TECHNICAL MANUAL

For

PORTABLE TRANSMITTER - RECEIVER Type HF 156 Mk.2

CODE NO TP 35
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BRITISH COMMUNICATIONS CORPORATION LIMITED

HIGH WYCOMBE BUCKINGHAMSHIRE ENGLAND

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ILLUSTRATIONS

Section 1

STATION LIST

Portable H.F. Transmitter-Receiver Type H.F.156
comprises the following items

	Code No.
TRANSMITTER-RECEIVER, complete in case with:-	
1 Aerial tuning unit 2 Accumulators Type ZVP19 1 Connecting lead for accumulators 1 Transistorised Power Supply Unit	6642-110/C
OR:-	
1 Aerial tuning unit 1 Plug/Relay Unit for dry battery operation (English version) (Malayan version)	 6642-110/E 6642-110/J
CARRYING BAG	6642-272
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Section 2

INTRODUCTION

The B.C.C. PORTABLE TRANSMITTER-RECEIVER TYPE H.F.156 Mk.11 is a low-power, crystal-controlled set capable of operation on any one of six spot frequencies within the 2.5 - 7.5 Mc/s band. The provision of six channels enables suitable frequencies to be used which will permit communication over long distances throughout the 24 hours.The set is equipped for either telephony or telegraphy operation, and is entirely self-contained, being powered by two rechargeable accumulators or alternatively a multi-voltage dry battery.

This transmitter-receiver is primarily intended for use by groups or individuals stationed in isolated posts or travelling through difficult terrain and where all kinds of climatic conditions are likely to be encountered. The weight has therefore been kept to a minimum while maintaining adequate mechanical strength to withstand rough treatment, and the whole equipment comprising the transmitter-receiver and the accessories is contained in two canvas bags which can be carried by one man. The second and smaller of these bags contains only the dipole and quarter-wave aerials and it can therefore be discarded whenever operational requirements are satisfied by the use of the rod aerial.

For distant communication the transmitter-receiver should be operated from a fixed position,using a properly-erected aerial such as the dipole or the quarter-wave aerial supplied with the equipment.

A rod aerial is also included and this is suitable for short-range communication; furthermore, it enables local contacts to be maintained by radio telephony while on the move with the equipment being carried in the normal manner, if so desired.

Section 3

GENERAL DESCRIPTION

THE TRANSMITTER-RECEIVER TYPE H.F.156 Mk.11 is contained in a lightweight, water-proof metal case. The upper half of the case is occupied by the transmitter-receiver unit, the control panel of which forms the top to the whole assembly.

Mounted on this panel are the aerial and earth terminals, channel switch, b.f.o. control, system switch, gain control, meter and two 6-way sockets. Secured by means of a chain to the top of the case is a protective cap for fitting over either of the two sockets when only one is in use.

The lower half of the case is occupied by the power supply unit and the two accumulators, all mounted together on a metal tray which forms the bottom of the case. This tray is secured to the body of the case by a pair of eye bolts and wing nuts.

Attached to one side of the case is the rod aerial tuning unit.

The set is supplied with a strong canvas bag. This bag has adjustable shoulder-straps and is padded at the back for comfortable fitting and to cushion the impact of the equipment while on the move. At the top of the bag is a flap giving access to the control panel; it is not necessary, therefore, to remove the set during normal operation, but only when changing accumulators, or for other maintenance purposes. A pocket is provided at the rear of the bag for storage of accessories and another pocket at one side of the bag houses the rod aerial.

The dipole aerial and quarter-wave aerial are housed in a separate carrying bag which is suitable for attachment to standard service webbing equipment.

The following accessories are provided:-

Telephone Headset Assembly	A pair of headphones with shrouded earpieces, a boom-mounted carbon microphone, and a connecting cable with a junction box and a 6-way plug for connection to the transmitter-receiver. The junction box incorporates a send/receive switch and has a clip for making attachment to the user's clothing.
Telephone Handset	A lightweight assembly incorporating an earpiece, a carbon microphone inset and a send/receive switch. Attached to the handset is a connecting cable with a 6-way plug.
Morse Key	An enclosed-type key with a knee-strap and a connecting cable with a 6-way plug.

Dipole Aerial	Complete on a winder with a 24-ft. length of coaxial cable, polythene-covered aerial wire, nylon-cord halyards and insulators. Both lengths of aerial wire are divided into six sections any number of which can be connected together by plug and socket links to provide the required overall length to correspond with the frequency in use.
Quarter-Wave Aerial	Two quarter-wave lengths of wire on a winder; one length of wire equipped with a nylon-cord halyard and insulator is used as the aerial, while the other length of wire is used as a counterpoise. The aerial wire is divided into six sections and equipped with links as in the case of the dipole.
Rod Aerial	Eight sections of copper tubing threaded on a steel wire; also, one flexible coupling tube. The length of the rod aerial when erected is 8 feet 9 inches.

Section 4

PREPARING FOR USE

4.1 ACCUMULATORS

The accumulators (cells) used with this equipment require careful treatment before being put into service and must be charged in accordance with the manufacturers' instructions which are written on the side of each accumulator.

Installing into Set

Slacken the two wing nuts one at either side of the bottom edge of the case and lift the case away from the bottom panel.

Place the two fully-charged accumulators in position on the bottom panel as shown in Figure 3. It will be necessary to slacken off the wing nuts on the vertical posts and swing the retaining plate around in order to provide clearance for the accumulators as these are fitted into position. Place the retaining plate over both accumulators as shown in Figure 3 and tighten the wing nuts securly.

Connect the red lead from the power supply unit to the positive (+) terminal of the accumulator nearest to the power supply unit and connect the black lead to the negative (−) terminal of the other accumulator. Connect together the remaining two terminals using the lead provided.

Check that the cable from the case is securely plugged in the 12-way socket at the side of the power supply unit and that the spring retainer is clipped over the plug cover. Lower the case down over the power supply unit and accumulators and then secure the bottom panel by means of the two eye bolts and wing nuts.

The bottom panel must be fitted so that the power supply unit is nearest the left-hand side of the case, i.e., the side to which the aerial tuning unit is attached.

NOTE: Both the case and the bottom panel incorporate projecting lugs which prevent the bottom panel being fitted the wrong way round.

4.2 DRY BATTERY VERSION

The dry batteries supplied are ready for immediate use. A special plug unit containing a relay is used to make connection to the set.

Installing into Set

Slacken the two wing nuts one at either side of the bottom edge of the case and lift the case away from the bottom panel.

Insert the plug/relay unit into the group of sockets on top of the battery. Slacken off the wing nuts on the vertical posts and remove the retaining plate, then lay the battery on its side on the bottom panel, ensuring that the 12-way socket on the plug/relay unit is uppermost as shown in Figure 2. Replace the retaining plate and tighten the wing nuts securely.

Plug the cable from the case into the 12-way socket on the plug/relay unit and clip the spring retainer over the plug cover. Lower the case down over the battery and secure the bottom panel by means of the two eye bolts and wing nuts.

Both the case and bottom panel incorporate projecting lugs which prevent the bottom panel being fitted the wrong way round.

4.3 AERIAL TUNING UNIT

Correct positioning of the aerial tuning unit is most important for efficient operation with the rod aerial.

The aerial tuning unit is secured to the side of the transmitter-receiver by two brackets, and the bottom edge of the tube should be flush with the bottom edge of the lower bracket.

If this is not so, the four screws (two on each bracket) should be slackened off and the aerial tuning unit moved up or down as necessary. Retighten the four screws. Once correctly positioned no further re-adjustment is required.

Section 5
OPERATION

5.1 METER

The meter mounted on the control panel (Figure 10) is permanently connected to read the voltage of the supply accumulators during the whole time these are fitted in the set. The condition of the accumulators can therefore be ascertained at any time whether the equipment is operating or not. Negligible current is consumed by the meter. Identical conditions hold when dry batteries are fitted.

The meter readings should always be checked when the transmitter-receiver is brought into service after an interval of non-use. During use, frequent checks of the meter reading should be made. Detailed instructions concerning the use of the meter and interpretation of the readings obtained are given below.

Checking Procedure

(1) When the system switch is set to "OFF", "R", "S" or "RT" the meter will indicate the voltage of the accumulators and this can be read directly from the meter scale which is calibrated from 0 volts to 6 volts. From 3.4 volts to 5 volts the scale is marked in green and this signifies the range of supply voltages which can be considered satisfactory and which will provide normal performance from the equipment.

(2) In the RT position with the headset or handset switch pressed the meter shows the voltage under fully-loaded conditions.

(3) The reading obtained in the RT position with the send/receive switch closed will always be lower than that obtained when the system switch is in the OFF position, and the difference between these two readings will provide a good indication of the state of charge of the accumulators. The smaller the difference in readings the longer the life that can be expected from the accumulators.

(4) Always check the accumulator voltage in the RT position with the headset or handset switch closed. If the meter reading falls below 3.4V (below the green portion of the scale) the accumulators must be recharged or replacements fitted (refer to Section 7).

(5) When the system switch is set to the Tune AE position the meter gives an indication of the aerial current and is used for tuning the aerial tuning unit when the rod aerial is fitted.

(6) The Tune AE position should only be used for this particular purpose (paragraph 5) and the system switch must not be left set to Tune AE after this adjustment has been performed, but must always be reset to one of the other four positions.

5.2 FREQUENCIES

Six frequencies are provided to enable long-distance communication to be maintained throughout the 24 hours, the higher frequencies (channels 4, 5 and 6) generally being used for daytime working and the lower frequencies (channels 1, 2 and 3) during the night. The lower frequencies may also often be suitable for short-distance working in the daytime.

Changeover of channels is normally made during the periods following sunrise or sunset, the most favourable time being determined by the circumstances prevailing over the transmission path such as season and latitude, and is subject to further modification due to any abnormal disturbances occurring in the ionosphere at the time.

With the approach of daybreak or nightfall, the deterioration of conditions on one channel may be either gradual or rapid whereas the rate of improvement in conditions on the alternative channel may not be the same. Consequently, at any instant during these unsettled conditions the best channel for communication between two particular points can be ascertained only by trial.

Table 1 shows the frequency coverage of the set.

TABLE 1

Channel	Frequency kc/s
1	2500 - 3700
2	2700 - 4300
3	2700 - 4300
4	4300 - 6000
5	4700 - 7500
6	4700 - 7500

Six fixed frequencies, one for each channel can be allocated within the frequency coverage shown in Table 1, according to customers requirements.

5.3 AERIALS - GENERAL

It should be appreciated that the results obtained from any h.f. radio equipment depend largely upon the type of aerial used and its location.

As a portable transmitter-receiver is likely to be employed under conditions where the choice of an operating site will be determined by general convenience rather than suitability from the radio-wave propagation point of view, the erection of an efficient aerial becomes of especial importance with equipment of this type.

While a haphazardly-erected wire may in some cases prove adequate for communication over short distances,it is likely to be useless for long-distance working; in any case the full capabilities of the set will not be realised.

Of equal importance is the length of the radiating portion of the aerial system and maximum efficiency in reception and transmission is obtained when this is related to the frequency used. Full details are given in the following sections of the method to be used for adjusting the length of the dipole and the quarter-wave aerials to suit all channel frequencies.

Although it is recommended that the aerial length should always be correctly adjusted when changing frequency channels,there may be occasions when working over short distances where the inconvenience of lowering and the re-erecting of the aerial is hardly justified as the results obtained from the unaltered aerial may be quite satisfactory. Operating with an aerial of incorrect length should be considered exceptional practice, however, and adopted only for so long as it provides trouble-free communication.

Detailed instructions appertaining to the three different aerial systems are given below, and should be carefully followed.

5.4 DIPOLE

This is the most efficient of the three aerial systems provided and should always be used where circumstances permit, and most particularly where long-range communication is required.

Adjustment of Length

The two halves of the dipole aerial each consist of six sections, each of a length determined by allocation of the 6 channel frequencies. These sections are separated by rubber insulators and links are provided to enable any adjoining sections to be connected together, thus the required length for any particular channel is obtained by utilising one or more sections of wire. The number of sections which must be connected together in each arm of the dipole for any one of the six channels can be obtained from Table 2, Page 51. Refer also to Figure 5 and Figure 8.

The sections are numbered from the centre insulator (coaxial feeder cable connection) outwards on both arms.

Having determined the number of sections required, the appropriate sections should be joined by fitting together the plug and socket connectors at adjoining ends of the sections, so linking (or bridging) across the separating insulator in each case.

All links on the unwanted sections must be disconnected and the plug and socket connectors must hang free and apart from one another. Refer to Figure 8.

Example On channel 4 the first three sections in each arm of the dipole are required.

Proceed as follows:- Join links between sections 1 and 2 and between sections 2 and 3. All other links must be disconnected.

Erection of Aerial

Suspend the aerial horizontally and in as straight a line as possible broadside to the direction in which it is intended to communicate. For this purpose choose trees or other convenient objects which are sufficiently far apart to allow the full length of the halyards to be utilised, if possible, and thus provide the maximum distance between the ends of the aerial wire and the supporting objects.The wire should be well clear of overhanging branches and foliage and as high above the ground as can be arranged, within the limit imposed by the length of the feeder cable. Thus, with the set positioned immediately beneath the centre of the aerial, the maximum height possible will be 24 ft.

If, however, circumstances compel the aerial to be erected in line with the direction of communication, it should in this case be sloped with the end nearest the required direction about half the height from the ground than the other. This will improve the end-fire radiation in the forward direction, i.e., from the low end. See Figure 4 inset.

Bring the coaxial feeder cable straight down from the centre of the aerial so that the first 5 to 6 feet,at least,are at right angles to the aerial wire,and connect the inner conductor to the insulated aerial terminal and the outer screening to the earth terminal on the control panel of the set.

5.5 QUARTER-WAVE AERIAL WITH COUNTERPOISE

This aerial is intended mainly for short-distance communication and as it occupies less space than the dipole and requires only one elevated fixing point its erection will generally be more easily and speedily accomplished than that of the dipole.These features will probably make it the ideal choice for short-range working providing the location does not present any abnormally difficult propagation characteristics.

Adjustment of Length

The aerial consists of two lengths of wire;one length of wire is continuous and is used as a counterpoise. The other length of wire is divided into six sections by rubber insulators and is the actual aerial wire. Links are provided enabling any adjoining sections to be connected together.

By utilising one or more sections the required length for any particular channel can be obtained.

The number of sections which must be connected together for any one of the six channels can be obtained from Table 2, Page 51. Refer also to Figure 7 and Figure 8.

The sections are numbered from the connecting-tag end outwards towards the halyard.

Having determined the number of sections required, the appropriate sections should be joined by fitting together the plug and socket connectors at adjoining ends of the sections, so linking (or bridging) across the separating insulator in each case.

All links on the unwanted sections must be disconnected and the plug and socket connectors must hang free and apart from one another. Refer to Figure 8.

