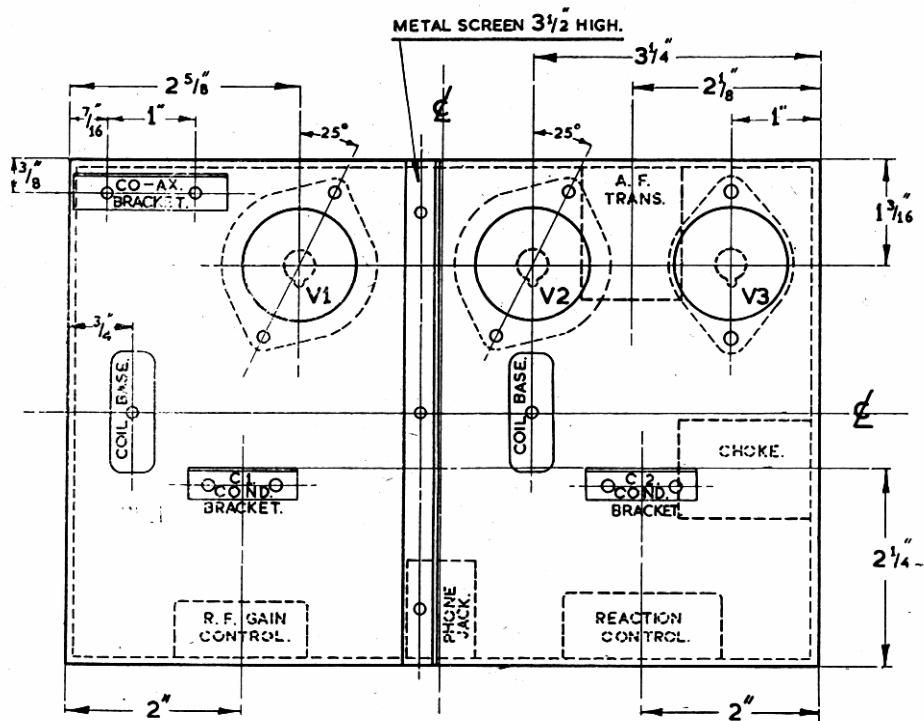


Fig. 2. Plan of receiver chassis.

periods of transmission. This can be done by fitting a single pole switch in a convenient position and wiring it in series with the H.T. supply.

### CONSTRUCTION.

A diecast aluminium chassis forms a rigid foundation upon which the receiver is built and ensures both electrical and mechanical stability—factors essential to any receiver but particularly so to one operating at very high frequencies.

Exact details of the chassis layout are given in the drawing, Fig. 2, which also shows dimensions of the screen between the R.F. and detector stages. Two brackets are required for the variable condensers, details being given in Fig. 5. These parts should be made of stout brass, at least 18 S.W.G. and preferably thicker. It has not been found necessary to fit screens beneath the chassis. The bracket for the coaxial aerial socket is identical with the one illustrated on page 9.

Two forms of construction of the tuned circuits are possible. If it is intended to cover the full range of frequencies, the coil bases are fitted alongside the tuning condensers, allowing a small clearance between the coils and condensers. Connecting wires are thus kept very short. If reception is to be restricted to one band of frequencies (e.g., the 60 Mc/s. band or the television sound on 41.5 Mc/s.), the appropriate coils may be soldered directly across the upper lugs of the tuning condensers. Note that holes  $\frac{1}{4}$ " diameter are required in the chassis for leads to pass through from the tuning condensers to the grids of V1 and V2 and to the anode of V2. A further hole is required near V3 to take the connection to its top cap.

The under-chassis photograph, Fig. 3, gives details of the location of the various components beneath the chassis. The majority of the small components are held by their own wires, tag strips being fitted where necessary to ensure firm support. The little additional wire necessary may be 20 S.W.G. tinned copper enclosed in insulating sleeving.

The method of mounting the small trimmer condensers will depend on the type employed. The ones recommended are Philips concentric trimmers of 10 pF maximum capacity and these may be held in the wiring providing the latter is stiff. If smaller ones are not obtainable, the 30 pF Philips trimmer may be used but the adjustment will be somewhat coarse. Small Wearite air trimmers, of 30 pF maximum capacity, are also available and are provided with mounting holes. These may be fixed to the chassis with 6BA bolts, using spacing pillars to reduce the stray capacity to earth. As a last resource, the usual small mica compression trimmer can be used quite successfully although again adjustment will be somewhat coarse. The trimmer associated with the detector tuned circuit should be soldered directly across the two stators of the variable condenser in a position which allows of easy adjustment. The photographs, Figs. 3 and 4, will assist in making these points clear.

At the rear of the chassis will be seen the tag strip to which H.T. and L.T. connections are brought and from which a three way cable to the power unit is taken through a hole in the chassis.

Holes  $\frac{3}{8}$ " diameter are required in the front of the cabinet to give clearance to the potentiometer spindles and to the telephone jack. Two 2BA screws

hold together the cabinet and the chassis, the holes in the latter being suitably tapped. Alternatively, the holes for the two potentiometers may be made  $\frac{3}{8}$ " diameter and the potentiometer fixing nuts used also to secure the chassis to the cabinet.

#### OPERATING THE RECEIVER.

For normal use, a small mains power unit delivering 20 mA at 200 volts and 1 ampere at 6.3 volts will prove satisfactory. During portable operation, the low tension supply will usually be derived from a 6 volt battery whilst the high tension supply may be from a vibrator unit, a small rotary converter or even from dry batteries. As a matter of interest, quite good results are obtainable from a 120 volt dry battery but it is then necessary temporarily to short circuit resistor R13 and increase the capacity of trimmer C9.

Preliminary adjustments are necessary for trimmer C8, which controls the degree of coupling between the R.F. and detector stages, and to trimmer C9, which is the preset reaction control. These adjustments are to some extent dependent on each other. With C8 set at a low value and the reaction potentiometer about two thirds advanced, adjust C9 until the detector valve oscillates. Then rotate C1 to resonance, indicated by an increase in noise level. If resonance is indeterminate, increase the capacity of C8. If, on rotating C1, the detector is pulled strongly out of oscillation, reduce the setting of C8. With a little experiment to the adjustments of C8 and C9, it will be found possible to attain settings which result in the resonance of C1 being sharp without unduly pulling the detector stage and which give smooth reaction control. Once set, further adjust-

ment of the C8 and C9 is unnecessary except perhaps at the extreme ends of the total frequency range. During the adjustments, the aerial should be connected to the input socket.

Thereafter the receiver handles in identical fashion to a straight regenerative one working on ordinary high frequencies. The detector stage should be kept in the just oscillating condition and the R.F. tuning condenser adjusted to resonance. Careful tuning will, of course, be necessary to bring in weak signals but once found, it is easy to hold them, since frequency drift is negligible.

The coil in the R.F. stage will always be larger than the one in the detector stage. For use on 60 Mc/s., the former should be an eight turn coil and the latter a three turn one. It is difficult to give a definite setting of the main tuning dial, since this will depend on the amount of trimmer capacity. The setting of the R.F. tuning dial is, however, an approximate guide to the amateur band. Adjust this to 29° with the main tuning dial at 50°, and rotate the trimmer condenser until the noise level peaks, indicating resonance. The amateur band covers about fifteen degrees of the main dial.

For reception of the television signal, a ten turn coil should be plugged in to the R.F. stage, resonance occurring at about 70°. In the detector stage, either a five turn coil with a good deal of trimmer capacity or an eight turn coil with very little, may be used.

To receive the 10 metre band, a 10 turn coil, with a 15 pF fixed ceramic condenser soldered in parallel, will be required for the R.F. stage and another 10 turn coil, but without a padding condenser, in the detector stage.

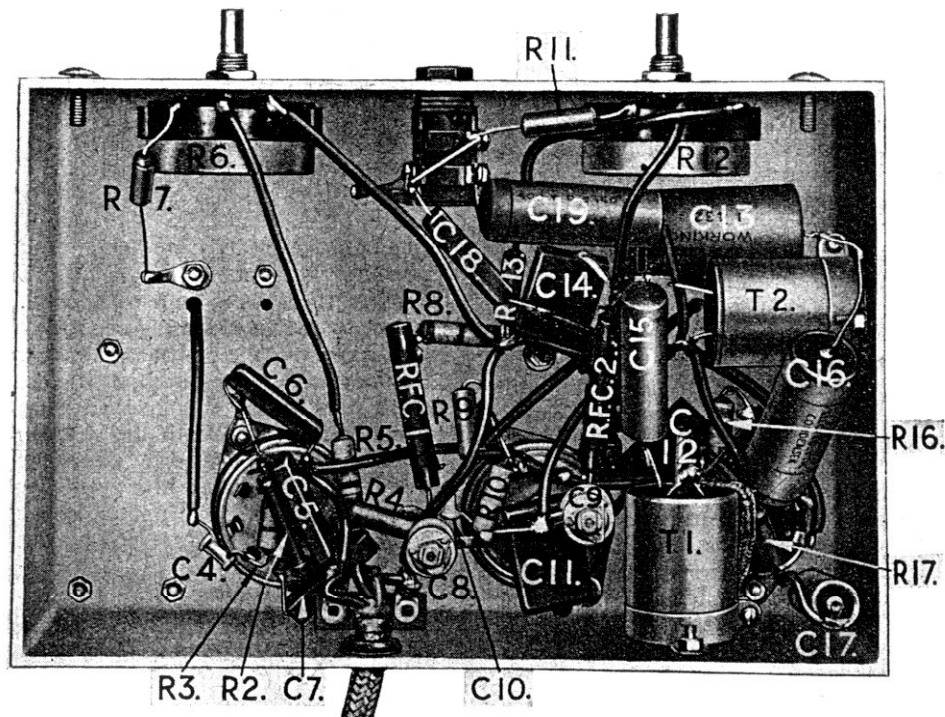


Fig. 3. Annotated photograph of the receiver chassis, from below.

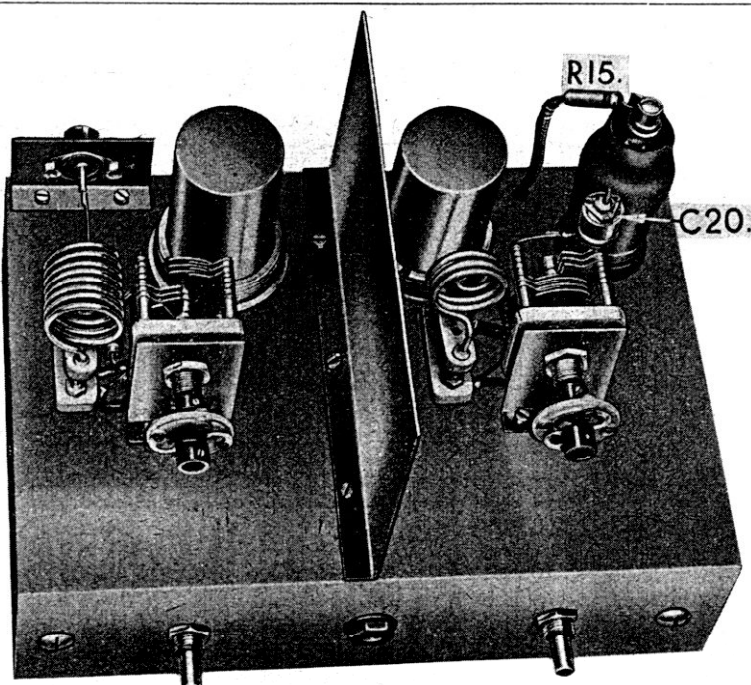


Fig. 4. Upper view of the V.H.F. Receiver.

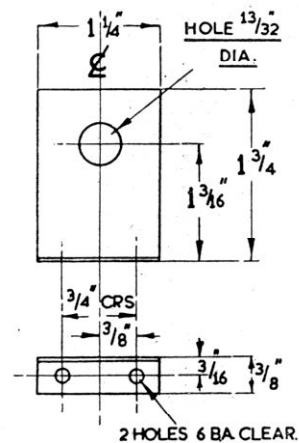


Fig. 5. Condenser mounting bracket. This is used also in the Short Wave Two Receiver and in the Heterodyne Frequency Meter.

**AERIAL COUPLING.**

The method of coupling the aerial to the receiver by a very small condenser (C<sub>3</sub>) is a good one for general purposes, since it is equally suitable for a long wire aerial or for low impedance feeders. The former should preferably be an odd number of quarter waves in length, and for portable operation in the 60 Mc/s. amateur band, an aerial 12 feet long overall

— 4 feet arranged vertically and 8 feet horizontally — will be found effective.

An alternative method of coupling is to arrange a single loop of insulated wire centrally around L<sub>1</sub>, one end being connected to the inner of the aerial socket and the other to a tag fitted beneath a fixing screw. This method is convenient when the tuning coils are soldered in position.

**LIST OF COMPONENTS.**

<b>EDDYSTONE.</b>			
1 Diecast Chassis	.. .. .	Cat. No.	643
1 Metal Cabinet	.. .. .		644
1 Slow Motion Drive, 2-inches, Black	.. .. .		597
1 Vernier Slow Motion Drive, 3 1/4-inches, Black	.. .. .		594
1 Variable Condenser, Split Stator, 25 x 25 pF (C <sub>1</sub> )	.. .. .		583
1 Variable Condenser, Split Stator, 15 x 15 pF (C <sub>2</sub> )	.. .. .		476
1 V.H.F. Coil, 8 turns	.. .. .		604
1 V.H.F. Coil, 3 turns	.. .. .		601
2 V.H.F. Coil Bases	.. .. .		606
2 Flexible Couplers, medium	.. .. .		529
1 R.F. Choke (RFC <sub>2</sub> )	.. .. .		1010
2 R.F. Chokes, V.H.F. Type (RFC <sub>1</sub> , 3)	.. .. .		1011
2 Instrument Knobs, 1 1/2"	.. .. .		592
<b>MISCELLANEOUS</b>			
2 Valveholders, B9G, Ceramic, with locking rings and retainers (L500/C and L568)	.. .. .	Belling-Lee	
1 Valveholder, Octal, Bakelite.	.. .. .	Belling-Lee	
1 Coaxial Socket (and Plug to match) (L604/S and L604/P)	.. .. .	Belling-Lee	
1 A.F. Transformer, Hyperloy, type 230 (T <sub>1</sub> )	.. .. .	Wearite	
1 A.F. Transformer, Hyperloy, type 208 (T <sub>2</sub> )	.. .. .	Wearite	
1 Closed Circuit Telephone Jack.	.. .. .		
1 Valve, Type EF64	.. .. .		Mullard
1 Valve, Type EF50	.. .. .		Mullard
1 Valve, Type EF37	.. .. .		Mullard
<b>CONDENSERS.</b>			
1 Ceramic, 3pF (C <sub>3</sub> ).	.. .. .		
2 Ceramic, 40 pF (C <sub>4</sub> , 10).	.. .. .		
7 Moulded or Silvered Mica, .0003 mF (C <sub>5</sub> , 6, 7, 11, 12, 14, 18).	.. .. .		
3 Tubular Paper, 1 mF (C <sub>15</sub> , 17, 19).	.. .. .		
1 Tubular Paper, .5 mF (C <sub>13</sub> ).	.. .. .		
1 Electrolytic Bias, 50 mF 12 volt (C <sub>16</sub> ).	.. .. .		
3 Miniature Trimmers, 10 to 20 pF max. (see text) (C <sub>8</sub> , 9, 20).	.. .. .		
<b>RESISTORS.</b>			
1 22 ohm, 1/2 watt (R <sub>4</sub> ).	.. .. .		
1 150 ohm, 1/2 watt (R <sub>2</sub> ).	.. .. .		
1 470 ohm, 1/2 watt (R <sub>8</sub> ).	.. .. .		
2 1000 ohm, 1/2 watt (R <sub>5</sub> , 16).	.. .. .		
5 20,000 ohm, 1/2 watt (R <sub>1</sub> , 7, 9, 11, 13).	.. .. .		
2 47,000 ohm, 1/2 watt (R <sub>14</sub> , 15).	.. .. .		
1 100,000 ohm, 1/2 watt (R <sub>17</sub> ).	.. .. .		
2 470,000 ohm, 1/2 watt (R <sub>3</sub> , 10).	.. .. .		
2 Potentiometers, 100,000 ohm linear (R <sub>6</sub> , 12).	.. .. .		

**AERIAL SYSTEMS—**Continued from page 9.

terminated with a plug at each end. The condenser in the unit is set at maximum capacity and the tank circuit of the transmitter tuned to minimum dip in the usual way. The aerial condenser is then rotated until maximum current is indicated on the meter in the anode circuit of the transmitter power amplifier valve. Adjustment of the degree of link coupling may be necessary to increase or reduce the anode current to its correct value. If the aerial tapping clip is too close to the earthy end of the coil, the rise of anode current will be sharp and tuning unduly critical and vice versa. The aim is to arrive at the happy medium

and some practice in manipulation will be necessary to secure optimum results.

One advantage of this system of matching the aerial is that the actual length of the latter does not matter — there is no necessity to cut it to any exact length.

Should the aerial happen to have an even number of quarter waves along it, voltage feeding will be necessary, with the tap approaching the "hot" end of the coil. Intermediate lengths of aerial can be matched by intermediate tapings, the aerial coupling unit acting as a potentiometer of the R.F.

# 60 Mc/s Crystal Controlled Transmitter

## INTRODUCTION.

The transmitter illustrated here-with has been designed to fulfil two functions — one, for use at the home station where it is presumed normal A.C. mains are available, and secondly for portable operation. Power units have been incorporated, making the transmitter completely self-contained as far as operation from A.C. mains is concerned. For portable use, it becomes necessary to employ auxiliary power supplies — the heater current can generally be taken straight off a car battery and the H.T. derived through the medium of either a vibrator unit or a rotary converter. Unless the latter provides high tension for the receiver also, little or no smoothing is necessary, since the smoothing filter in the transmitter may be utilised. A plug and socket fitting on the rear of the chassis enables the change-over from mains to battery power to be made without alteration to the internal wiring. Should portable operation not be contemplated, the plug and socket arrangement may, of course, be omitted.

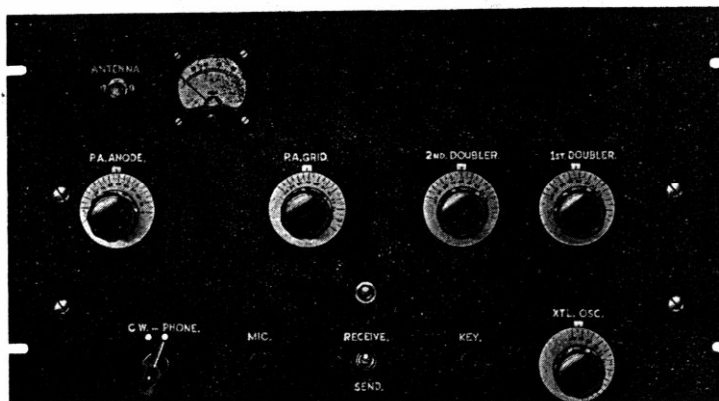
The transmitter is intended chiefly for C.W. operation, keying being effected in the cathode of the second (R.F.) valve. As one would expect, the note is a pure T<sub>9</sub> in character. To allow the use of telephony, a simple but effective modulator has been included. To avoid the complication of producing 10 watts or so of audio power (which would be necessary in the case of anode modulation) and also to reduce the current drain (an important point for portable operation), cathode modulation is employed.