Example On Channel 4 the first three sections are required. Proceed as follows:- Join links between sections 1 and 2 and between sections 2 and 3. All other links must be disconnected.

No adjustment need be made to the counterpoise wire.

Erection of Aerial

Secure the aerial by means of the halyard to as high a point above the ground as possible and connect the other end to the insulated aerial terminal on the control panel of the set.The set should be so placed that the wire descends almost vertically or at the greatest possible angle to the ground.

Attach the second length of wire (the "counterpoise") to the earth terminal on the set and stretch it out in a straight line along the ground, beneath the aerial wire and following roughly the same direction. See Figure 6.

Changes in the disposition of the counterpoise wire can sometimes considerably effect the performance of the whole aerial system,therefore it may be worthwhile to try it in different positions.Also, instead of placing it directly on the ground, the counterpoise may give better results if fixed 1 to 2 feet above the ground. See Figure 6 inset.

The quarter-wave aerial relies upon good ground conductivity for efficient working, consequently best results will be obtained from locations where the soil is moist.River banks or lakeside sites are particularly suitable for this reason; rocky and dry, sandy districts will have poor conductivity.

5.6 ROD AERIAL

The rod aerial is suitable for local communication only. It is used in conjunction with an aerial tuning unit. See Figure 11.

With the rod in position the set becomes a completely self-contained portable station which can be used for telephony operation while being carried on the back in the normal manner, control being effected by the send/receive switch on the headset junction box or on the handset. See Figure 9.

When used at a fixed location - for either telegraphy or telephony operation - an improvement in radiation and a consequent increase in the operating range is likely to be obtained by connecting the counterpoise wire (see "Quarter-Wave Aerial") to the earth terminal of the set.

Connecting Up

Connect the flying lead from the aerial tuning unit to the aerial terminal on the control panel.

Remove the rod aerial from its pocket, open out and erect by fitting the eight sections together. Commence with the largest diameter sections and work towards the top, keeping the wire taut throughout by pulling it out through the end section.

Fit the flexible coupling into the socket at the top of the aerial loading unit and secure it by means of the wing nut.

Fit the larger end of the rod into the top of the flexible coupling.

Tuning

Tune the aerial tuning unit as follows:-

NOTE: Where possible this adjustment should be performed with the set in the intended operating position, i.e., either fastened onto the operator's back or placed on the ground, as the correct setting is likely to be somewhat different for each case due to the ground or self-capacity effect. It will be advisable to recheck the tuning if the environment has changed.

(1) Set the channel switch to the required frequency.

(2) Plug the headset or the handset into one of the 6-way sockets on the control panel.

(3) Set the system switch to the tune AE position and rotate the tuning control at the base of the aerial tuning unit until maximum deflection on the meter is observed. The aerial tuning unit is now correctly tuned for the channel selected.

(4) Set the system switch to the OFF position.

NOTE: Never leave the system switch in the Tune AE position once this adjustment has been completed, but reset it immediately to any other position.

The aerial loading unit must always be returned when changing to another channel.

The correct setting for each channel should be noted by reference to the calibrated scale at the side of the aerial tuning unit and this will simplify subsequent retuning.

When the rod aerial is not being used the flying lead from the aerial tuning unit must be disconnected from the aerial terminal on the control panel.The lead can be fastened by means of the wing nut at the top of the aerial tuning unit.

5.7 TELEPHONE HEADSET ASSEMBLY

The telephone headset is the standard equipment worn by the carrier-operator, and once correctly adjusted and fitted requires no further handling or attention. The wearer's hands are entirely free and his movement unrestricted. See Figure 9 A and B.

The headset should be worn with the boom microphone to the left side of the face. The head strap can be adjusted in length to suit the wearer. By slackening the knurled ring on the left-hand earpiece the microphone boom can be slid out or back and also rotated a few degrees upwards or downwards. After adjusting the boom so that the microphone is directly in front of the mouth retighten the knurled screw.

The junction box should be secured to the chest of the operator by attaching the clip to the clothing or to equipment harness.

5.8 TELEPHONE HANDSET

The telephone handset can be used either in addition to, or instead of, the headset during telephony operation. When connected to the transmitter-receiver the send/receive switch in the handle of the handset functions in exactly the same way as the switch on the junction box of the headset assembly. See Figure 9C.

A second person can, by plugging in the telephone handset, listen-in to the signals being received and operate the transmitter-receiver at any time without otherwise disturbing the regular operator or his equipment. This does not apply to telegraphy (C.W.) operation.

5.9 OPERATING PROCEDURE

Telephony (R.T.)

(1) Plug the telephone headset into one of the two 6-way sockets on the control panel. See Figure 10. Either socket may be used.

(2) If required, plug the telephone handset into the other 6-way socket. The handset itself should always be stored in the back pocket of the carrying bag until actually required. It must not be allowed to hang free.

(3) Where only one socket is in use the protective cap should be fitted over the vacant socket and screwed down securely.

(4) Set the channel switch to the required frequency (refer to Section 5.2).

(5) When using the rod aerial, set the system switch to "T.AE" and tune according to the instructions in Section 5.6.

(6) Set the system switch to "R.T.".

The receiver is now operative and signals received will be heard in the headphones.

(7) Adjust the gain control until a satisfactory output level is obtained in the headphones. Maximum volume is obtained when the gain control is turned fully clockwise.

(8) To transmit, press the switch on the junction box and hold it in this position while speaking into the microphone. If using the telephone handset, press the switch in the handle of this instrument and hold in this position while speaking into the microphone.

(9) To ensure transmission of an audible and clearly understood message the following points should be observed:-

(i) Speak directly into the microphone
(ii) Speak slowly and distinctly
(iii) Speak at normal conversational level

(10) When finished release the send/receive switch and the receiver will become operative again.

Telegraphy (C.W.)

(1) Plug the telephone headset into one of the two 6-way sockets on the control panel. See Figure 10. Either socket may be used.

(2) Plug the morse key into the other 6-way socket. The key can be secured to the knee by means of the strap provided. Set the channel switch to the required frequency (refer to Section 5.2).

(3) When using the rod aerial, set the system switch to "T.AE" and tune according to the instructions in Section 5.6.

(4) Set the system switch to "R" - (receive).

The receiver is now operative and signals received will be heard in the headphones.

(5) Adjust the gain control until a satisfactory output level is obtained in the headphones. Maximum volume is obtained when the gain control is turned fully clockwise.

(6) Adjust the B.F.O. control for the preferred signal pitch. This control is also useful for separating the required signals from interfering transmissions.

(7) To transmit, set the system switch to "S" - (send), and commence keying.

(8) At conclusion of each transmission reset the system switch to "R" and the receiver will become operative again.

Switching Off

Set the system switch to OFF.

IMPORTANT: The set should always be switched off immediately operations are finished,in order to conserve power supplies.

Section 6

SIMPLE FAULT FINDING

(a) If the meter shows no deflection when the system switch is in the OFF position the set may have the following faults:-

(1) Accumulators or battery discharged
(2) Fuse blown
(3) Connections between the power supply and set not properly made.

If the meter shows only a small deflection, below the green portion of the scale, the accumulators require recharging, or the battery replacing.

(b) With the S.U.T. (Supply Unit Transistorised) and accumulators in use, and the system switch is set to any position other than "OFF" or "S" a faint "buzz" should be heard from the power supply unit. This sound denotes that the S.U.T. is functioning and also that the accumulator connections are correct; it does not denote, however, that the accumulator voltage is necessarily up to standard.

If no "buzz" is heard but the meter shows the proper deflection the S.U.T. is probably faulty or needs adjustment. (See Page 39).

(c) Make sure that the external connections to the headset, handset or morse key are securely made at the sockets on the control panel.

Try, in turn, both the headset switch and the handset switch with the transmitter-receiver set to "RT".

(d) To check whether the transmitter is functioning fit the rod aerial and set the system switch to Tune AE.

With the channel switch set to each position in turn, adjust the aerial tuning unit for the correct scale reading (as previously determined and recorded). Carefully readjust for maximum reading in the meter; this indicates the accurate tuning point. Any movement of the tuning control knob, either clockwise or anti-clockwise, should cause the meter reading to decrease.If,however,the reading remains steady throughout the whole range of the tunin g scale, a failure in the transmitter circuits is likely and the equipment must be returned to a maintenance base for attention.

Section 7

TECHNICAL DATA

B.C.C. policy is one of continuous progress and the right to change the specification without prior notice is reserved.

General

System:	Telephony (R.T.) or Telegraphy (C.W.).
Application:	Single-frequency simplex.
Frequency Range:	2500-7500 kc/s
Frequency Channels:	Six
Frequency Tolerance:	0.01% within the temperature range $-20^{o}+70^{o}$C.
Aerial Input Impedance;	45 to 72 ohms

Transmitter

Power Output:	1.1 to 2.5 watts on C.W.) depending 0.9 to 1.5 watts on R.T.) on frequency
Crystal Frequency:	Same as signal frequency
Modulation Capability:	Not less than 85%
Modulator Response:	Within 6 dB from 300 to 3,000 c/s.

Receiver

Sensitivity:	2 to 6 μV (e.m.f.) for a 12 dB signal-to-noise ratio for a signal modulated 30% at 1,000 c/s, or for a 20 dB ratio on C.W.
Crystal Frequency:	(Signal frequency - 465 kc/s).
I.F.:	465 kc/s
Selectivity:	6 dB bandwidth is 6 kc/s wide. 20 dB bandwidth is 13 kc/s wide.

Image Attenuation:	24 dB to 60 dB depending on frequency
Maximum A.F.Output:	2 mW
Gain:	Not more than 12 μV (e.m.f.) for 0.1 mW output for a signal modulated 30% at 1000 c/s.
A.F. Response.	Within 9 dB between 300 c/s and 2000 c/s.
A.G.C.:	Audio power output does not vary by more than 13 dB for a 70 dB increase of input signal level relative to sensitivity signal.
B.F.O.:	Continuously-tuned by manual control.

Power Supply Unit Transistorised (S.U.T.)

Accumulators:	Two lead acid accumulators ZVP19, 2 volt 20 AH.	
L.T. Consumption:	R.T. (Receive	0.68A
	R.T. (Transmit, carrier only	4.0 A
	R.T. (with full mod.	4.6 A
	C.W. (Receive	0.68A
	C.W. (Transmit, key open	0.75A
	C.W. (key closed	3.4 A
	Tune AE	3.4 A
	OFF	380 μA

Dry Battery Power Supply

Battery:	One type G 1306	90/60/4½/20 volts

Valve Complement

	V1 CV448	Meter rectifier
	V2 DL93	Crystal oscillator
	V3 NT2	Voltage limiter
	V4 DL93)	Power amplifier
	V5 DL93)	
	V6 DF91	R.F.amplifier
	V7 DL93)	Modulator
	V9 DL93)	
	V8 DK92	Frequency changer
	V10 DF91)	I.F. amplifier
	V11 DF91)	
	V12 CV448	Noise limiter
	V13 DAF91	Detector and output
	V14 CV448	A.G.C.rectifier
	V15 DF91	B.F.oscillator
Transistors in S.U.T.	VT1 CC35)	Matched pair
	VT2 CC35)	

Physical

Dimensions of Units:	Height	Width	Depth/ Length
Transmitter-Receiver complete in case with accumulators or dry battery	17 in.* (43.18 cm)	15 in. (38.1 cm)	6 in. (15.24 cm)
Carrying Bag	15 1/2 in. (39.37 cm)	13 1/2 in. (34.3 cm)	10 in. (25.4 cm)
Telephone Headset	----	----	----
Telephone Handset	----	----	----
Flexible Coupling	----	----	10¾ in. (26 cm)
Aerial Carrying Bag	9 in. (22.9 cm)	10 1/2 in. (26.7 cm)	5 in. (12.7 cm)
Morse Key	----	----	----
Dipole Aerial	----	----	----
Quarter-Wave Aerial	----	----	----
S.U.T.	5 3/4"	3 3/4"	4 5/8"
Dry Battery	8 3/4"	4 1/8"	3 3/8"
Plug/relay Unit	2 1/4"	3 1/8"	4 1/4"

* including 2-in. projection of aerial loading unit.

Finish: Stove enamel, olive drab matt.

Section 8

CIRCUIT DESCRIPTION

8.1 TRANSMITTER

R.F. Stages

One of the six crystals XL1-XL6 is selected by the channel switch SA2F, SA3F and connected between grid and anode of the crystal oscillator V2.This valve is choke-capacity coupled to the parallel-connected power amplifiers V4, V5.

On channels 1 to 3 the power amplifier anode load consists of an r.f. transformer T1 which is tuned to resonance by C17, C16 or C15. On channels 4 to 6 the r.f. transformer T2 is used in conjunction with C14, C13 or C12. The r.f. transformers are selected by SA1F and the tuning capacitors by SA4F. The secondary of T1 or T2 is connected to the aerial terminal AE1 via SA1B.

Modulator

For telephony operation the carbon microphone is connected via SK2 or SK3, pins F and C, to the modulator input transformer T4 which drives the two push-pull valves V7 and V9. These valves operate in class AB1, a standing bias-voltage being applied to their control grids via the centre tap on the secondary of T4. A d.c. polarising voltage for the microphone is derived from the l.t. supply and is applied via the primary of T4 when the microphone switch is closed. The secondary of the modulator output transformer T3 carries the h.t. anode current for the power amplifier stages V4,V5, while one section of the primary winding carries their screen current, and so the r.f. carrier is modulated by the audio frequencies.

H.T. and H.T. and L.T. Supplies

The positive side of the h.t. supply is fed from PL1, pin 5, via RLA1 (when energised) to the transmitter valves.

The 2.8 volt (nominal) filaments of the modulator valves V7 and V9 are connected in parallel with one side earthed, and are fed from the l.t. positive supply via SB2F,R28, and SB3B whenthe system switch is in the "RT" position;in the "S" and "TUNE AE" positions a dummy load resistor R27 is connected in place of the filaments.

The 2.8 volt (nominal) filaments of V2, V4 and V5 are connected in parallel with one side earthed, and are fed from the l.t. positive supply via SB2F, R28 and SB3B when the system switch is in the "S", "R.T.", or "TUNE AE" position.

Side Tone

During R.T. operation, a fraction of the modulating signal from the secondary of the modulator input transformer T4 is fed via C60 to the primary of the audio output transformer T8 and thus is heard in the headphones or handset when transmitting.

8.2 RECEIVER

R.F. Stages

The input from the aerial is fed via the r.f. tuned circuit to the grid of the r.f.amplifier V6.

On channels 1 to 3 the r.f. input circuit consists of T1 tuned by C17, C16 or C15. On channels 4 to 6 the r.f. transformer T2 is employed and is tuned by C14, C13 or C12. The r.f. transformers are selected by SA4B and the tuning capacitors by SA4F.

NOTE: These circuits are common to both transmitter and receiver and tuning is performed in the transmit condition.