Excellent results, over both long and short distances and using both C.W. and telephony, have been obtained from the prototype models. The transmitter will be found thoroughly efficient, perfectly stable, easy to adjust and very reliable.

## CIRCUIT.

The complete circuit diagram is given in Fig. 1. The first valve, a 6V6 beam tetrode, is used in a well proven triode circuit, the crystal frequency being in the region of 7.4 Mc/s. and the output frequency about 14.8 Mc/s. Then follows a S.T.C. 4074A double triode, each section of which is used as a separate frequency doubler, giving a final frequency within the 58.5 to 60 Mc/s. band. The anode circuits of this valve are of the balanced type discussed earlier.

The third valve is another 4074A, this time used as a straightforward neutralised power amplifier. The overall efficiency of the R.F. circuits is excellent and, with an applied voltage of 300, up to 20 watts input is possible. With the transformer specified, the H.T. voltage is about 325 and enables the transmitter to be run on C.W. at the full permitted input of 25 watts, without any ill-effect on the life of the



valves. With a reduced H.T. voltage, which may be more convenient when operating portable, the efficiency is still good and although there will be a falling off in output, the fact that a good location will usually be chosen will more than make up the loss.

The modulator circuit employs two valves only — the first a high gain amplifier and the second a beam tetrode giving a maximum output of about 4 watts. Precautions have been taken to prevent stray R.F. currents upsetting the stability. When required, the modulator is switched into circuit by closing S<sub>3</sub>, which applies H.T. to the anodes of V<sub>4</sub> and V<sub>5</sub>. If it is important to save heater current drain, this switch may be of the double pole type one pole then being used to close the heater circuit.

The secondary winding of the modulation transformer should shew a D.C. resistance of about 50 ohms. It is left in circuit continuously since it tends to prevent key clicks when operating with C.W. Should its resistance be greater than 50 ohms, the value of R<sub>20</sub> should be reduced so that the total resistance in the cathode circuit of V<sub>3</sub> is not more than 250 ohms. A carbon microphone, preferably of the G.P.O. type, and a suitable matching transformer are required — the audio gain is insufficient for full modulation with an insensitive microphone of the crystal or moving coil type.

The following specification for the modulation transformer should be quoted when ordering. Primary 5,000 ohms impedance, to carry 50 mA. ; secondary 200 ohms impedance, to carry 80 mA. ; audio wattage 5.

A proportion of the D.C. voltage developed in the cathode circuit of V<sub>5</sub> is tapped off for energising the microphone and a separate battery is not required.

For the sake of good regulation, the mains power unit incorporates a choke input filter in the smoothing system. The mains transformer must therefore deliver over 400 volts R.M.S., the final value of the H.T. voltage depending on the characteristics of the swinging choke.



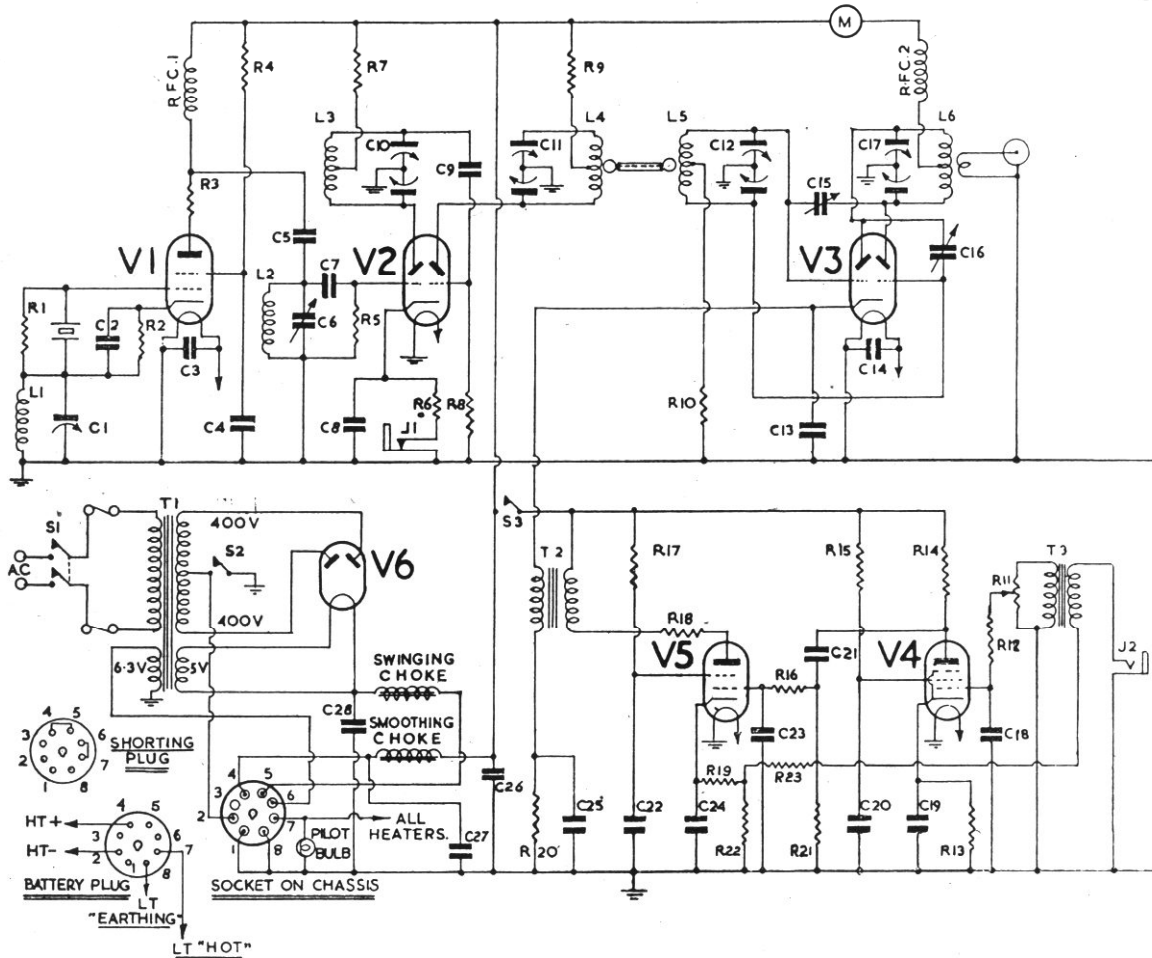


Fig. 1. Circuit diagram of the transmitter.

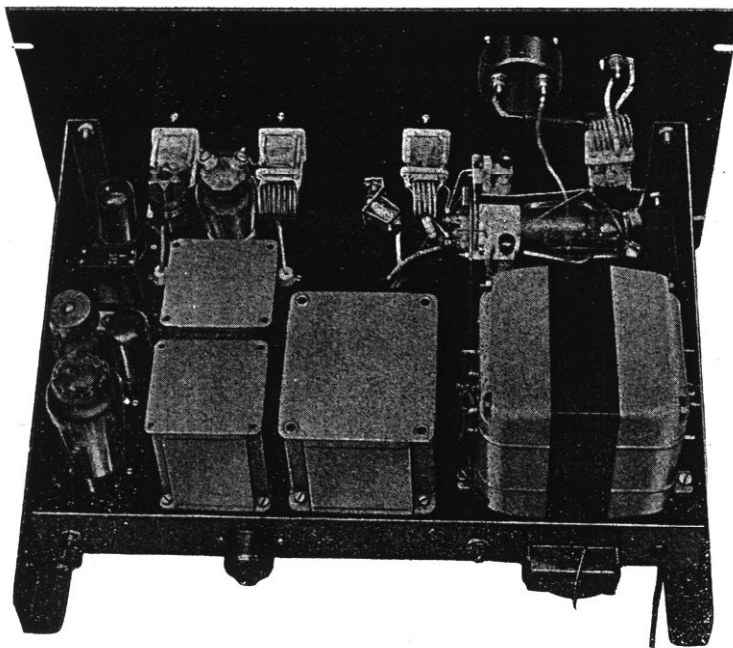


Fig. 2. Photograph of the top of transmitter chassis.  
A coupling link (not shown) is inserted at the centres of L4 and L5 (see page 18)

Bias for the P.A. valve is secured through a cathode resistor, which causes a 20 volt or so drop in the H.T. applied between anode and cathode. Allowance must therefore be made for this.

The L.T. and H.T. connections are wired up to the octal valve socket fitted at the rear of the chassis and, for A.C. operation, a plug short-circuits the appropriate pins. For use with external power supplies, another plug is fitted with leads as shown in Fig. 1. It may be noticed that, for the latter service, the swinging choke is not required and is therefore cut out of the circuit.

**CONSTRUCTION.**

The transmitter is built on a standard Eddystone chassis. The layout is symmetrical, with the R.F. circuits grouped in a line. The tuning condensers are mounted directly on the 10½" panel, no insulation being necessary.