The anode of V6 is tuned; on channels 1 to 3 the circuit consists of L3 tuned by C25, C24, or C23; on channels 4 to 6 L2 is tuned by C22, C21 or C20. The coils are selected by SA7B and the capacitors by SA7F.

Frequency Changer

The signal at the anode of V6 is applied to the third grid of the frequency changer V8 via R8 and C29; R8 is, however, shorted out of circuit on channels 4, 5 and 6 by SA7B. The first and second grids of V8 act as grid and anode respectively of the local oscillator which is crystal-controlled.One of the six crystals (XL7-XL12) is selected by the channel switch SA5F, SA6F. On channels 1, 2 and 3 an additional capacitor C36 is connected across C32 by SA6B. The oscillator frequency is 465 kc/s below that of the incoming signal. The two frequencies are mixed in V8,the anode of which is tuned to 465 kc/s by the i.f.transformer T5.

I.F., Detector and A.F. Stages

After two stages of i.f. amplification, V10 and V11, the signal is demodulated by the diode section of V13 and then passed through the series noise-limiter V12 to the volume control potentiometer RV1, the slider of which feeds the grid of the a.f. output stage. The output transformer T8 matches V13 anode to the headphone, which is connected via SK2 or SK3, pins E and C.

Automatic Gain Control

Part of the i.f. signal is taken via C43 and rectified by V14 and the resultant voltage developed across R21 applied to the grids of V6, V10 and V11 for a.g.c. purposes. Positive bias is applied to V14 from the l.t.supply and provides delayed operation of the a.g.c.circuit.

B.F.O.

The beat-frequency oscillator V15 is provided for the reception of c.w. signals and is operative only in position "R" of the system switch. This oscillator is tuned to 465 kc/s and the output combined with the i.f. signal at the secondary of T7. The trimmer capacitor C55 enables the oscillator frequency to be varied thus affecting the resultant audio tone produced.

H.T. and L.T. Supplies

The positive side of the h.t. supply is fed from PL1, pin 5, via RLA1 (when de-energised) to all receiver valves except V15. The h.t. supply is fed to V15 via the system switch SB2B and is connected in the "R" (receive) position only.

The 1.4 volt filaments of the six receiver valves are arranged in series-parallel and connected to the l.t. supply via the dropping resistor R32, relay contact RLA2 and the system switch SB2F in the "R" and "R.T." positions only.

8.3 SUPPLY UNIT TRANSISTORISED

H.T. Supply

A convertor oscillator VT1/VT2 and transformer T1 provide the h.t. supply; the h.t. winding of T1 being tapped for two different output voltages. The lower voltage is used for the receiver, but when the transmitter is operating relay contact RLD1 switches the larger winding into circuit and thus increases the h.t. voltage. After smoothing,the output is taken via socket SKTA,pin 5, to the transmitter-receiver unit.The negative side is taken to SKTA pin 4.

Bias Supply

Bias voltage for the push-pull modulator valves is obtained from an additional winding on the transformer T1, rectified by MR1 and then taken to SKTA, pin 12.

L.T. Supply

Two two 2 volt accumulators are connected in series and the positive side of this 4 volt supply is fed via the fuse FS1 and T1 to VT1 and VT2, and also to the transmitter-receiver via socket SKTA, pins 7 and 8. The negative side of the supply is connected to chassis.

8.4 CONVERTER OSCILLATOR AND RELAY SWITCHING

The l.t. positive line is connected to the centre-tap of T1 primary the ends of which are connected to VT1 and VT2 emitters. Both collectors and the l.t. negative line are connected to chassis.

The bases of VT1 and VT2 are connected via a centre-tapped feedback winding to one of the two bias circuits selected by relay contacts RLC1, RLD2. The oscillator can only operate when both RLC and RLD are in the same state, i.e. both energised or both de-energised but in the "OFF" position, with both relays de-energised, operation is prevented by SB1B short-circuiting the bases of VT1 and VT2.

NOTE: A detailed explanation of the operating circuits is given under "8.6.System Switch".

8.5 METER

The meter M is permanently connected between PL1, pin 8, and chassis, and thus indicates the voltage of the accumulators. A series resistor R16 is incorporated in the positive lead.

When the system switch is set to "TUNE AERIAL" the r.f. stages of the transmitter are brought into operation and an additional resistor R14 is placed in parallel with R16, thus increasing the standing reading of the meter, while at the same time a voltage derived from the rectification of part of the r.f. signal by V1 is applied via R17 in opposition. The negative voltage is inversely proportional to the r.f. current in the aerial circuit, and is at minimum when the transmitter output circuit is resonant, and therefore at this condition a maximum deflection of the meter needle is obtained.

8.6 SYSTEM SWITCH

The functions performed by the various sections of the system switch SB for each mode of operation are summarised below.

NOTE: This switch consists of three wafers numbered 1, 2 and 3. The letters F and B signify front and back respectively, of a wafer. Refer to Figure 13 for details of this switch

"OFF"

SB1B tags 11,12:	Short-circuits bases of VT1 and VT2 in S.U.T. thus rendering the oscillator inoperative.

"R" - (receive)

SB1F tags 3,4:	Connects one side of the output transformer T8 and SK2, SK3, pin C, to chassis.
	Connects PL1,pin 10, to chassis thus completing the base bias circuit of the S.U.T.
SB2B tags 6,7:	Connects the h.t. positive supply to the b.f.o. valve V15.
SB2F tags 11,8:	Connects the receiver valve filaments to the 4 volt positive line at PL1, pin 7, via series resistor R32 and relay contacts RLA2 (de-energised).
SB1F tags 4,5:	Connects S.U.T. smoothing capacitor C6 to chassis.

"S" - (send)

SB1F tags 3,4:	Connects SK2, SK3, pin C, and therefore one side of the morse-key, to chassis.
	Connects PL1,pin 10, to chassis thus completing the base bias circuit of S.U.T.
SB2F tags 2,5:	In series with SB3B, completes the circuit for the transmitter valve filaments.
	Connects PL1, pin 9, to the l.t. supply so energising the relays RLA and RLD,with the following results:-
	Contacts RLA1 disconnect the h.t. positive line from the receiver and connect it to the transmitter stages.
	Contact RLD1 switches the secondary tap on transformer T1 in the Supply Unit.
	Contact RLD2 switches VT1 and VT2 in Supply Unit from receiver base biassing (R1, R2, RV1) to transmitter base biassing (R3, RV2).
SB3B tags 12,2:	Connects the transmitter valve filaments V2, V4 and V5, via R28 and SB2F, to the l.t. supply at PL1, pin 8.
tags 3,2:	Connects a dummy load resistor R27 into circuit in place of the modulator, V7, V9 filaments.
SB3F tags 6,9:	Completes the energising circuit of RLC in S.U.T. via SKTA pin 1, PL1 pin 1, SK2 and SK3 pin D, morse key, SK2 and SK3 pin C and SB1F tags 3 and 4. RLC1 switches base biassing of VT1 and VT2 from the receive to the transmit condition. RLC2 connects C6 in S.U.T. to chassis.

"R.T."

SB1F tags 4,5:	See SB1F tags 4,5 under "R".
SB1F tags 3,4:	Connects one side of the output transformer T8 and one side of the phones to chassis (via SK2, SK3, pin C).
SB3F tags 6,10:	Connects PL1,pin 10, to chassis thus completing the base bias circuit of S.U.T. transistors.

SB2F tags 10,11:	Connects the receiver valve filaments to the 4 volt positive line at PL1,pin 7,via series resistor R32 and relay contacts RLA2 (de-energised).
SB2F tags 3,5:	Connects the l.t. supply from PL1, pin 8, to SK2, SK3, pin A; also, via R30 and T4 primary winding to SK2, SK3, pin F. When the microphone switch is closed, pins A and B are linked and so the l.t. supply is fed to the transmitter valve filaments; also to PL1, pin 9, and so RLA, RLC and RLD are energised (see under "S"). Another pole on the microphone switch completes the microphone circuit, thus applying the l.t. to the microphone via R30, the primary of T4 and SK2, SK3, pin F.
SB3B tags 12,2:	Connects the transmitter valve filaments via R28 to SK2, SK3, pin B.
SB3B tags 4,2:	Connects the modulator valve filaments to SK2, SK3, pin B.
SB3F tags 6,10:	Connects one side of RLC coil to chassis via PL1, pin 1.

"Tune Aerial"

SB1B tags 9,6:	Connects R14 in parallel with the meter M series resistor R16 which is connected to PL1,pin 8.
SB1B tags 10,6:	Connects the positive side of meter M via R17 to the r.f. rectifier V1.
SB1F tags 4,5:	See SB1F tags 4,5 under "R" or "R.T.".
SB2F tags 4,5:	See SB2F tags 2,5 under "S".
SB3B tags 12,2:	See SB3B tags 12,2 under "S".
SB3B tags 5,2:	See SB3B tags 2,3 under "S".
SB3F tags 11,6:	See SB3F tags 6,10 under "R.T.".

Section 9

MAINTENANCE

9.1 TEST INSTRUMENTS

The following instruments cover all maintenance requirements:-

(a) H.F.Signal generator,70 ohm output,(Marconi TF.144 or equivalent).

(b) Valve Voltmeter (Marconi TF.1100 with probe head TM.5269).

(c) A.F. load resistor, 150 ohms.

(d) A.F. signal Generator (Advance J.1 or equivalent).

(e) Universal Meter, 20,000 ohms/volt (AVO Model 8).

(f) R.F. load resistor, 68 ohms, 3 watt, non-inductive.

(g) Oscilloscope (Phillips GM.5654 or equivalent).

(h) Test cable (6566-100 Ed. "A").

9.2 DESICCATOR

A desiccator is fitted in the chassis of the transmitter-receiver unit (see Figure 13) and it will remain effective so long as the unit is sealed within the case.

Whenever the unit is removed the desiccator must either be re-activated or be replaced by a new one.

The new or re-activated desiccator should receive the minimum of handling and must be clipped into position immediately before the transmitter-receiver unit is refitted into the case.

A new desiccator should not be taken out of its sealed tin until immediately before required for use.

To re-activate a saturated desiccator proceed as follows:-

(1) Place the desiccator in an oven or other clean source of heat with a temperature of approximately 250°-280°F for a period of 1 to 2 hours.

(2) Directly the desiccator is removed from the oven place it in its tin and seal immediately,or fit it in the transmitter-receiver if the latter is ready to be refitted into the case.

9.3 DISMANTLING

Supply Unit Transistorised

Slacken the two wing nuts, one at either side of the bottom edge of the case, and lift the case away from the bottom panel.

NOTE: Remove fuse or disconnect accumulators before disconnecting the power supply plug.

For further dismantling of the unit, see "9.9 Supply Unit Transistorised".

Transmitter-Receiver Unit

(1) Remove fuse from S.U.T. or disconnect accumulators.

(2) Disconnect the aerial tuning unit lead from the aerial terminal.

(3) Remove the six screws at the top edge of the case and lift out the transmitter-receiver.

9.4 CONNECTING UP FOR TEST PURPOSES

Remove both units as described under "Dismantling" and unplug the cable from the 12-way socket at the top of the power supply unit. This case can now be put to one side until all work is completed and the units are to be re-installed.

Plug the test cable into the 12-way socket on the power supply unit, and fit the socket at the other end of this cable over the 12-way plug at the rear edge of the transmitter-receiver unit.

9.5 OPERATING FREQUENCIES

Crystals

Refer to Figure 12 for location of the various crystal sockets and fit a pair of crystals for each channel to be used as detailed in the table below. (See also section 9.11).

It is advised that channel frequencies be allocated in increasing order of frequency in agreement with the channel numbering; on account of the arrangement of sections on the dipole and quarter-wave aerials.

Fit the crystals securely in their correct sockets and ensure that the retaining strips are screwed down over both sets of crystals.

Channel	Frequency Range	Transmitter Crystal		Receiver Crystal	
		Chassis Ref.	Frequency	Chassis Ref.	Frequency
1	2.5 - 3.7 Mc/s	TX1	Signal Frequency	RX1	Signal Frequency Minus 465 kc/s
2	2.7 - 4.3 Mc/s	TX2		RX2	
3	2.7 - 4.3 Mc/s	TX3		RX3	
4	4.3 - 6.0 Mc/s	TX4		RX4	
5	4.7 - 7.5 Mc/s	TX5		RX5	
6	4.7 - 7.5 Mc/s	TX6		RX6	

Tuning

The transmitter circuits must always be correctly-aligned before any tuning adjustments are made to the receiver.

To retune the transmitter-receiver after fitting new crystals or to check the existing alignment carry out in this order:-

(1) Transmitter R.F.Alignment

(2) Receiver R.F.Alignment (page 35)

9.6 TRANSMITTER ADJUSTMENTS

R.F. Alignment

Instruments used: (b), (f) (from list 9.1)

(1) Connect the r.f. load resistor (68 ohms) across the aerial and earth terminals of the transmitter-receiver and connect the valve voltmeter across the load resistor.

(2) Connect either the telephone headset or the handset into one of the 6-way sockets, SK2 or SK3.

(3) Set the system switch to "R.T.".

(4) Set the channel switch to "1" and slacken off the locking sleeve on the trimmer C17. Press the microphone switch and adjust C17 for maximum output as indicated in the valve voltmeter, and then lock the trimmer. Release the microphone switch when the adjustment has been completed.

(5) Tune each of the other channels in the manner described in paragraph 4. The trimmer for each channel is given below.

Channel	Trimmer	
	Circuit Ref.	Chassis Ref.
1	C17	1
2	C16	2
3	C15	3
4	C14	4
5	C13	5
6	C12	6

These tuned circuits are common to both the transmitter and the receiver and once correctly preset for the maximum output of the transmitter they should not be disturbed again when tuning the receiver.

Modulation Test

Instruments used: (d), (f), (g)

The Modulator requires no adjustment but the modulation on each channel can be checked as follows:-

(1) Connect the r.f. load resistor (68 ohms) across the aerial and earth terminals.

(2) Connect the oscilloscope across the r.f. load in such a manner that it does not load the transmitter.

(3) Connect the a.f. signal generator across the primary of T4 (tags 1 and 5), and set it up to 1000 c/s.

(4) Connect either the telephone headset or the handset into one of the 6-way sockets, SK2 or SK3.

(5) Set the system switch to the "R.T." position.

(6) Press the microphone switch and adjust the a.f. level (not more than 400 mV) for full modulation, which should be at least 85% with not more than 10% distortion as viewed on the oscilloscope.

NOTE: A simple modulation check can be carried out as follows:-

With connections made as in paragraphs 1, 2 and 4 above, and the system switch set to "R.T.", press the microphone switch and whistle into the microphone. A modulated waveshape should appear on the oscilloscope.

9.7 RECEIVER ADJUSTMENTS

A.F. Stages

Instruments used: (b), (c), (d), (g)

The performance of the a.f. stage can be checked as follows:-

(1) Connect the a.f. load resistor (150 ohms) between pins C and E of SK2 or SK3.

(2) Connect the valve voltmeter across the load resistor.

(3) Connect the a.f. signal generator to the grid of V13 (pin 6) and chassis.

(4) For an input of not more than 500 mV at 1000 c/s, an output of 2 mW (545 mV across the 150 ohm load) with not more than 10% distortion as viewed on the oscilloscope.

I.F. Stages

Instruments used: (a), (b), (c)

I.F. alignment should always be carried out following the replacement of any valves, transformers, or other components in the i.f. amplifier chain.

The procedure for re-adjusting the permeability-tuned i.f. transformers is as follows:-

(1) Connect the h.f. signal generator to V8 grid (pin 6) via a 0.1 µF paper-type capacitor with 100 kohms in parallel.

(2) Connect the a.f. load resistor (150 ohms) between pins C and E of SK2 or SK3.

(3) Connect the valve voltmeter across the load resistor.

(4) Set the system switch to "R.T.", and set the gain control to maximum.

(5) Apply a 465 kc/s signal modulated to 30% at 1000 c/s.

(6) Adjust each core in turn for maximum output reading. When adjusting one winding the other side of the transformer should be damped by means of a 1000 ohm resistor and a 1000 pF capacitor connected in series across the winding. The i.f. transformers may be adjusted in any sequence and it is immaterial whether primaries or secondaries are adjusted first. The primary (anode) core is near the bottom of the transformer can, and the secondary (grid) is near the top.

(7) The individual i.f. stages can be checked in turn by applying to each grid the input specified in the table.

I.F. Sensitivity

Typical signal levels at the grids of the i.f. valves to give an a.f. output of 0.1 mW, or 123 mV across 150 ohms, are given in the following table.

Valve	Pin	Applied Signal
V8	6	150 μV ±6 dB
V10	6	1.25 mV ±3 dB
V11	6	72 mV ±1 dB

Beat Frequency Oscillator

Instruments used: (a), (b), (c)

(1) Connect the h.f. signal generator to V8 grid (pin 6) via a 0.1 uF paper-type capacitor with 100 kohms in parallel.

(2) Connect the a.f. load resistor (150 ohms) between pins C and E of SK2 or SK3.

(3) Connect the valve voltmeter across the load resistor.

(4) Set the system switch to "R" (receive c.w.), and set the gain control to maximum.

(5) Set the b.f.o. control to the mid-position, plates half-meshed.

(6) Apply a 465 kc/s unmodulated signal at a level of 150 μV.

(7) Adjust the cores of the b.f.o. transformer T9 for zero beat.

R.F. Alignment

Instruments used: (a), (b), (c)

The transmitter must first be preset as described above (page) before the following procedure is carried out.

(1) Connect the h.f.signal generator across the aerial and earth terminals of the transmitter-receiver.

(2) Connect the a.f. load resistor (150 ohms) between pins C and E of SK2 or SK3.

(3) Connect the valve voltmeter across the load resistor.

(4) Set the system switch to "R.T.", and set the gain control to maximum.

(5) Set the channel switch to "I" and slacken off the locking sleeve on the trimmer C25.

Apply a strong signal of the correct operating frequency modulated to 30% at 1000 c/s, and adjust C25 for maximum reading on the valve voltmeter.The input signal level should be gradually reduced as the circuit is brought into tune until normal sensitivity is obtained. Then lock the trimmer.

(6) Tune each of the other channels to their respective frequencies in the manner described in paragraph 5. The trimmer for each channel is given below:-

Channel	Trimmer	
	Circuit Ref.	Chassis Ref.
1	C25	1
2	C24	2
3	C23	3
4	C22	4
5	C21	5
6	C20	6

9.8 VOLTAGE AND CURRENT TABLES

Valve Voltages

Instruments used: (e)

The following readings were taken without signals or modulation applied, and are typical for a correctly-aligned transmitter-receiver. All voltages were measured with respect to chassis and with an instrument having a resistance of 20,000 ohms/volt (AVO Model 8). The accumulator voltage was 4 volts as shown by the front panel meter with the system switch in the "OFF" position.

Variations of up to ± 20% can be expected between individual sets.

Position of System Sw.	Transmit T or Receive R	Valve		Anode		Screen		Grid	
		Cct.Ref.	Type	Pin	Volts	Pin	Volts	Pin	Volts
RT	T	V2	DL93	2,6	150	3	65	4	-16
RT	T	V4	DL93	2,6	140	3	122	4	-30
RT	T	V5	DL93	2,6	140	3	122	4	-30
RT	R	V6	DF91	2	50	3	30	--	---
RT	T	V7	DL93	2,6	150	3	147	4	-19
RT	R	V8	DK92	2	50	3,5	50	--	---
RT	T	V9	DL93	2,6	150	3	147	4	-19
RT	R	V10	DF91	2	48	3	48	--	---
RT	R	V11	DF91	2	48	3	48	--	---
RT	R	V13	DAF91	5	48	4	50	--	---
R	R	V15	DF91	2	27	3	27	--	---

Supply Currents and Voltages

Instrument used: (e)

All readings in the table below are typical for a correctly-aligned transmitter-receiver. Variations of up to ± 10% can be expected between individual sets.

	OFF	C.W.			R.T.			Tune Aerial
		Rec.	Send		Rec.	Send		
			key up	key down		carrier	full mod.	
ACCUMULATOR VOLTAGE measured on F.P. meter	4.0	3.95	3.90	3.7	3.95	3.7	3.7	(meter used as tuning indicator)
ACCUMULATOR CURRENT measured at F.S.		680 mA	750 mA	3.4A	680 mA	4.0A	4.6A	3.4A
H.T.VOLTAGE (volts) measured at RLA1 - pin 22	0	51	0	155	51	153	149	155
H.T.CURRENT (mA) measured at RLA1 - pin 22	0	7-10	0	43	10	60	70	42
BIAS (volts) measured at joint T4-tag 6 and R13	0	-20	----	-19	-20	-19	-18.5	-19
FILAMENT VOLTAGE (volts) measured at								
V8 pin 7	0	2.8	0	0	2.8	0	0	0
V8 pin 1	0	1.4	0	0	1.4	0	0	0
V4 pin 7	0	0	3.0-3.2	3.0-3.2	0	2.9-3.1	2.9-3.1	3.0-3.2

9.9 SUPPLY UNIT TRANSISTORISED

Fuse

A 7-ampere cartridge type fuse is fitted in the positive battery lead. The fuse is located at the outside of the power unit chassis.

Removal of Power Supply Unit

To obtain access to T1, RV1, RV2, R2 or C6 loosen 4 screws on the side of S.U.T.and slide up the cover.To obtain access to any other components, the S.U.T. must first be removed from the bottom plate of the case. Proceed as follows:-

Disconnect the leads from the accumulators. Remove the four screws which fasten the unit to the bottom of the case and lift out the unit. Remove the bottom cover which is held in position by two screws.

Potentiometer Adjustment

The bias potentiometers RV1 and RV2 in the Transistorised Power Supply Unit are adjusted for optimum performance on leaving the factory.It has sometimes been found necessary to re-adjust them in service, particularly when low ambient temperatures are encountered.

The normal adjustment should be made by selecting a mean point between the upper and lower limits of adjustment within which oscillation can be heard.This adjustment should be carried out at the lowest ambient temperature likely to be encountered.

The H.T. voltage should be metered during adjustment and should read approximately 50V on Receive and 145V on Transmit. No attempt should be made to adjust for peak H.T. voltages since in this condition the oscillator becomes unstable.

If the adjustment cannot be made at the lowest ambient temperatures, the bias potentiometers should be adjusted as far anti-clockwise as possible while maintaining the approximate H.T. voltages as above.

Incorrect setting of RV2 can also cause the oscillator to operate in the "S" (Send CW) position. This causes a continuous C.W. to be transmitted.

9.10 CHARGING UNIT S.A.M.1

The S.A.M.1 which is a self-contained, fully portable one-man load, is for recharging accumulators in the field. It consists of a two-stroke petrol engine, driving a 90 watt,6 - 7.5 volt generator,and the output is brought up to a suitable switchboard.From this switchboard it is possible to charge two groups of batteries,each consisting of one to three type ZVP19 cells. The charging current is adjustable by a series resistance and is indicated by an ammeter in each circuit.

Full details of the S.A.M.1 Charging Unit, which has been specially designed for use with the HF.156 and is fully tropicalised, are available on request.

9.11 FREQUENCY RANGE MODIFICATION

Channels 1, 2 and 3.

Reference to the table in section 9.5 gives the frequency range for each channel. It will be seen that channel 1 covers a lower range than channels 2 and 3. This is achieved by wiring capacitor C58 in parallel with C25 (see Figure 18).

Should the frequency range of channels 2 or 3 be required to be lowered to that of channel 1 a similar capacitor to C58 should be wired in parallel with C24 or C23 respectively.

Similarly the frequency range of channel 1 may be raised to that of channels 2 and 3 by the removal of C58.

Channels 4, 5 and 6.

The frequency range of channel 4 is lower than that of channels 5 and 6. This is achieved by wiring capacitor C59 in parallel with C22 and capacitor C61 in parallel with C14 (see Figure 18).

The frequency range of channels 5 and 6 may be lowered to that of channel 4 by adding a similar capacitor in parallel with C21 and C13 or C20 and C12 respectively.

Similarly the frequency range of channel 4 may be raised to that of channels 5 and 6 by the removal of C59 and C61.

Section 10

THIS SECTION CONTAINS A COMPREHENSIVE
PARTS LIST FROM WHICH ORDERING
INFORMATION FOR SPARES CAN BE OBTAINED

WHEN ORDERING SPARES PLEASE
QUOTE THE FULL CODE NUMBER
OF EACH ITEM REQUIRED

ANY ENQUIRIES OR ORDERS FOR SPARES
SHOULD BE ADDRESSED TO

BRITISH COMMUNICATIONS CORPORATION LIMITED
HIGH WYCOMBE BUCKINGHAMSHIRE
ENGLAND

Section 10

SPARE PARTS LIST

10.1 ELECTRICAL PARTS

Transmitter-Receiver

Reference	Value	Tol. ± %	Rating	Code No.
Resistors			Watts	
R1	47 kohms	20	¼	6642-111/12
R2	470 "	20	¼	6642-111/13
R3	3.3 "	20	½	6642-111/14
R4	470 "	20	¼	6642-111/13
R5	1 Mohm	20	¼	6642-111/15
R6	47 kohms	20	¼	6642-111/12
R7	68 "	20	¼	6642-111/16
R8	1 "	20	¼	6642-111/20
R9	1 Mohm	20	¼	6642-111/15
R10	2.2 Kohms	20	½	6642-111/18
R11	100 "	20	¼	6642-111/19
R12	1 "	20	¼	6642-111/20
R13	220 "	20	¼	6642-111/21
R14	22 "	20	¼	6642-111/17
R15	220 "	20	¼	6642-111/21
R16	24 "	20	¼	6642-111/29
R17	68 "	10	¼	6642-111/22
R18	1 "	20	¼	6642- 111/20
R19	1 Mohm	20	¼	6642-111/15
R20	1 kohm	20	¼	6642-111/20
R21	1 Mohm	20	¼	6642-111/15
R22	220 kohms	20	¼	6642-111/21
R23	220 "	20	¼	6642-111/21
R24	150 "	20	¼	6642-111/23
R25	1 Mohm	20	¼	6642-111/15
R26	100 kohms	20	¼	6642-111/19
R27	15 ohms	10	½	6642-111/25
R28	1 "	20	½	6642-389
R29	220 kohms	20	¼	6642-111/21
R30	47 ohms	20	¼	6642-111/27
R31	150 kohms	20	¼	6642-111/23
R32	10 ohms W.W.	5	¼	6642-111/28
Variable Resistors				
RV1	2 Mohms carbon potentiometer			6642-114/2

Reference	Type	Value	Tol. ± %	Rating	Code No.
Capacitors				Volts	
C1	Paper, sleeved	0.01 µF	25	150	6642-111/31
C2	" "	0.1 "	25	200	6642-111/32
C3	" "	0.01 "	25	150	6642-111/31
C4	Ceramic stand off	560 pF	20		6642-274/25
C5	Ceramic	75 "	20		6642-111/34
C6	"	75 "	20		6642-111/34
C7	"	1000 "	20		6642-111/35
C8	"	10 "	20		6642-111/36
C9	Paper, sleeved	0.003 µF	20	350	6642-111/37
C10	Ceramic	1000 pF	20		6642-111/35
C11	"	1000 "	20		6642-111/35
C12	Variable	5-100 "			6642-172
C13	"	5-100 "			6642-172
C14	"	5-100 "			6642-172
C15	"	5-100 "			6642-172
C16	"	5-100 "			6642-172
C17	"	5-100 "			6642-172
C18	Paper, sleeved	0.1 µF	25	150	6642-111/38
C19	Ceramic	1000 pF	20		6642-111/35
C20	Variable	5-100 "			6642-172
C21	"	5-100 "			6642-172
C22	"	5-100 "			6642-172
C23	"	5-100 "			6642-172
C24	"	5-100 "			6642-172
C25	"	5-100 "			6642-172
C26	Ceramic stand off	560 "	20		6642-274/25
C27	Paper, sleeved	0.01 µF	20	150	6642-111/31
C28	" "	0.003 "	20	350	6642-111/37
C29	Ceramic	50 pF	20		6642-111/39
C30	Paper, sleeved	0.1 µF	25	200	6642-111/32
C31	Ceramic	20 pF	20		6642-111/40
C32	"	20 "	20		6642-111/40
C33	Paper, sleeved	0.003 µF	20	350	6642-111/37
C34	Ceramic	1000 pF	20		6642-111/35
C35	Paper, sleeved	0.1 µF	25	150	6642-111/38
C36	Ceramic	300 pF	20		6642-111/41
C37	Paper, sleeved	0.1 µF	25	150	6642-111/38
C38	" "	0.01 "	20	150	6642-111/31
C39	" "	0.01 "	20	150	6642-111/31
C40	" "	0.01 "	20	150	6642-111/31
C41	" "	0.01 "	20	150	6642-111/31

Reference	Type	Value	Tol. ± %	Rating	Code No.
Capacitors				Volts	
C42	Ceramic	75 pF	20		6642-111/34
C43	"	20 "	20		6642-111/40
C44	Paper, sleeved	0.1 µF	25	150	6642-111/38
C45	" "	0.01 "	20	150	6642-111/31
C46	Ceramic	1500 pF	20		6642-111/42
C47	Silver Ceramic	1 "	½pF		6642-111/45
C48	Ceramic	75 "	20		6642-111/34
C49	"	75 "	20		6642-111/34
C50	Paper, sleeved	0.01 µF	20	150	6642-111/31
C51	" "	0.5 "	25	150	6642-111/43
C52	Electrolytic	2 "	-20 +50	350	6642-111/48
C53	" "	500 "	-20 +50	6	6642-274/20
C54	Electrolytic, sleeved	100 "		6	6642-111/44
C55	Variable	5.5-30 pF			6642-114/5
C56	Paper, sleeved	0.01 µF	20	150	6642-111/31
C57	" "	0.01 "	20	150	6642-111/31
C58	Ceramic	20 pF	5	750	6642-111/46
C59	"	25 "	5	750	6642-111/47
C60	"	1000 "	20		6642-111/35
C61	"	15 "	10	750	6642-111/52