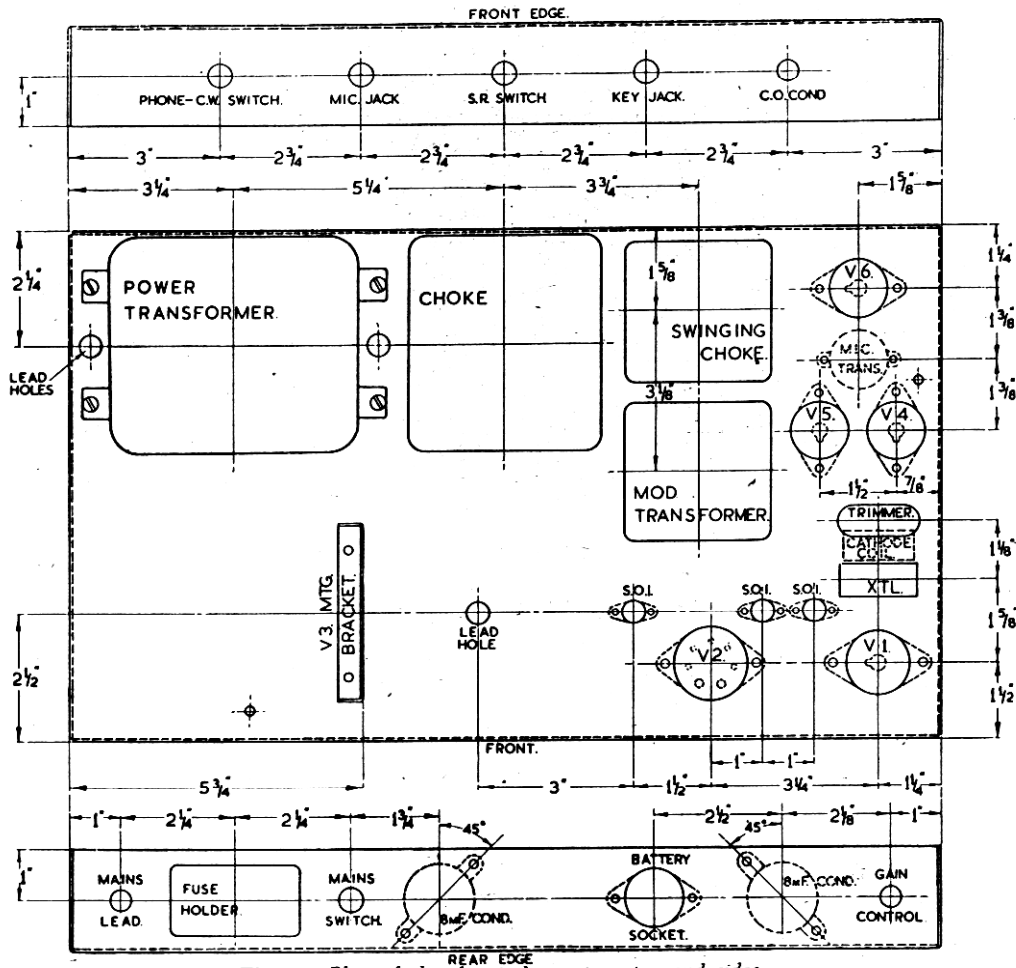


Fig. 3. Plan of the chassis lay-out — top and sides.

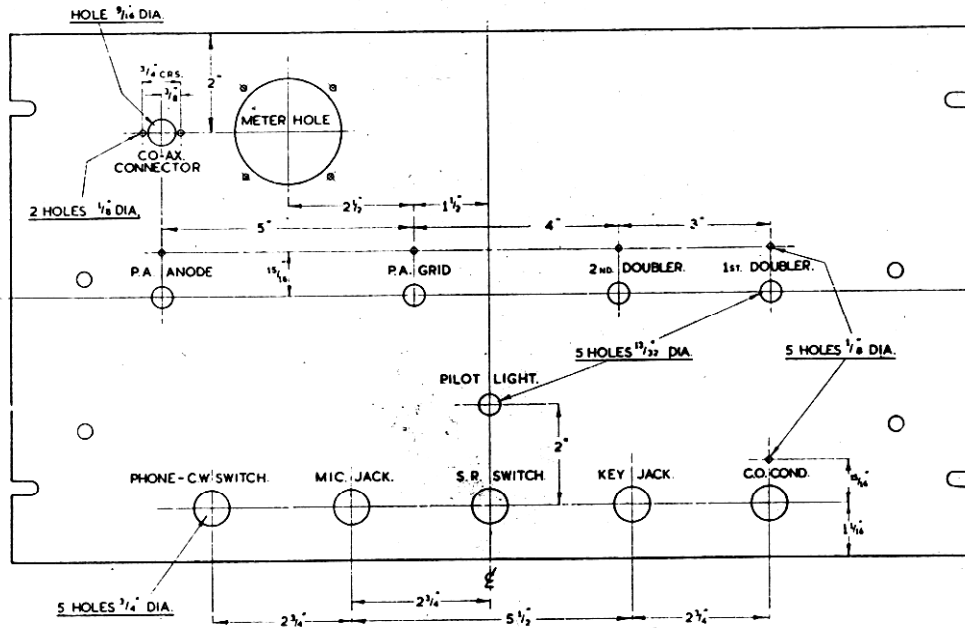


Fig. 4. Lay-out of the front panel.

The photographs and drawings convey very complete information regarding the positioning of the components on the chassis and on the panel, and it is only necessary to comment on a few particular points.

The small stand-off insulators (marked SOI in Fig. 3) are used as lead throughs, being fitted from the underside of the chassis. The nut and bolt is removed and the wire passed straight through. The right hand insulator carries the H.T. lead to L3, the next the lead from C9 to the grid of V2, and the third the H.T. lead to L4.

The valveholders should be mounted as shewn, to enable all R.F. wiring to be kept short. The position of the crystal socket allows the use of either round or flat crystal holders.

The P.A. valve is mounted horizontally and a special bracket is required, details being given in Fig. 5. Bending up as shewn strengthens the bracket and, if possible, the lower joints should be soldered. The two holes at the top of the bracket enable the neutralising condensers to be mounted symmetrically and in easily accessible positions.

**WIRING.**

The photograph of the underside of the chassis Fig. 6, has been annotated to indicate the positions of the various components and, in conjunction with the circuit diagram, no difficulty should be experienced in wiring the transmitter. Wiring should commence with the crystal oscillator circuit and the

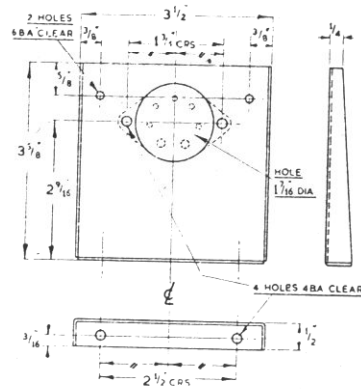


Fig. 5. Details of the valve mounting bracket.

power circuits (mains transformer, etc.) left to the last.

The coils are soldered directly in place across the condensers. The resistors R7, 9 and 10 and the R.F. choke RFC2 should be soldered to centre taps on the coils, keeping the length of wire on the coil side as short as possible.

A screened top cap fitting is desirable on V4, the stopper resistor R12 being soldered inside the cap. The condenser marked C18 in Fig. 1 was found to be unnecessary and can be omitted.

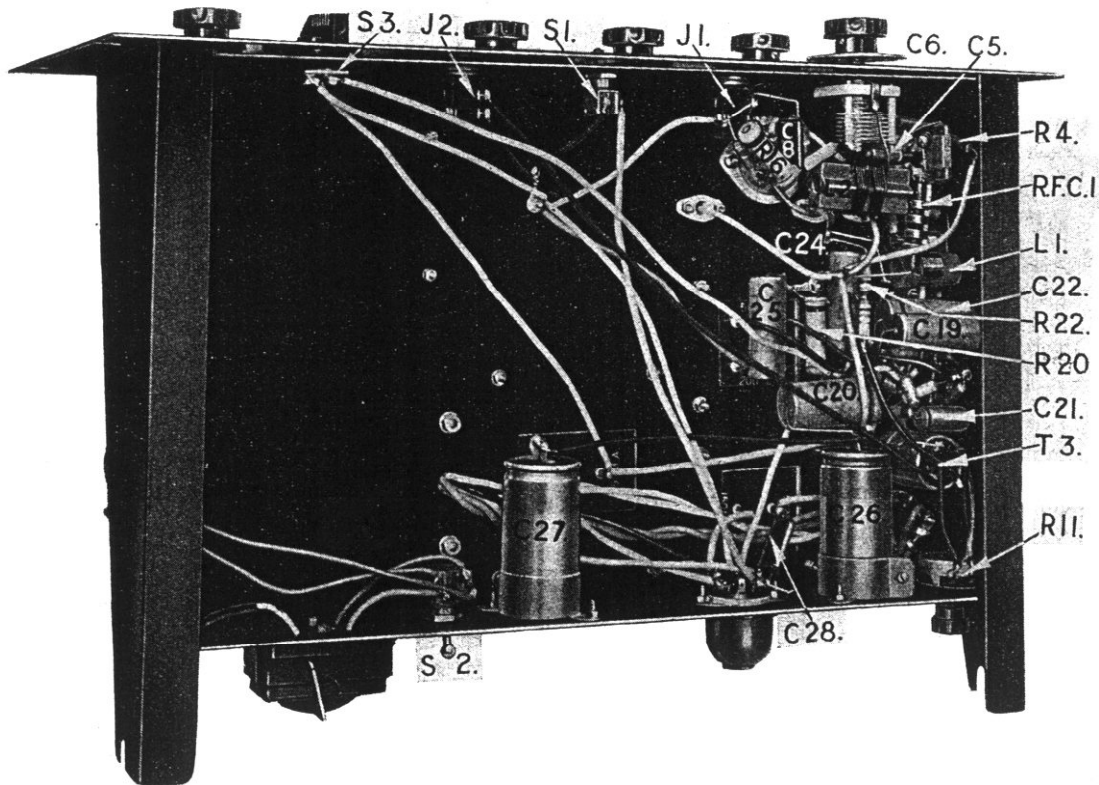


Fig. 6. Below chassis construction of transmitter.