Reference	Description	Code No.
Inductors		
L1	ATU Tuning Coil	6642-243
L2	H. F. Coil	6642-170
L3	H. F. Coil	6642-171
Chokes		
RFC1	R. F. choke	6642-181/E
RFC2	R. F. choke	6642-309
RFC3	R. F. choke	6642-181/E
RFC4	R. F. choke	6642-181/D
RFC5	R. F. choke	6642-181/D
RFC6	R. F. choke	6642-181/D
RFC7	R. F. choke	6642-181/D

Reference	Description	Code No.
Transformers		
T1	H. F. transformer	6642-167
T2	H. F. transformer	6642-168
T3	Modulation transformer	6642-308
T4	Microphone transformer	6642-338
T5	I.F. transformer, 465 kc/s	6642-169
T6	I.F. transformer, 465 kc/s	6642-169
T7	I.F. transformer, 465 kc/s	6642-169
T8	Output transformer	6642-338
T9	B.F.O. transformer, 465 kc/s	6642-340
Plugs		
PL1	12-way, fixed	6642-111/53
PL2	6-way, free, part of telephone headset assembly	6642-269/3-9
PL3A	6-way, free, part of morse-key cable	6642-269/3-9
PL3B	6-way, free, part of telephone handset	6642-269/3-9
Sockets		
SK2	6-way, fixed	6642-114/18
SK3	6-way, fixed	6642-114/18
Switches		
SA	Channel switch	6642-124
SB	System switch	6642-121
Miscellaneous		
AE1	Aerial insulator	6642-114/8
M	Meter	6642-122
RLA	Relay, 45 ohms	6642-274/22
X1	Flying lead (Set to ATU)	6642-317/B
XL1-12	Crystal	B.C.C.Spec. 112 *
	* Frequency to be specified	

Reference	Description	Code No.	CV No.
Valves			
V1	Crystal diode		CV448
V2	Pentode	DL93	CV807
V3	Neon lamp	NT2	
V4	Pentode	DL93	CV807
V5	Pentode	DL93	CV807-
V6	Pentode	DF91	CV785-
V7	Pentode	DL93	CV807
V8	Heptode	DK92	
V9	Pentode	DL93	CV807
V10	Pentode	DF91	CV785
V11	Pentode	DF91	CV785
V12	Crystal diode		CV448-
V13	Diode-pentode	DAF91	CV784-
V14	Crystal diode		CV448
V15	Pentode	DF91	CV785

Supply Unit Transistorised

Reference	Value		Tol. ± %	Rating	Code No.
Resistors				Watts	
R1	3.3 kohms		20	¼	6642-520/32
R2	68 ohms		20	¼	6642-520/34
R3	100 "		20	¼	6642-520/35
R4	100 kohms		20	¼	6642-520/33
R5	3 ohms		10	1.5	6642-520/37
R6	1.8 "		10	1.5	6642-520/36
Potentiometers					
RV1	500 ohms		10	1	6642-520/30
RV2	10 "		10	3	6642-520/31
Capacitors	Type	Value			
C1	Paper, sleeved	0.04 µF	20	200	6642-520/40
C2	Stantelum	1.5 "	20	50	6642-520/42
C3	"	1.5 "	20	50	6642-520/42
C4	"	1.5 "	20	50	6642-520/42
C5	Electrolytic sleeved	2 "	50 -20	200	6642-520/41
C6	" "	8 "	50 -20	200	6642-520/43

Reference	Description	Code No.
Chokes		
RFC1	R. F. choke	6642-306
LFC1	L. F. choke	6642-562
Miscellaneous		
RLC	Relay	6642-296
RLD	Relay	6642-296
T1	Transformer	6642-556
X2	Cable Assembly	6642-568
MR1	Rectifier	6642-520/49
MR2	Rectifier, silicon	6642-520/48
MR3	Rectifier, silicon	6642-520/48
MR4	Rectifier, silicon	6642-520/48
MR5	Rectifier, silicon	6642-520/48
SKTA	Socket, 12-way	6642-520/45
FS1	Fuse link 7A	6642-520/47
VT1)	Matched pair of)	6642-520/44
VT2)	OC 35 Transistors)	

10.2 MECHANICAL PARTS

Description	Quantity	Code No.
CASE, for transmitter-receiver	1	6642-177
Bracket for aerial tuning unit	2	6642-193
Spring washer, small, 2 B.A.	4	6642-177/22
Screw, cheese-head, 2 B.A. x 1 3/8"	4	6642-177/17
O-ring seal	4	6642-177/14
Saddle for aerial tuning unit	2	6642-192
Washer, small, 6 B.A.) securing	4	6642-177/24
Screw, cheese-head, 6 B.A. x 3/8 in.) above	4	6642-177/20
Connector assembly (SK1 and cable)	1	6642-194
Screw (securing above)	4	6642-203
Clip	1	6642-197
Washer, small, 4 B.A.)securing	2	6642-177/23
Screw, cheese-head, 4 B.A. x 5/16 in.) above	2	6642-177/19
Bush	1	6642-198
Sealing washer	1	6642-177/7
Washer	1	6642-202
Grommet	1	6642-177/8
Washer	1	6642-199

Description	Quantity	Code No.
Nut	1	6642-200
Clip	1	6642-374
Washer, small, 4 B.A.	1	6642-177/23
Screw, cheese-head, 4 B.A. x 3/8 in.	1	6642-177/18
PL4, plug 12-way	1	6642-177/13
Cover for plug	1	6642-201
TRANSMITTER-RECEIVER UNIT, complete (English)	1	6642-111/C
TRANSMITTER-RECEIVER UNIT, complete (Burmese)	1	6642-111/D
Screw, cheese-head, 4 B.A. x 1¼ in.) securing	6	6642-114/30
Washer, small, 4 B.A.) above to	6	6642-114/41
O-ring) case	6	6642-114/26
Top panel assembly (English)	1	6642-114/C
Top panel assembly (Burmese)	1	6642-114/D
Gasket	1	6642-141
Knob, for channel and system switches	2	6642-114/15
Collect assembly	2	6642-114/17
Knobs, for b.f.o. and gain controls	2	6642-114/16
Collet assembly	2	6642-114/17
AE1 aerial insulator assembly	1	6642-125
E earth terminals:-		
Wing Nut, 2 B.A.	1	6642-114/38
Washer, small, 2 B.A.	1	6642-114/40
Stud	1	6642-142
Washer	1	6642-114/27
Washer, small, 2 B.A.	1	6642-114/40
Solder tag	1	6642-114/28
Nut, 2 B.A.	1	6642-114/36
Lock-nut, 2 B.A.	1	6642-114/37
SA channel switch	1	6642-124
C55 variable capacitor, b.f.o.	1	6642-114/5
RV1 potentiometer	1	6642-114/2
Sealing washer	1	6642-372
SB system switch	1	6642-502
SK2,3, 6-way socket, fixed	2	6642-114/18
Protective cap	1	6642-114/19
Screw, cheese-head, 4 B.A. x ¼ in.) securing	1	6642-114/32
Spring washer, 4 B.A.) above	1	6642-114/39
M meter	1	6642-122
Chassis assembly	1	6642-274
Screw, cheese-head, 4 B.A. x 3/8 in.) securing	6	6642-274/49
Washer, small, 4 B.A.) panel to) chassis	6	6642-274/61

Description	Quantity	Code No.
Valve cans	11	6642-111/11
BOTTOM PANEL ASSEMBLY	1	6642-204
Bottom panel	1	6642-205
Eye-bolt assembly	2	6642-208
Pin 3/16 in. x 1 in.	2	6642-205/3
Gasket	1	6642-141
Plug/relay unit	1	6642-514
Dry battery or:-	1	6642-569
Screening cover, top	1	6642-543
Screw, cheese-head, 6 B.A. x 5/16 in.) securing	4	6642-520/56
Washer, small, 6 B.A.) above	4	6642-520/61
Screening cover, underside	1	6642-544
Screw, cheese-head, 6 B.A. x 3/8 in.) securing	4	6642-520/55
Washer, small, 6 B.A.) above	4	6642-520/61
X2 cable assembly	1	6642-568
Spring retainer	1	6642-240
Screw, cheese-head, 4 B.A. x 5/16 in.) securing	4	6642-500/9
Washer, small, 4 B.A.) power	4	6642-500/10
) supply unit		
Accumulator, Type ZVP19	2	6642-500/5
X3 connecting lead	1	6642-234
Pillar	1	6642-527
Clamp plate	1	6642-523
Bolt)	1	6642-522
Lock nut, ¼ in. B.S.W.) used with pillar	1	6642-519/12
Washer, small ¼ in. B.S.W.)	1	6642-519/13
Rubber pad (P.S.U.)	1	6642-524
Rubber pad (accumulators)	1	6642-525
AERIAL TUNING UNIT, complete (English)	1	6642-241/C
Base assembly	1	6642-310
Screw, counter-sunk, No.2 x ¼ in. (securing base assembly to body)	3	6642-241/31
Bush	1	6642-314
Sealing ring	1	6642-241/7
Nut, hex.	1	6642-241/20
Spring washer	1	6642-241/21
Knob for tuning control	1	6642-241/11
Collet assembly	1	6642-241 '12

Description	Quantity	Code No.
AE2 aerial socket:-		
Screw, round-head, 2 B.A. x 1¼ in.	1	6642-276/6
Insulator	1	6642-342
Clamp	1	6642-345
Holder	1	6642-344
Washer, small, 2 B.A.	1	6642-276/7
Wing Nut, 2 B.A.	1	6642-276/8
X1, flying lead	1	6642-317/B
Screw, round-head, 4 B.A. x ¼ in., (securing above)	1	6642-241/23

10.3 ACCESSORIES

Description	Code No.
TELEPHONE HEADSET ASSEMBLY, complete	6642-266
Microphone insert	6642-266/3
Receiver insert	6642-266/4
TELEPHONE HANDSET, complete	6642-268
Microphone insert	6642-266/3
Receiver insert	6642-266/4
MORSE KEY, complete	6642-596
DIPOLE AERIAL, complete	6642-250/A
QUARTER-WAVE AERIAL, complete	6642-250/B
AERIAL CARRYING BAG	6642-273
ROD AERIAL	6642-570
FLEXIBLE COUPLING	6642-249
HEXAGON KEY	6642-100/35
CARRYING BAG (Transmitter/Receiver)	6642-272

When ordering spares, please quote full description and code number of part.

TABLE 2

Channel	Allocated Frequency	No. of Sections	Total length of :- (a) Quarter-Wave Aerial Wire (b) Each arm of Dipole as calculated from formula below
1		6	
2		5	
3		4	
4		3	
5		2	
6		1	

NOTE: The correct length of each arm of the dipole aerial or the total length of the quarter-wave aerial is given by the formula:-

$$l = \frac{71,300}{f} \text{ metres} \qquad \text{OR,} \qquad l = \frac{234,000}{f} \text{ feet}$$

f = the operating frequency in kc/s.

The above table is provided for the convenience of users. Each channel frequency and the lengths of quarter-wave aerial and each arm of the dipole may be added for reference during the service of the equipment.

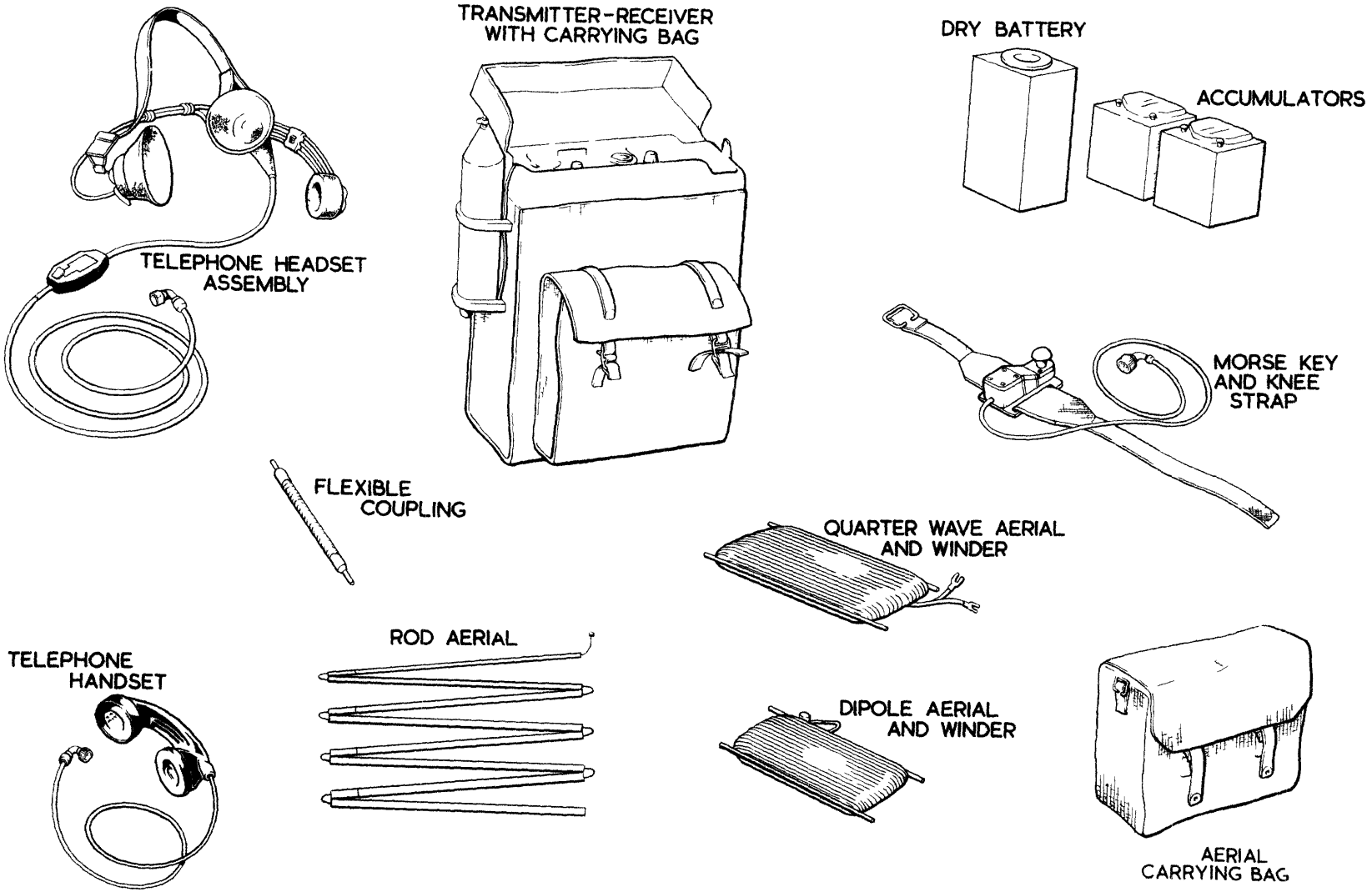


FIG.1 GENERAL VIEW OF H.F.156 MK.II EQUIPMENT

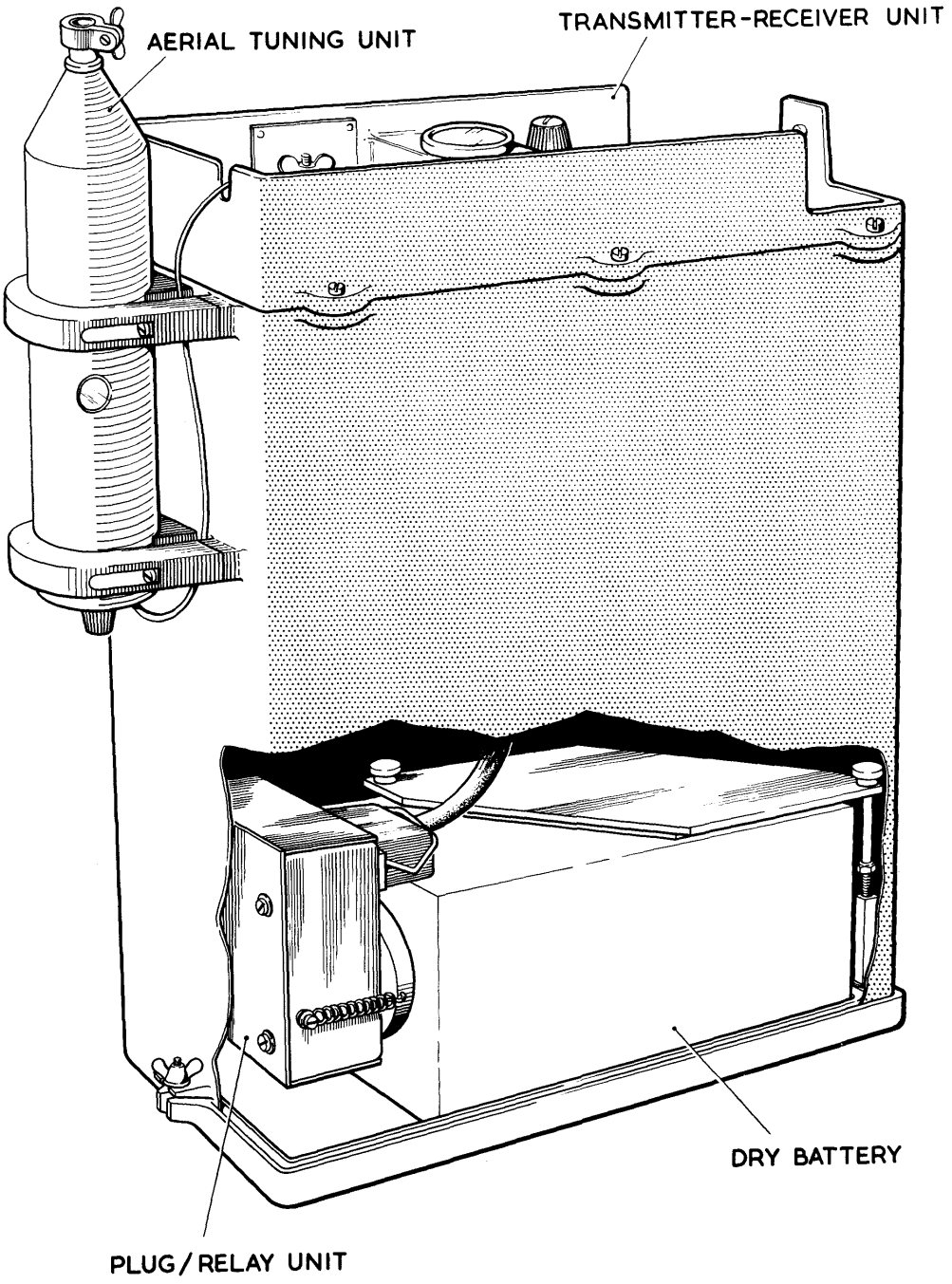


FIG.2 TRANSMITTER-RECIEVER
ASSEMBLY OF DRY BATTERY VERSION

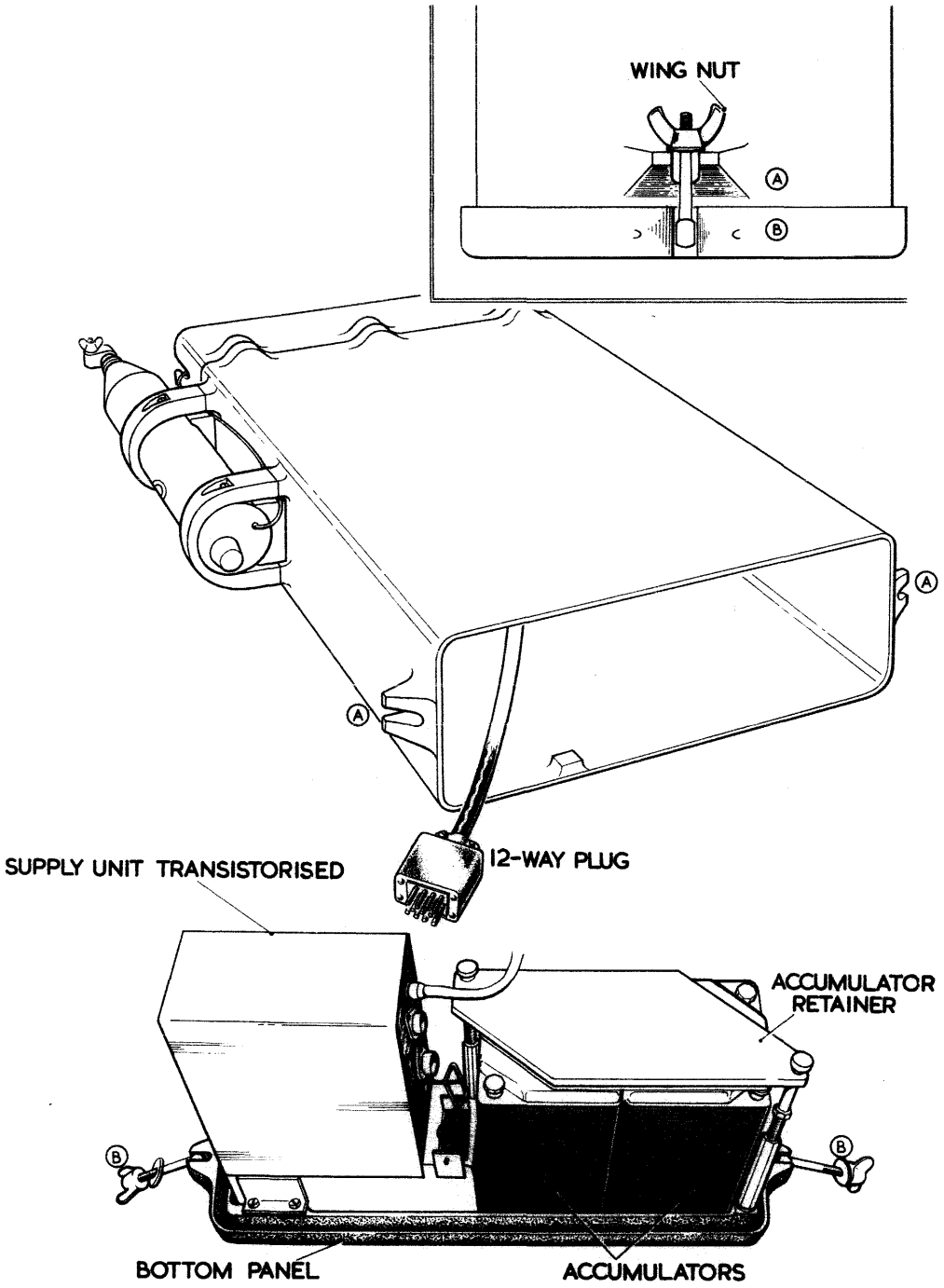


FIG.3. POWER SUPPLY UNIT
AND ACCUMULATORS

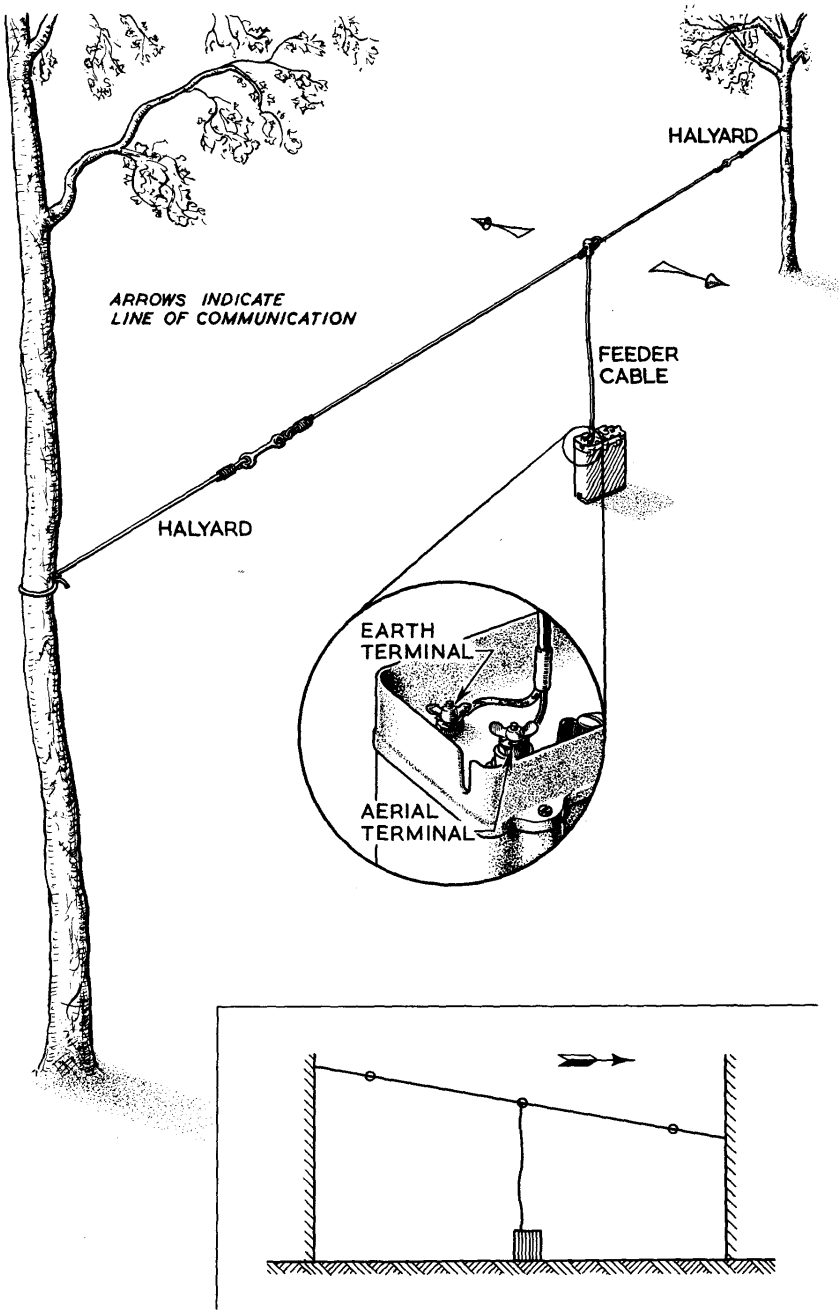


FIG4. ERECTION OF DIPOLE AERIAL

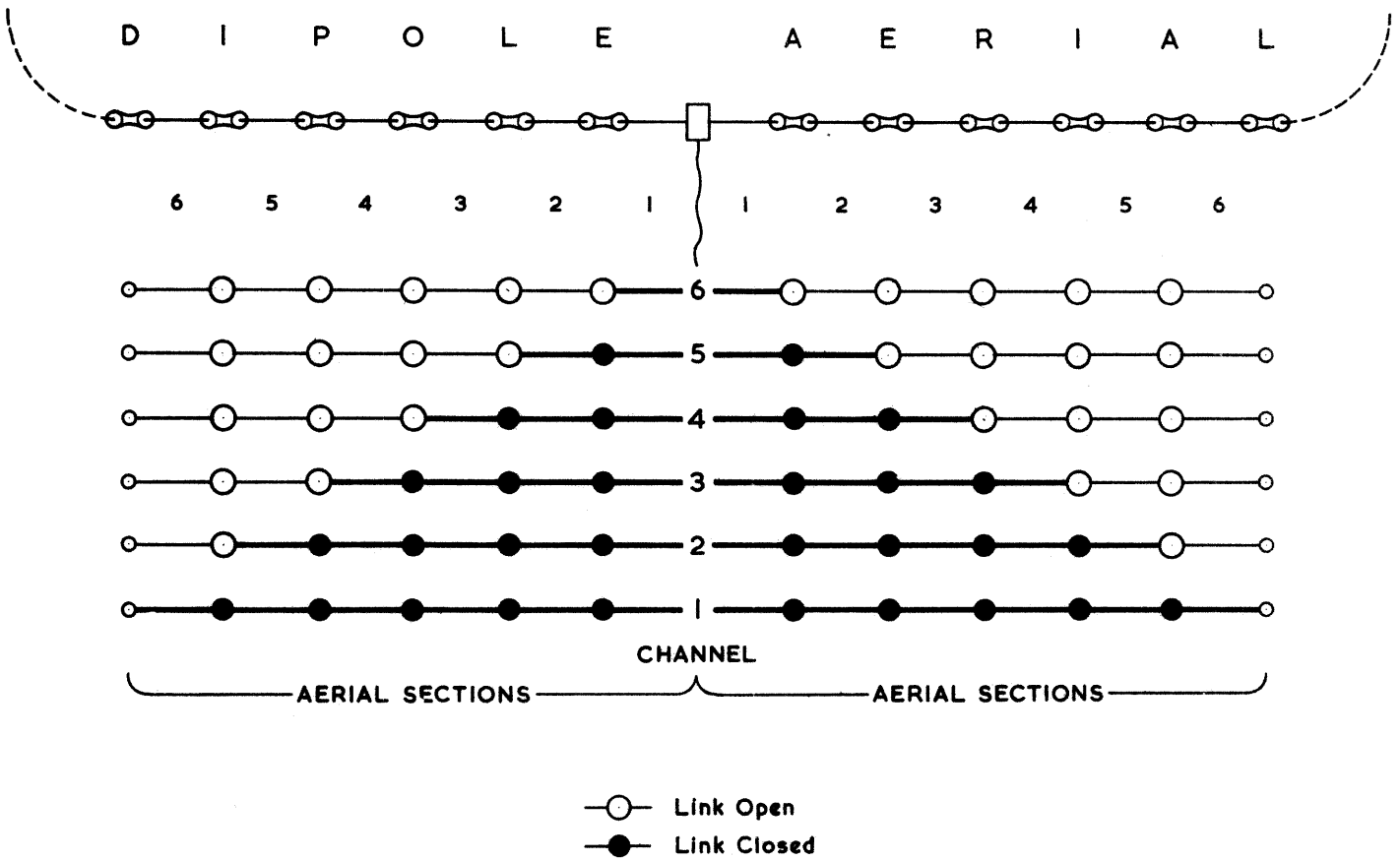