**COIL SIZES.**

L1—Cathode Crystal Oscillator : 14 turns 22 g.enam. on Cat. 647 Former close wound.

L2—Anode Crystal Oscillator : 10 turns 18 g.enam. on 1" Former (646) close wound.

L3—Anode First Frequency Doubler : 10 turns 18 g. enam. on 1" Former (646) close wound (centre tapped).

L4—Anode Second Frequency Doubler : 8 turns V.H.F. Coil Cat. 604.

L5—Grid of P.A. : 5 turns V.H.F. Coil Cat. 603.

L6—Anode of P.A. : 8 turns V.H.F. Coil Cat. 604.

Link between Second F.D. Anode coil and Grid P.A. coil : 14 inches of 18 S.W.G. wire enclosed in sleeving and ends soldered together. Ends formed into loops of approximately  $\frac{3}{4}$ " in diameter.

Aerial coupling loop : 6 inches of 18 S.W.G. wire enclosed in sleeving and arranged round centre of L6.

**TUNING THE TRANSMITTER.**

The transmitter is quite straightforward to adjust. With the first valve in a non-oscillating condition, a meter plugged into J1 should read a current in the region of 30 mA. (assuming 300/325 volts H.T.). On adjusting the trimmer condenser C1 and rotating C6 to resonance, this current will increase, indicating that the crystal is oscillating. The setting of C1 is not critical — on screwing it down, a point will occur at which oscillation ceases. It will be found possible to unscrew the trimmer some way before the output begins to fall off, as indicated by the meter current dropping. The final setting should be intermediate between these two points, giving stable operation with low crystal current. Rotation of C10 will result in the needle of the meter flickering, and bringing C11 to resonance will cause a pronounced drop in current.

The next step is to ensure that the P.A. is properly neutralised. Condensers C10 and C11 should be set off tune to avoid erroneous results. Rotating condensers C12 and C17 will probably result in the current indicated by the panel meter varying violently, which means that the P.A. is self oscillating. The neutralising condensers C15 and C16 are then adjusted simultaneously, keeping the capacities as nearly equal as possible, until the meter current remains quite steady at any settings of C12 and C17 (except possibly at zero setting of C12). The cups of C15 and C16 will be about one-third engaged.

The earlier stages may now be tuned up again and the link inserted with the loops at the centres of coils L4 and L5. On rotating C12, the anode current of V3 will rise to a high value — 80 mA. or more — and no time should be lost in bringing C17 to resonance, when the current will drop to a low value.

Having roughly adjusted the transmitter, fine tuning is possible using the panel meter only or by the indications given by a neon lamp held near the output circuit. Adjustment of the link will be necessary to secure maximum drive to the P.A.

As a guide, the following dial readings were obtained in a prototype transmitter, the final frequency being 58.8 Mc/s.

C.O. Cathode 33 degrees. Grid P.A. 47 degrees.

C.O. Anode 54 degrees. Anode P.A. 10 degrees.

2nd Doubler 57 degrees.

**AERIAL COUPLING.**

The most satisfactory type of aerial is undoubtedly a horizontal half-wave dipole (with or without director and/or reflector), fed with low impedance feeder. As shewn in the photograph Fig. 2, a Belling-Lee co-axial socket is mounted on the panel near the P.A. tank coil, and a single loop of insulated wire arranged at the centre of the latter. One end of the loop is soldered to the inner socket, the other end to a tag fitted beneath one of the securing bolts. A resonant aerial will be found to draw strongly — adjustment of the aerial coupling is effected by partially withdrawing the loop, if necessary.

A long wire aerial may also be used with the same method of coupling but it will probably be necessary to experiment with the actual aerial length — a few inches at a time — so that the P.A. valve loads up satisfactorily. Although somewhat uncommon, a Windom aerial can be successfully employed and is particularly convenient for portable work. It may consist of a 7-ft. 10-in. length of metal tubing suitably supported, the feeder being clipped on and moved until a good match is secured.

With S3 open, the final valve may be allowed to draw up to 70 mA. On closing S3, a reduction of anode voltage occurs and the anode current will drop slightly. If used continuously on telephony, the anode loading should not exceed 60 mA.

**AERIAL SYSTEMS—Continued from page 13**

voltage produced by the transmitter, but with practically no inherent losses. Since the coupling unit will be earthed to the transmitter chassis via the cable, no additional earthing of the unit will be necessary.

Whilst primarily intended for use with a transmitter, this aerial coupling unit will also be found of benefit where the absolute maximum of sensitivity is wanted from a receiver — for instance, on the 60 Mc/s. band. The unit will be coupled to the input circuit of the receiver via a length of coaxial cable and resonance of the tuned aerial circuit will be indicated by an increase in noise. As before, aerial matching will be correct when the tuning is neither unduly sharp nor too flat.

LIST OF COMPONENTS.

**EDDYSTONE.**

1 Standard Chassis	Cat. No.	617
1 Panel, 10 1/2"		619
1 Pair of Angle Brackets		618
1 Air Dielectric Trimmer Condenser, 60 pF (C6)		582
3 Air Dielectric Trimmer Condensers, 25 x 25 pF (C10, 11, 12)		583
1 Air Dielectric Trimmer Condenser, 15 x 15 pF (C17)		476
5 Direct Drive Dials, Black		595
2 V.H.F. Coils, 8 turns		604
1 V.H.F. Coil, 5 turns		603
1 R.F. Choke (RFC1)		1010
1 R.F. Choke (RFC2), V.H.F. type		1011
1 Coil Former, Small, plain		647
2 Coil Formers, 1" ribbed, plain		646
1 Instrument Knob, 1"		593
2 Neutralising Condensers (C15, 16)		481
3 Miniature Insulators		1019
1 Pointer Knob (for S3)		1044

**MISCELLANEOUS**

- 1 Valveholder, Octal, Ceramic (V1)
- 4 Valveholders, Octal, Bakelite (C4, 5, 6 and rear socket).
- 2 Valveholders, American, Medium 7-pin Ceramic (V2, 3).
- 2 Octal Plugs (if portable operation intended), type P112.
- 1 Mains Transformer, Input 0-210-230 volts 50 cycles. Outputs 425-0-425 volts 150 mA, 6.3 volts, 4 amps, 5 volts, 3 amps.
- 1 Swinging Choke, 5 Henries, 150 mA.
- 1 Smoothing Choke, 20 Henries, 150 mA.
- 1 Modulation Transformer (T2), Special (see text for details).
- 1 Microphone Transformer (T3), Hyperloy type 210.
- 1 Crystal (between 7320 and 7500 Kc/s.).
- 1 Crystal Holder.
- 1 Open Circuit Jack (Microphone, J2).
- 1 Closed Circuit Jack (Key, J1).
- 1 Coaxial Socket (and Plug to match), type L604/P and L604/S

- 1 Moving Coil Meter, 0/100 mA.
- 1 Twin Fuseholder and Fuse (1 ampere), type L1033/C3
- 1 Switch, D.P.S.T., Toggle type S288 (S1).
- 1 Switch, S.P.S.T., Toggle type S280 (S2).
- 1 Switch, S.P., Rotary (S3).
- 2 Valves, 4074A (V2, V3)
- 2 Valves, 6V6G (V1, 5)
- 1 Valve, EF37 (V4)
- 1 Valve, 5U4G (V6)
- 1 Panel Indicating Light.

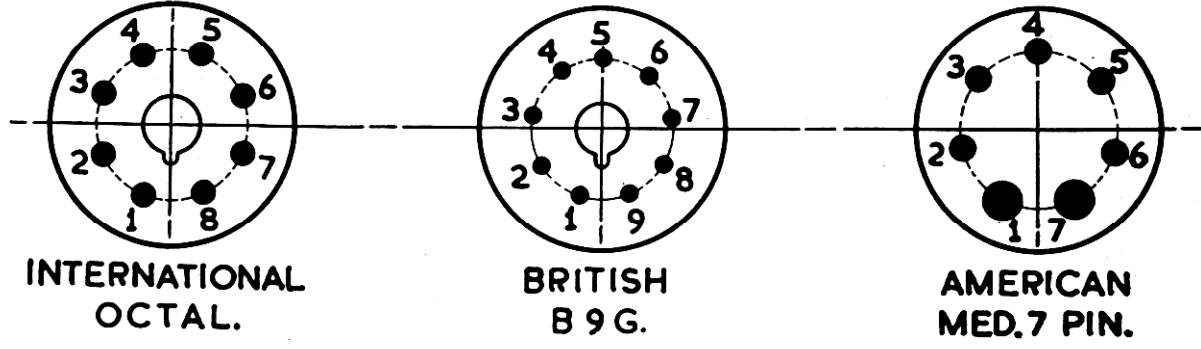
**CONDENSERS.**

- 3 Moulded Mica or Ceramic, 100 pF (C7, 9, 23).
- 1 Mica Trimmer, 250 pF Max. (C1).
- 2 Moulded Mica, .0003 mF (C13, 14).
- 5 Moulded Mica, .001 mF (C2, 3, 4, 5, 8, 28).
- 1 Tubular Paper, .01 uF (C21).
- 2 Tubular Paper, .5 uF (C20, 22).
- 2 Electrolytic Smoothing, 8 mF 500 v. (C26, 27).
- 2 Electrolytic Bias, 25 mF 25 v. (C24, 25).
- 1 Electrolytic Bias, 50 mF 12 v. (C19).

**RESISTORS.**

- 2 1/2 watt, 22 ohm (R3, 18).
- 2 1/2 watt, 100 ohm (R22, 23).
- 1 1/2 watt, 150 ohm (R19).
- 1 3 watt, 200 ohm (R20).
- 2 1 watt, 220 ohm (R2, 19).
- 1 3 watt, 400 ohm (R6).
- 2 1 watt, 470 ohm (R7, 9).
- 1 1 watt, 1,000 ohm (R13).
- 2 1 watt, 5,000 (or 4,700) ohm (R10, 17).
- 3 1/2 watt, 10,000 ohm (R4, 12, 16).
- 2 1/2 watt, 47,000 ohm (R1, 8).
- 2 1/2 watt, 100,000 ohm (R5, 14).
- 1 1 watt, 1 megohm (R15).
- 1 1/2 watt, 250,000 ohm (R21).
- 1 Potentiometer, 250,000 ohm (R11).

VALVE BASE DATA



**OCTAL BASED VALVES.**

Valve	Pin 1	2	3	4	5	6	7	8	Top Cap
EF37	M	H	A	G2	G3	—	H	K	G1
6V6	M	H	A	G2	G1	—	H	K (G3)	—
KF35	M	F+	A	G2	G3	—	F—	—	G1
KL35	—	F+	A	G2	G1	—	F— (G3)	—	—

**BRITISH 9-PIN BASED VALVES.**

Valve	Pin 1	2	3	4	5	6	7	8	9
EF50	H	G2	A	G3	S	K	G1	S	H
EF54	H	A	G2	K, S, G3	S	G1	S	S	H

**AMERICAN 6-PIN BASED VALVE.**

Valve	Pin 1	2	3	4	5	6	7	Top Caps
4074A	H	—	G1	K	G1	—	H	A

- M .. Metallising.
- S .. Shield.
- H .. Heater.
- F .. Filament.
- D .. Diode.
- G1 .. Control Grid.
- G2 .. Screen Grid.
- G3 .. Suppressor Grid.
- A .. Anode.
- K .. Cathode.

# Heterodyne Frequency Meter

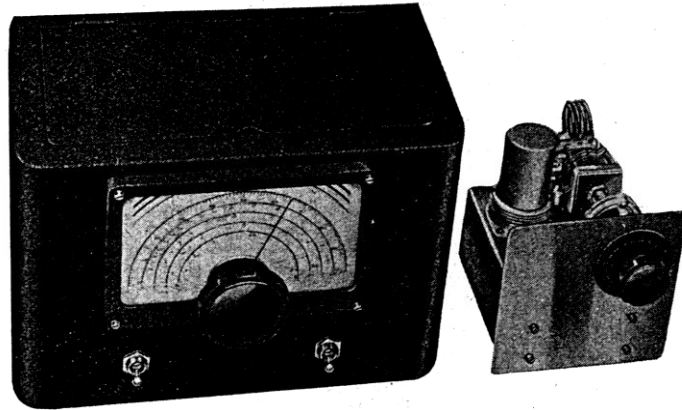
To the short wave enthusiast, a frequency meter of the heterodyne type can be most useful for the alignment and testing of receivers and for measuring frequencies. The design described below is versatile in its applications, is fairly simple to construct and can be relied upon to maintain its accuracy of calibration.

The meter is built in the form of two units. The first covers normal frequencies from 32 megacycles downwards and includes a source of audio modulation. The second unit, which plugs into the first one, oscillates in the very high frequency range and provides a useful test signal for the 28 and 60 Mc/s. amateur bands, as well as for television and other frequencies.

## CIRCUIT OF MAIN UNIT.

The circuit diagram of the main section of the frequency meter is shown in Fig. 1. The radio frequency oscillator is of the "transitron" type, the constancy of which is unaffected by small changes in the voltages of the power supplies, either H.T. or L.T. Oscillation can be maintained with a single coil, without tappings or a second coupling coil, an advantage which can be put to good use, as described later.

The resistors in the anode and screen circuits are equal but, due to the lower screen current, the screen potential is higher than that of the anode. The suppressor grid is coupled to the screen grid through condenser C2. The remaining electrodes



do not carry radio frequency potentials — the cathode and grid are directly earthed whilst the anode is effectively earthed through the by-pass condenser C1.

The valve used in a transitron circuit must possess a high mutual conductance and must have the suppressor grid brought out to a separate pin. The Mullard EF50 valve has therefore been chosen but the Mazda SP41 (4 volt heater) should prove equally suitable.

The use of Eddystone plug-in coils enables a wide range of frequencies to be covered. These coils are manufactured to close tolerances and near agreement will be found with the figures for frequency coverage given, in an instrument built as described.

Two connections are brought out to stand off insulators for the purpose of testing other coils.

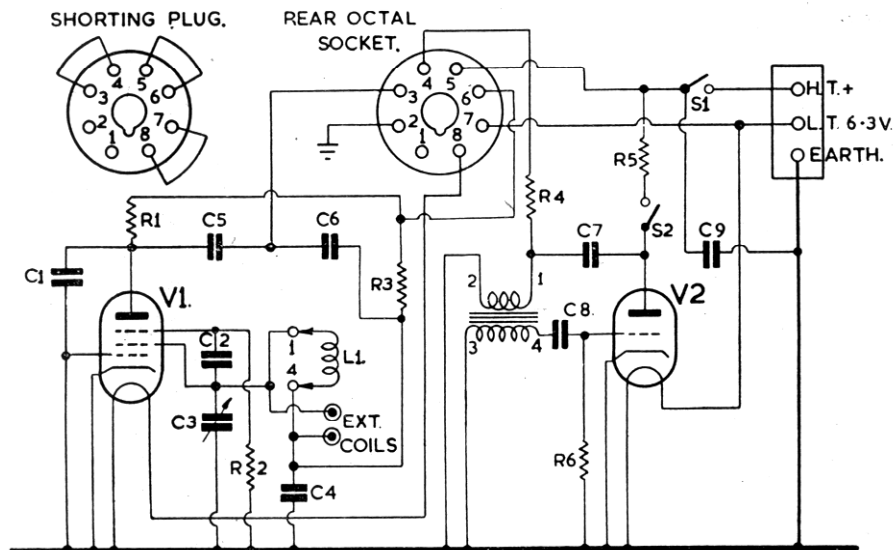


Fig. 1. Circuit diagram of the Main Unit.

The second valve is arranged as an audio frequency oscillator, with a parallel fed transformer, in a normal circuit. The transformer specified occupies little space and can be conveniently mounted beneath the chassis.

The modulating voltage must be applied simultaneously to the anode and screen of the EF50 and the network R4, C5 and C6 ensures that it is applied in the correct ratio.

Switch S1 breaks the H.T. supply but leaves the heaters on, so that the instrument is available for

immediate use when required. Switch S2 in the anode circuit of the second valve enables the modulation to be switched on or off at will.

An external power supply is required, but since the consumption is low—6.3 volts .6 amp. L.T., 200 volts 10 mA. H.T.—this can often be derived from other equipment.

**CIRCUIT OF V.H.F. UNIT.**

Many users will be interested also in the very high frequencies and the simple unit illustrated forms a valuable addition to the main instrument. For ease of operation, the V.H.F. unit plugs into a socket at the rear of the main unit. The R.F. oscillator valve in the latter is automatically cut out of circuit but the audio modulation remains available. The circuit of the subsidiary unit is given in Fig. 2. The valve is again an EF50 but a rather different

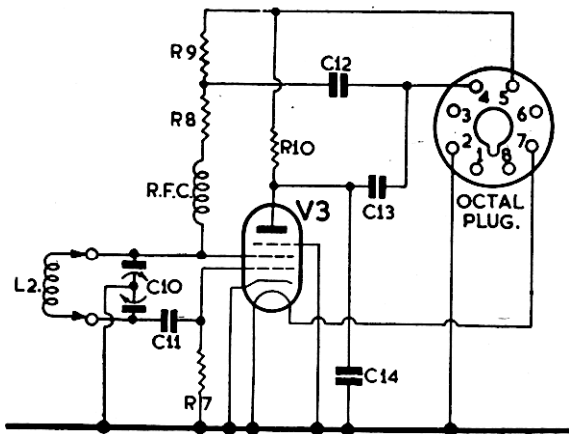


Fig. 2. Circuit diagram of the V.H.F. Unit.

type of circuit is employed. It is possible to use the transitron circuit at very high frequencies but it is not so reliable as the one shown, which oscillates smoothly over a range from 26 to 103 Mc/s., and even higher if required. The advantages of a single coil are retained, as before.

**CONSTRUCTION.**

The construction of both units is made very clear in the accompanying drawings and photographs. Full details are given of the chassis lay-out, bracket dimensions, etc., in Figs. 3 and 4. The condenser mounting brackets are identical to those used in the V.H.F. Receiver and details are given on page 13. The small insulators are used as lead throughs and are mounted from beneath the chassis, the metal parts being removed from those insulators which carry wires from the tuning condensers through the chassis.

The wiring should be made as short and direct as possible. In the point-to-point diagrams, Figs. 5 and 6, the wiring has been extended for the sake of clarity but in actual fact, it can be made much shorter.