FIG 5. DIPOLE AERIAL LINKING DIAGRAM

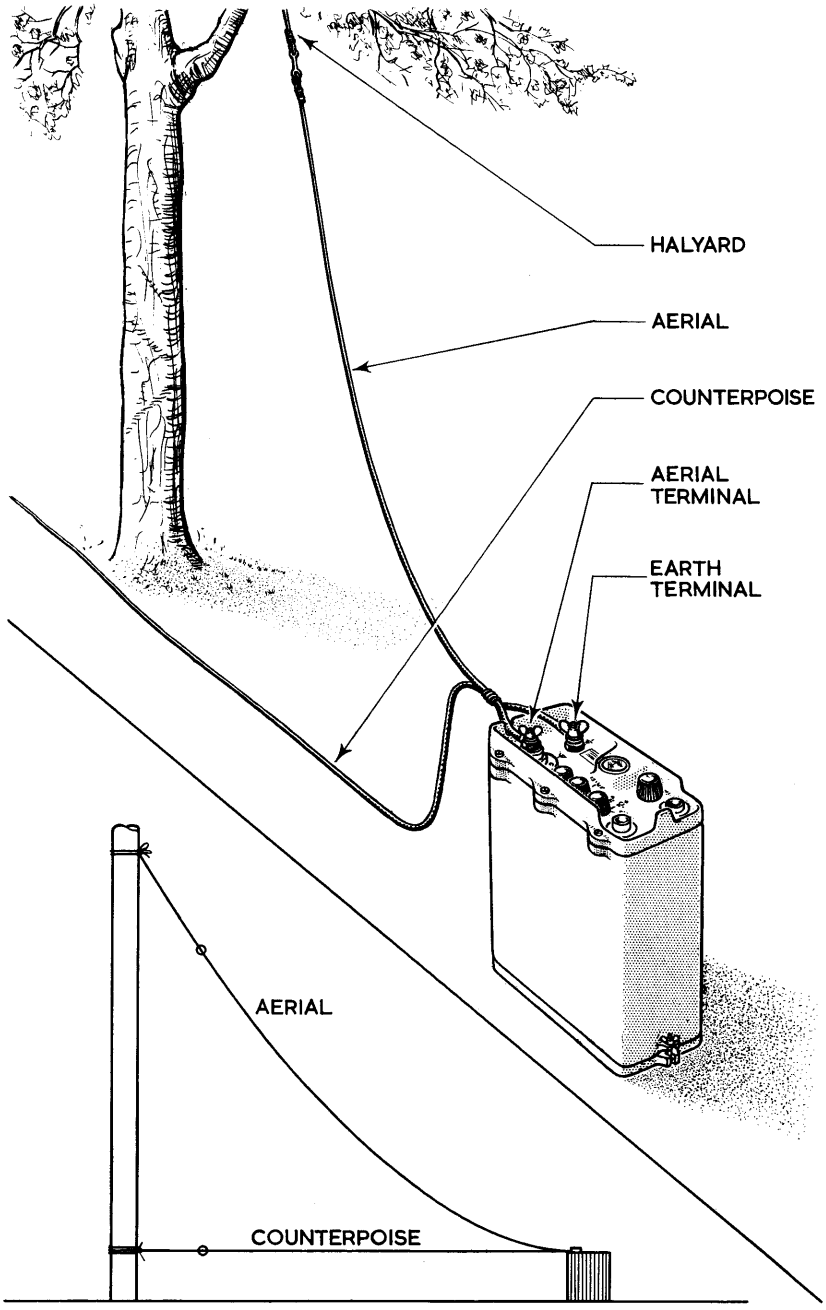


FIG.6. ERECTION OF QUARTER-WAVE AERIAL

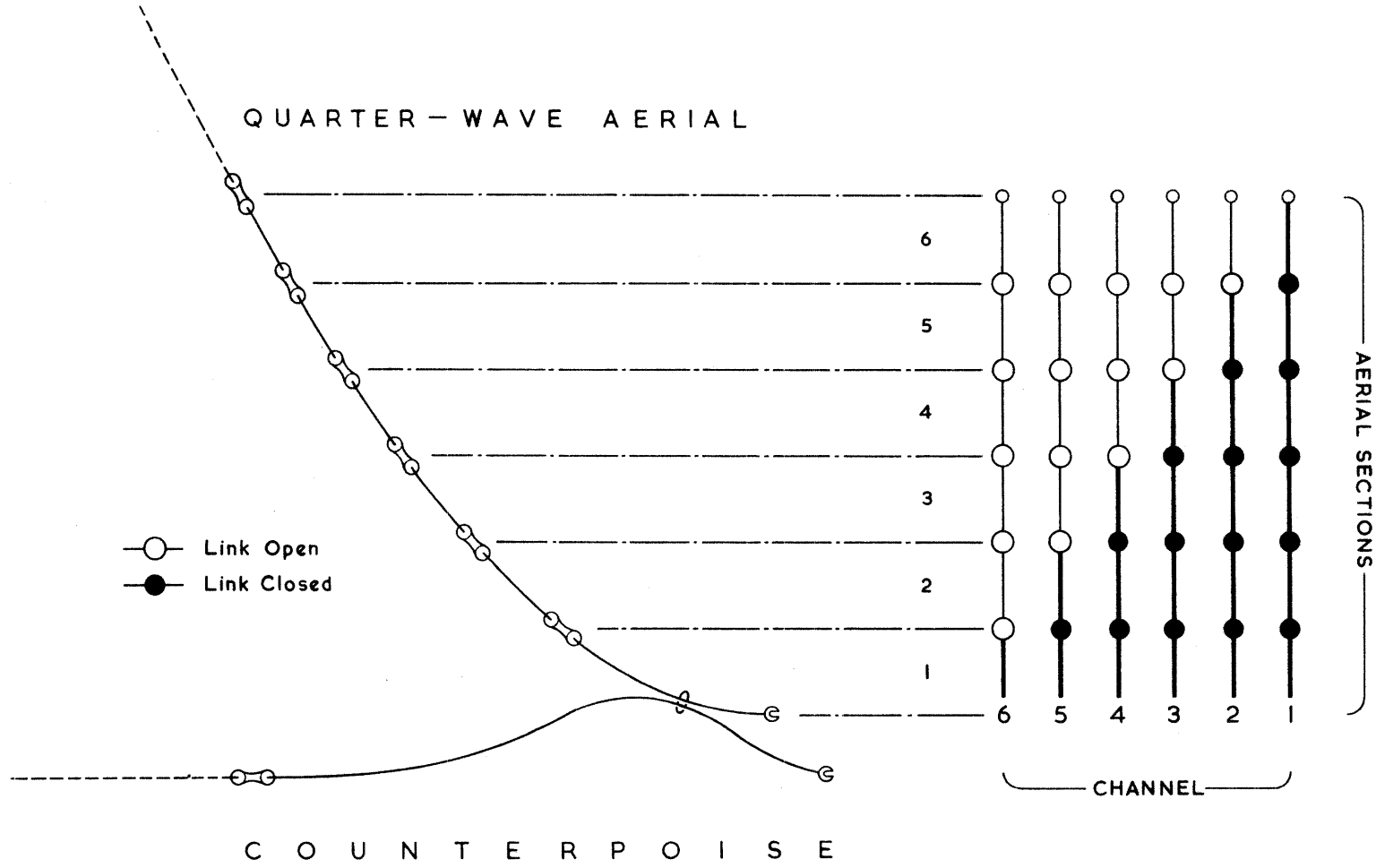


FIG 7. QUARTER-WAVE AERIAL LINKING DIAGRAM

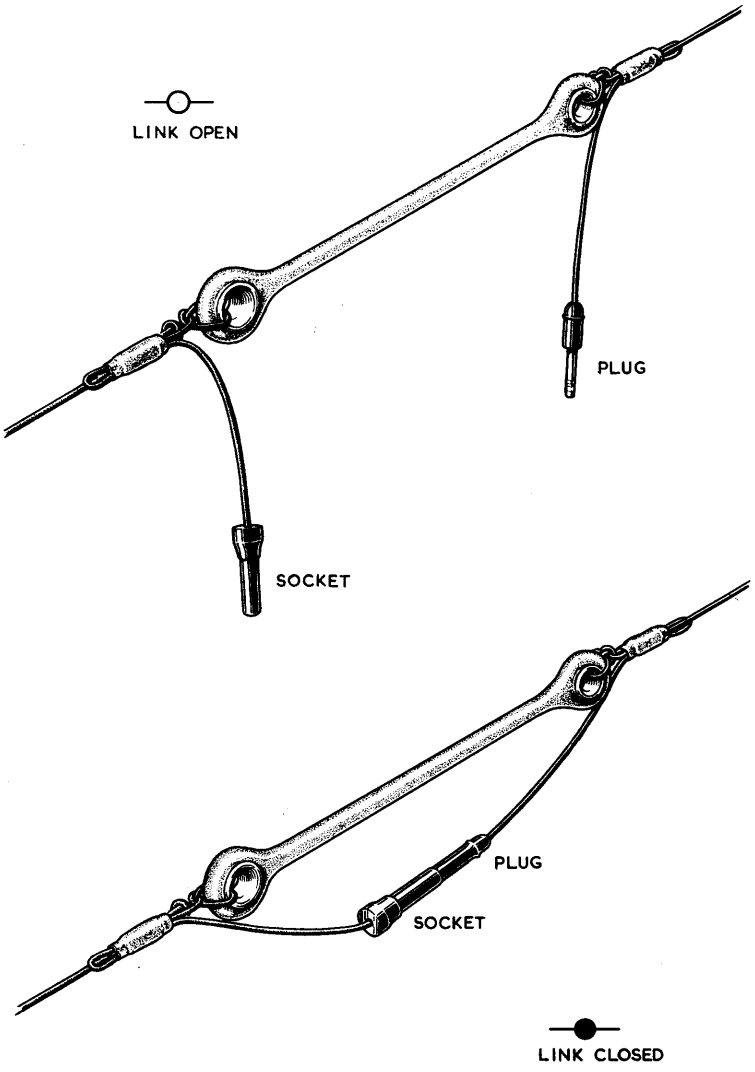


FIG. 8 AERIAL LINKS, SHOWING PLUG AND SOCKET CONNECTORS

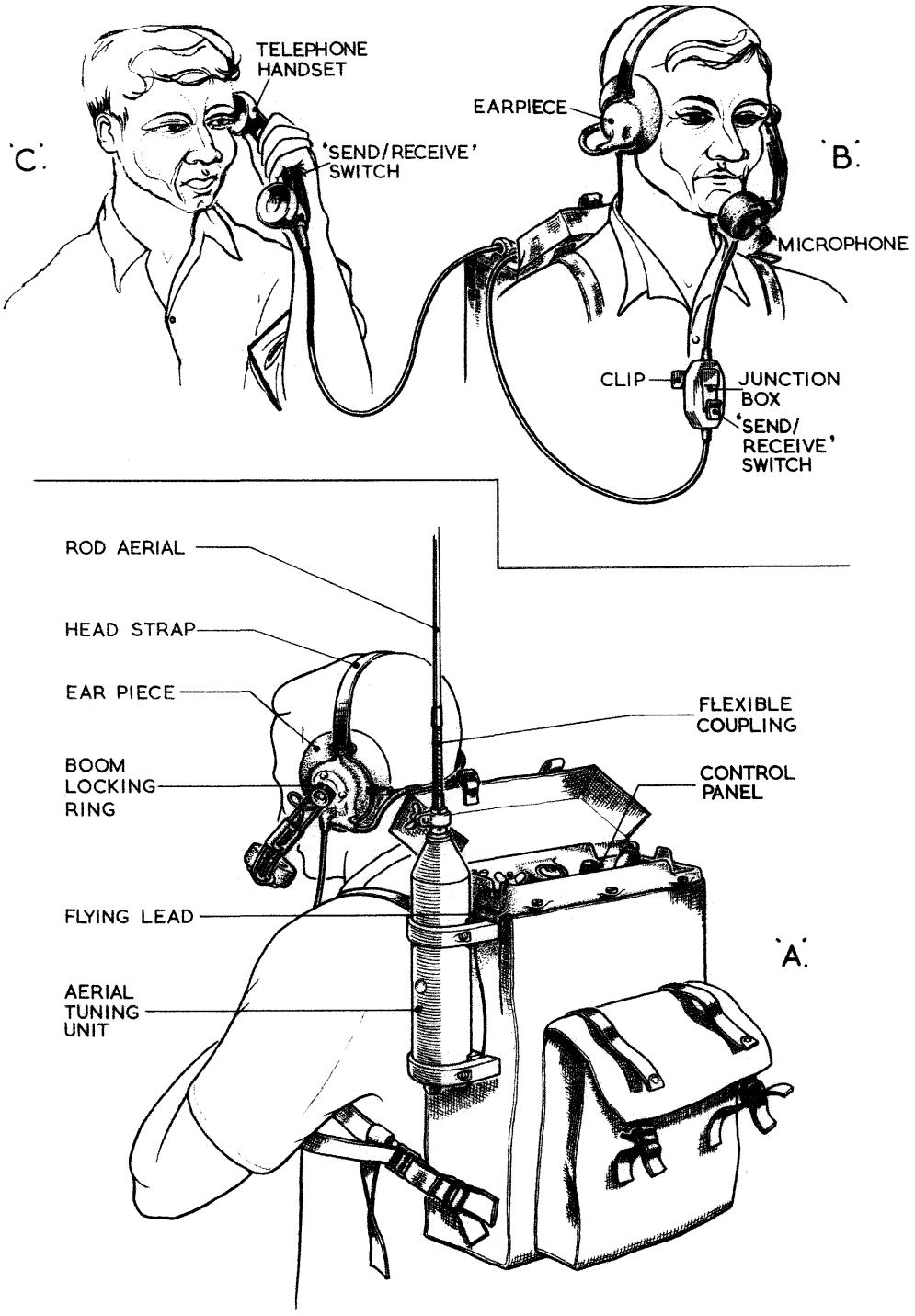