The cabinet and chassis are held together by means of the fixing nuts on the switches. To ensure a good fit, the switch holes (1/8-inch diameter) should be made in the cabinet first and then holes to match made in the chassis. The switches are supplied with two nuts—the smaller ring type is used to fix the switch to the chassis, which is then locked to the cabinet with the larger nuts. A temporary short extension spindle fitted to the tuning condenser shaft will permit the hole for the slow motion drive to be located accurately on the front of the cabinet.

**FREQUENCY COVERAGE.**

The approximate frequency ranges to be expected from the specified coils are as follows:—

6 LB ..	28 to 13 Mc/s.
6 Y ..	15 to 7.5 Mc/s.
6 R ..	8 to 4 Mc/s.
6 W ..	4 to 2 Mc/s.
6 P ..	2 to 1 Mc/s.

Broadcast frequencies may also be covered but if the instrument is regularly used on such frequencies, it will be advisable to fit a 160 pF Microdenser instead of the 100 pF specified.

The calibration of the meter is best carried out with the friendly aid of the owner of an accurately calibrated receiver. Failing this, signals from broadcast stations and amateurs, on known frequencies, must be relied on. The dial scale can be directly marked—preferably with black drawing ink—on the three ranges most frequently used.

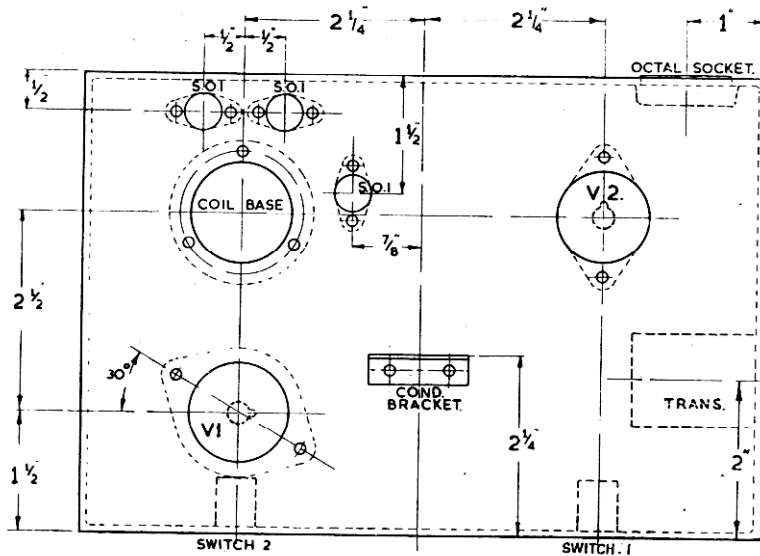


Fig. 3. Plan of Main Unit chassis lay-out.

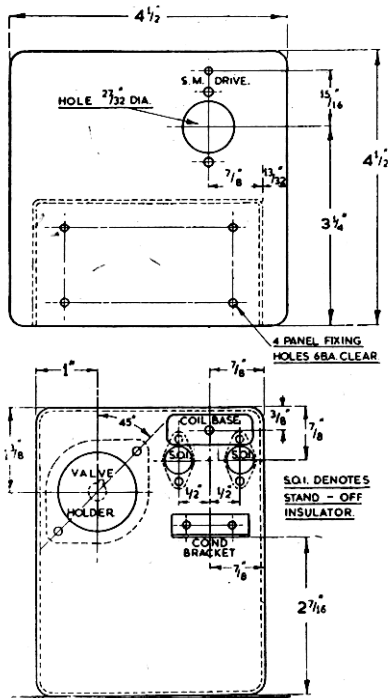


Fig. 4. Lay-out details of the V.H.F. Unit.

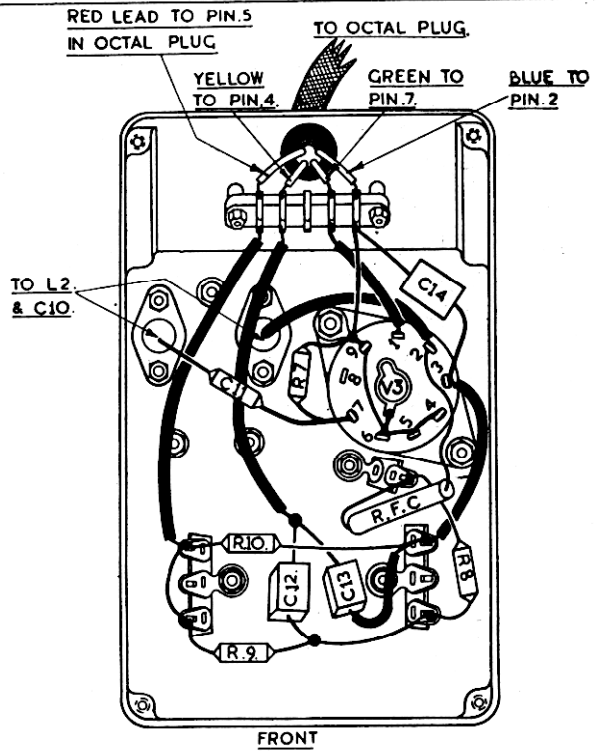


Fig. 5. Point-to-point wiring diagram of V.H.F. unit.

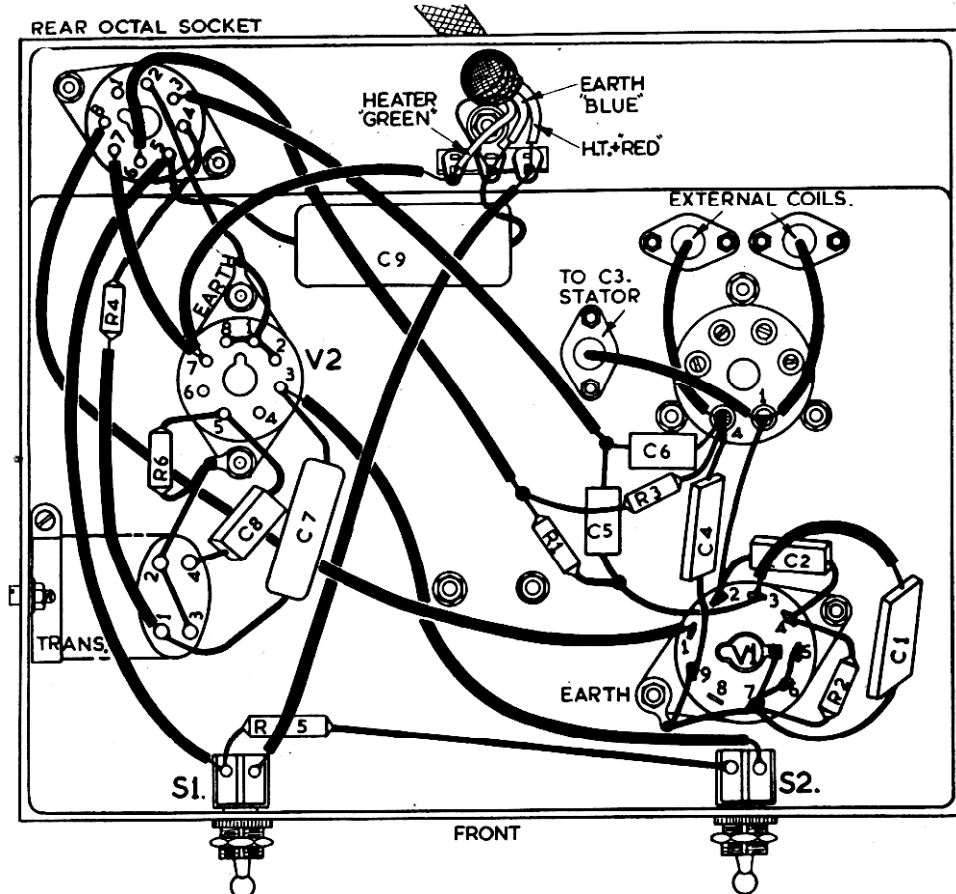


Fig. 6. Point-to-point wiring diagram of main Unit.



The frequency ranges of the V.H.F. unit with the five sizes of coil available are shown below :—

**Dial Reading.**

COIL.	0	50	100
*10 Turns	31	27.5	25.8
10 Turns	50	41	35.5
8 Turns	59	49	42
5 Turns	74	62	53.5
4 Turns	86	72	63
3 Turns	103	87.5	76

All readings are in megacycles, and are necessarily approximate. Coil marked\* has a 20 pF fixed condenser connected across its pins.

The 60 Mc/s. amateur band falls at about 60 degrees with a 5-turn coil, whilst the television frequencies should be found near 45 and 20 degrees (10-turn coil), vision and sound respectively. Due to minor differences in construction, the figures given above should be treated only as a guide. It is suggested that a graph be drawn for each coil, for future reference when measuring unknown frequencies.

**APPLICATIONS OF THE FREQUENCY METER.**

The normal function of the meter will be to provide a signal of known frequency, modulated or otherwise, for the purpose of checking, aligning or adjusting a receiver. For such a purpose the meter renders the user independent of signals from outside sources and further enables one to judge more accurately whether or not an actual improvement results from any particular adjustment. If the pick-up from the meter is not sufficient, a short lead (not more than a foot or so) may be attached to the inner stand-off insulator.

To check the frequency of any type of oscillator, the signal emitted by the latter must first be tuned in on a receiver. The meter is then switched on and adjusted until the beat note from it is audible at the same receiver dial reading, taking care that it is the fundamental of the meter and not a harmonic. The meter may also be used as an absorption wave-meter, for which purpose no connection need be made to any power supplies. Coupling to the coil may conveniently be done with the aid of a link,

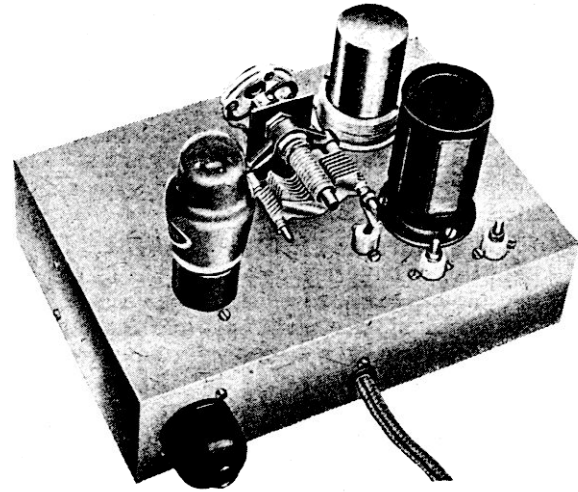


Fig. 7. Top view of Main Unit removed from cabinet.

consisting of a pair of twisted wires terminating in loops of a few turns. The loops should be of a size that one drops over the coil in the meter and the other fits over the coil in the oscillator, the frequency of which is to be measured. Adjustment of the link may be called for and the resonance indication will be given in the usual way by a variation in the anode current of the oscillator or by a violent change in frequency.

A further purpose to which the meter may be put is that of matching or testing coils. In the latter case, the coil under test should be connected to the two insulators, the plug-in coil being removed. At a given meter dial reading, the signal generated by the meter is tuned in on a receiver. The coil is then removed and changes of plug-in coils and condenser tuning made until the original frequency is again arrived at, as made evident by the signal being audible at the unchanged receiver setting. The frequency being known approximately, the inductance of the coil and its total frequency coverage with a given capacitance may now be calculated.

To match up two (or more) coils, one is placed across the test terminals, the meter dial set to 50 degrees and the resulting signal tuned in on a receiver. The other coil is then substituted and rotation of the meter dial will indicate whether more or less capacitance is required to bring the second coil into resonance with the original frequency. By adding or subtracting turns, it will be possible to match up the coils sufficiently accurately to enable them to be used in ganged circuits.

**LIST OF COMPONENTS.**

<b>EDDYSTONE.</b>	
1 Chassis	Cat. No. 643
1 Metal Cabinet	644
1 Diecast Box	650
1 Microdenser, 100 pF (C3)	1130
1 A.D.T. Condenser, Split Stator, 25 x 25 pF (C10)	583
1 Full Vision Dial	598
1 Slow Motion Drive, 2" Black	597
Coils, type 6LB, 6R, 6Y, etc. (see text)	959
1 R.F. Choke, V.H.F. type	1011
1 Flexible Coupler, Large (Main Unit)	50
1 Flexible Coupler, Medium (V.H.F. Unit)	529
5 Miniature Insulators	1019

1 V.H.F. Coil Base	Cat. No. 606
V.H.F. Coils (see text) (L2)	601/605
<b>MISCELLANEOUS</b>	
2 Octal Valveholders, Bakelite.	
2 B9G Valveholders, Type L500/C Belling-Lee	
2 Locking Rings and Retainers for above, Type L568	Belling-Lee
2 Octal Plugs, Type P112.	
2 Valves, Type EF50	Mullard
1 Valve, Type L63	Osram
2 Switches, Toggle S.P.S.T., Type S280.	
1 A.F. Transformer, Hyperloy Type 209.	
<b>RESISTORS.</b>	
2, ½ watt, 10,000 ohm (R4, 10).	

2 ½ watt, 20,000 ohm (R1, 3).
4 ½ watt, 47,000 ohm (R2, 6, 7, 9).
1 ½ watt, 100,000 ohm (R5).
1 ½ watt, 470 ohm (R8).
<b>CONDENSERS.</b>
1 Moulded Mica, .0005 mF (C5).
2 Moulded Mica, .001 mF (C1, 8).
3 Moulded Mica, .002 mF (C6, 12, 13).
1 Moulded Mica, .01 mF (C4).
1 Ceramic Cartridge, 40 pF (C11).
2 Ceramic Cup, 200 pF (C2, 14).
1 Tubular Paper, .1 mF (C7).
1 Tubular Paper, .5 mF (C9).

## Aerial Systems

The subject of aerials for use with the equipment described has been passed over briefly, the reason being that it calls for specialised treatment. The following hints may, however, prove of some assistance in securing maximum results.

### LOW IMPEDANCE FEEDER CABLE.

The use of low impedance (70 ohms) coaxial feeder cable has many advantages. Good matching easily arranged at each end; low losses at all frequencies; undesirable radiation and coupling effects minimised — are a few.

One of the simplest and also most effective types of aerial for high frequency work is the half-wave dipole, or doublet, as it is also known. Each arm should be made forty-six inches long for 60 Mc/s. and 8½ feet for 28 Mc/s., with longer lengths in proportion for the other bands. Adjustments to the length are desirable for spot frequency use.

For very high frequencies, the arms should be of copper or dural tubing — below 28 Mc/s., fairly thick copper wire is adequate. The feeder is connected directly at the centre of the dipole, one side to each arm, a small insulator being used for mechanical support.

The impedance at the centre of a half-wave dipole is about 80 ohms and a 70 ohm feeder therefore forms a good match. A twin balanced cable may be used in lieu of coaxial — theoretically, it should be better but, in actual practice, the difference is negligible.

The dipole may be erected either vertical or horizontal — in the former case, radiation will be omni-directional and, in the latter, directional in a plane at right angles to the length of the aerial. Horizontal polarisation is to be preferred, as it generally results in a lower angle of radiation, which is an advantage for long distance communication.

The directivity can be increased by adding director and reflector elements, respectively in front of and behind the radiating element. The director should be 5 to 10 per cent shorter than the radiator and the reflector a similar amount longer. The spacing between the elements should approximate to a quarter wavelength (4 feet for 60 Mc/s. and 8 feet for 28 Mc/s.) but adjustment of the actual spacing is necessary to secure optimum forward radiation.

The effect of adding these extra elements is to reduce the impedance at the centre of the aerial but not sufficiently seriously to affect the matching. Closed spaced arrays, having four or five elements, are also popular, but the working impedance at the centre is then much reduced and special matching arrangements become necessary.

A beam aerial can make a big improvement in results, particularly when the location is not good.

### AERIAL CHANGE OVER METHODS.

At the equipment end, the difficulty arises of changing over the feeder cable termination from transmitter to receiver — to do so by manually

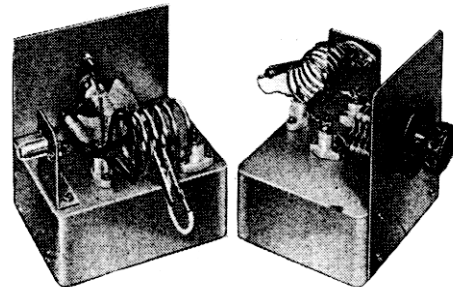
transferring the terminating plug from one end to the other is a somewhat clumsy process which, incidentally, will not do the plug or feeder end any good. It is therefore advocated that a change over relay system be constructed — the Eddystone Cat. No. 650 box is very suitable for the purpose. The choice of a relay must be left to the constructor — types are available for either 2 or 6 volt operation. Three sockets will be required, one for the feeder cable and two for short lengths of cable connected to the transmitter and to the receiver. A three-way lead is brought out and connected via a battery to a change over switch. If the latter is of the double pole type, one pole can be utilised to switch the transmitter on and off, thereby making a complete change over in one operation. Incidentally, the Cat. No. 650 box is ideal for the purpose of mounting a number of switches for the control of various circuits.

### LONG WIRE AERIALS.

Unquestionably, good results can be secured on long wire aerials providing consideration is given to the siting and matching requirements. Such aerials will normally have a vertical component and radiation therefrom will be omni-directional. Radiation from the horizontal portion is likely to be directional in four major lobes, the exact angles of which will depend on the number of half wavelengths incorporated. For example, if the horizontal portion of the aerial approximates to 33 feet (four half waves at 60 Mc/s.) maximum radiation will occur (at 60 Mc/s.) at angles of 37 degrees. If possible, therefore, the run of the aerial should be arranged so that radiation from the four lobes occurs in directions in which it is desired to establish communication.

Suitable aerial coupling units, for use with long wire aerials, are illustrated in the accompanying photograph. They are built upon Eddystone Cat. No. 650 diecast boxes, used as miniature chassis. Construction of both units is similar. In one, designed for the 28 to 30 megacycle band, a 40 pF Microdenser is employed, the vane spacing being adequate for powers in excess of 100 watts. The coil, which consists of six turns of 10 S.W.G. copper wire, 1½" external diameter, spaced to occupy 1½", is mounted on two midget insulators (Cat. No. 1019).

*Continued on page 9*



### COMPILER'S NOTE.

*All the equipment described in this Manual has been subjected to thorough tests before inclusion, with satisfactory results. Much as we desire that it should give equal satisfaction to all who make use of the articles, we are unable to enter into long correspondence concerning difficulties which may arise through faulty construction or the substitution of different components.*

*With the assurance that, if built exactly to instructions, the equipment is capable of excellent results, we request that constructors who may have initial troubles should check their apparatus carefully before writing to us. Finding out the cause of one's own troubles is, moreover, not only a reason for self-satisfaction but is highly instructive.*

*STRATTON & CO. LTD.*

*BIRMINGHAM, 31*



*Short Wave Specialists  
since 1924*