FIG.9 R.T. OPERATION WITH SET IN NORMAL CARRYING POSITION

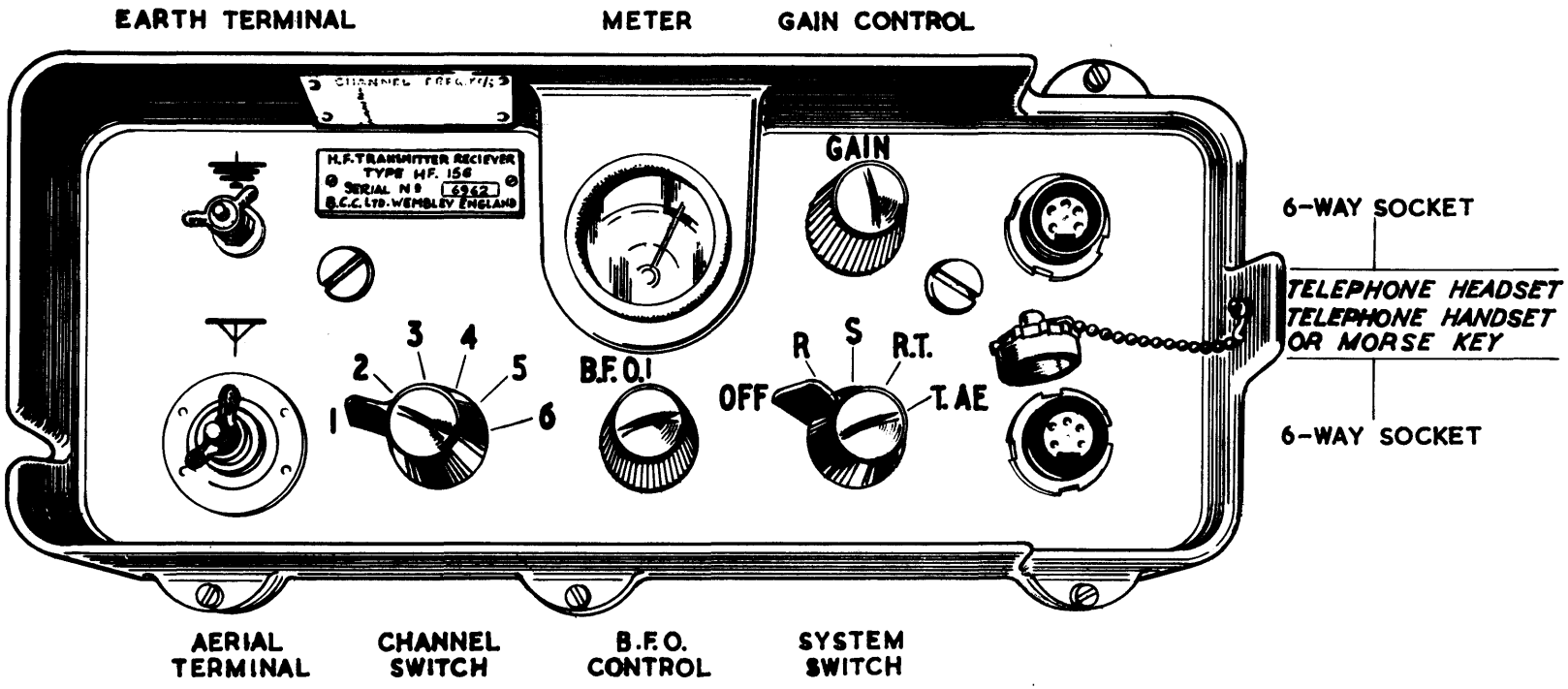


FIG.10 CONTROL PANEL

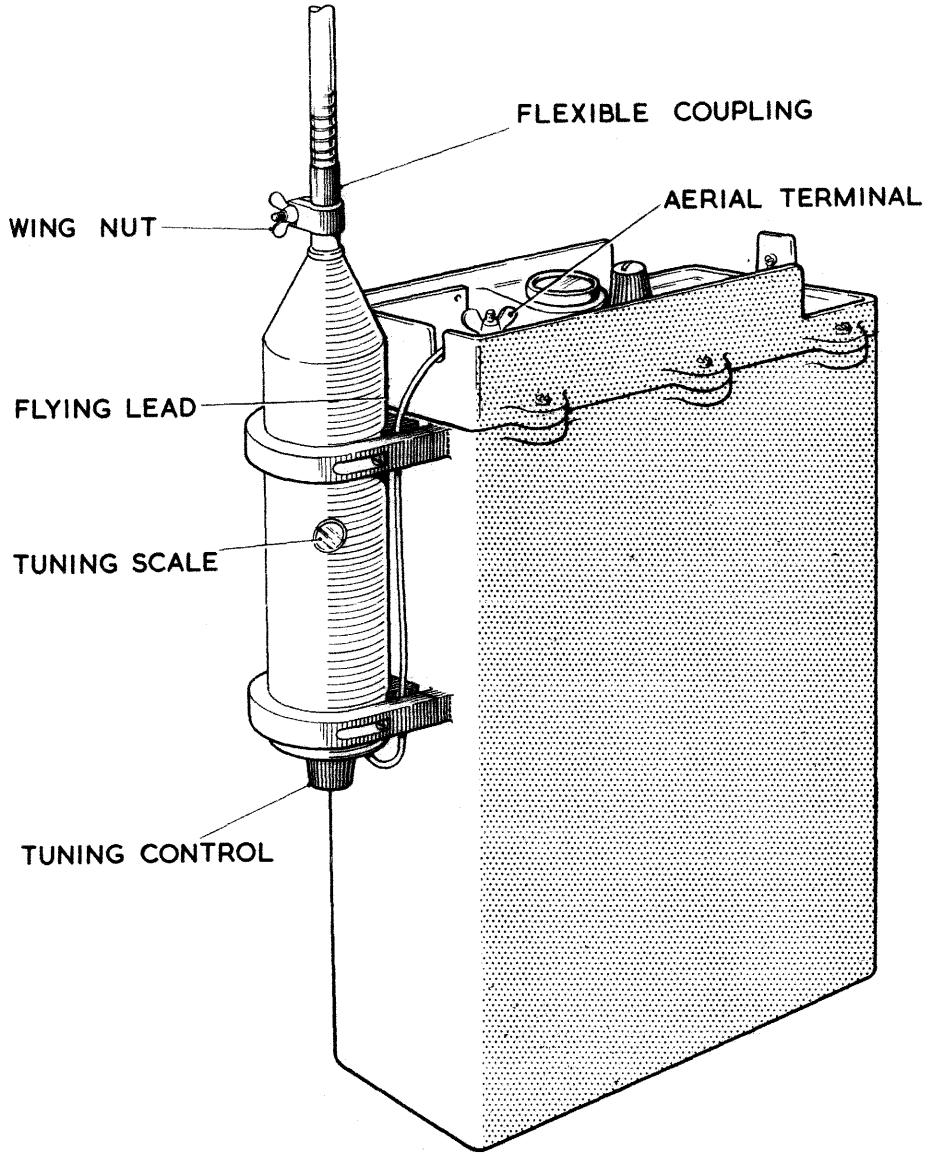


FIG. 11 AERIAL TUNING UNIT

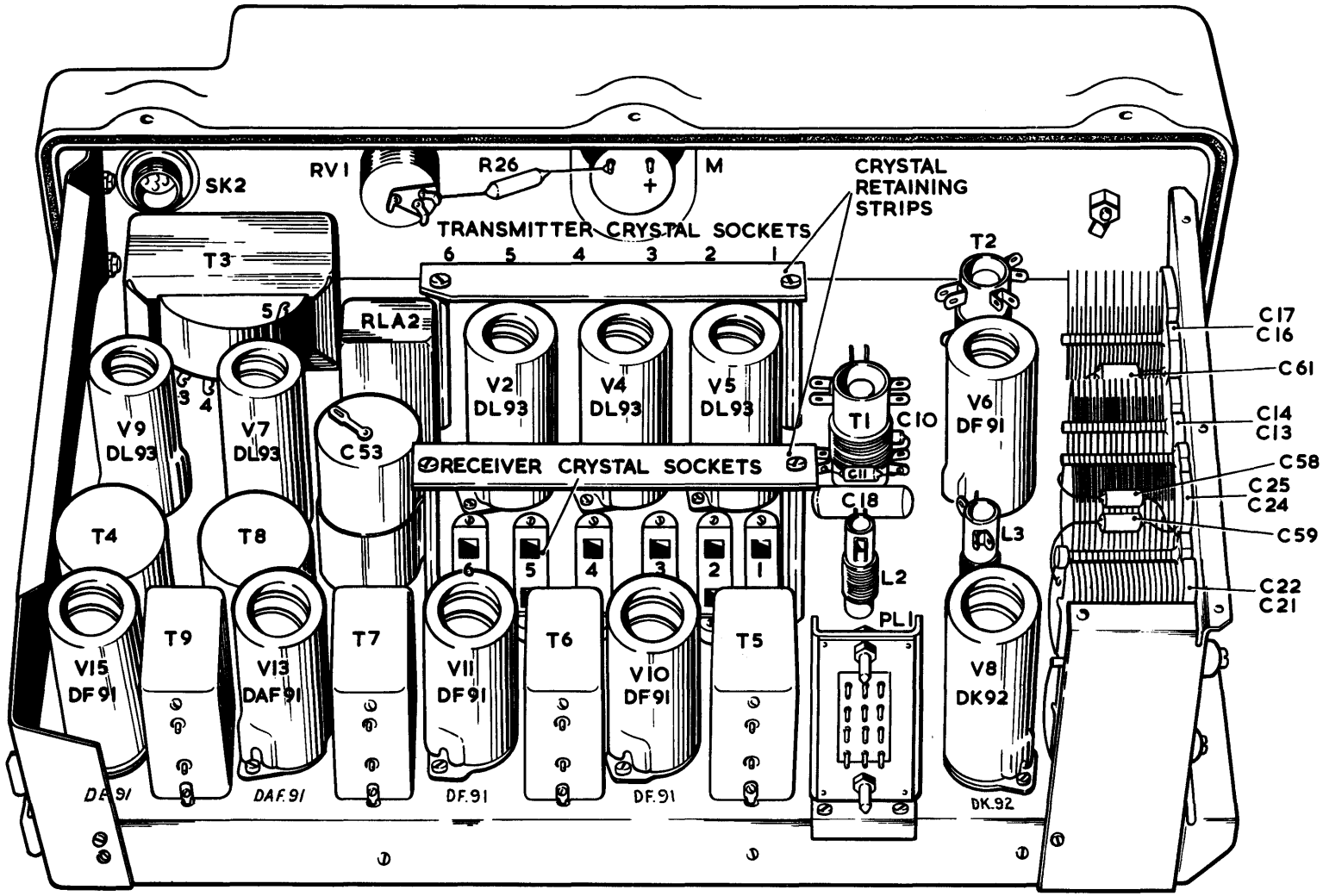


FIG.12 TRANSMITTER RECEIVER :TOP VIEW OF CHASSIS

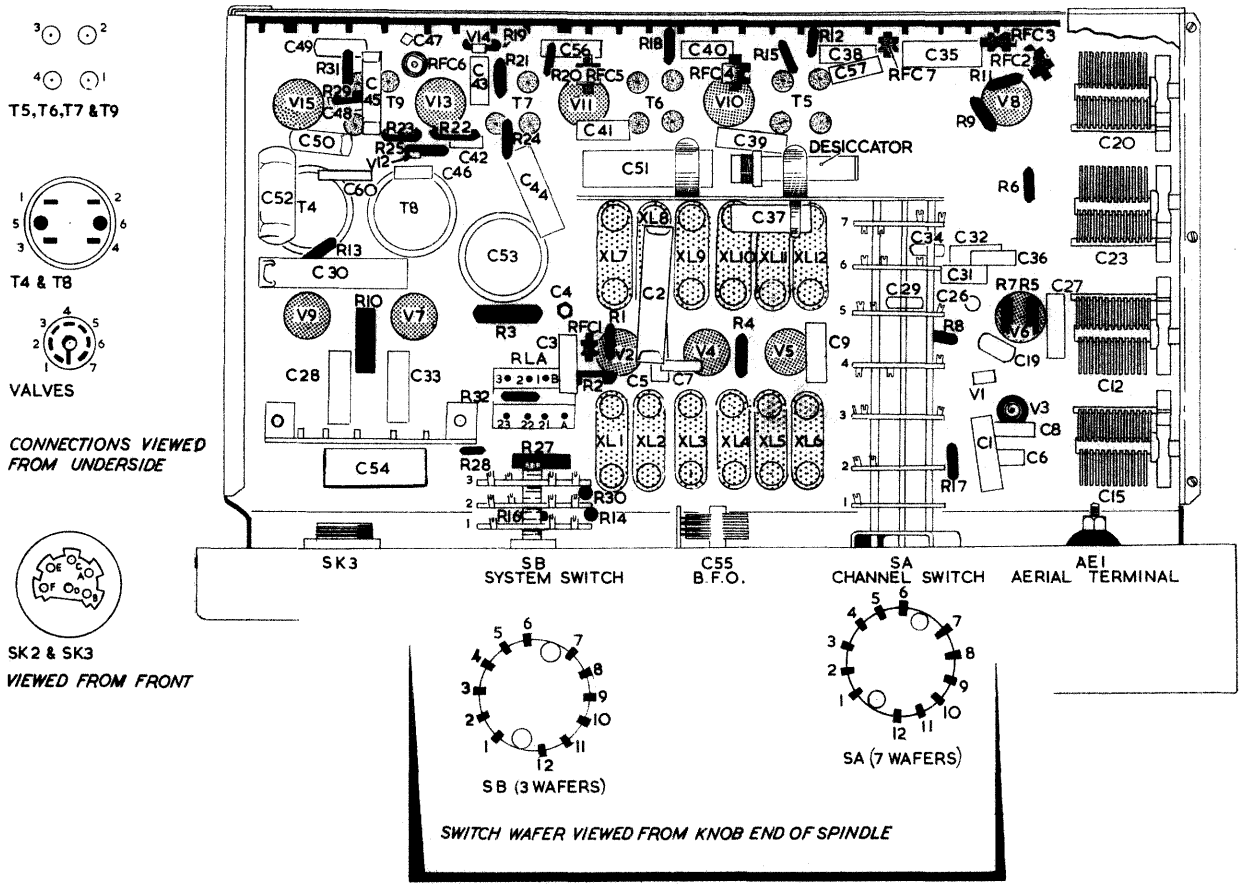


FIG.13. TRANSMITTER - RECEIVER: UNDERSIDE VIEW OF CHASSIS.

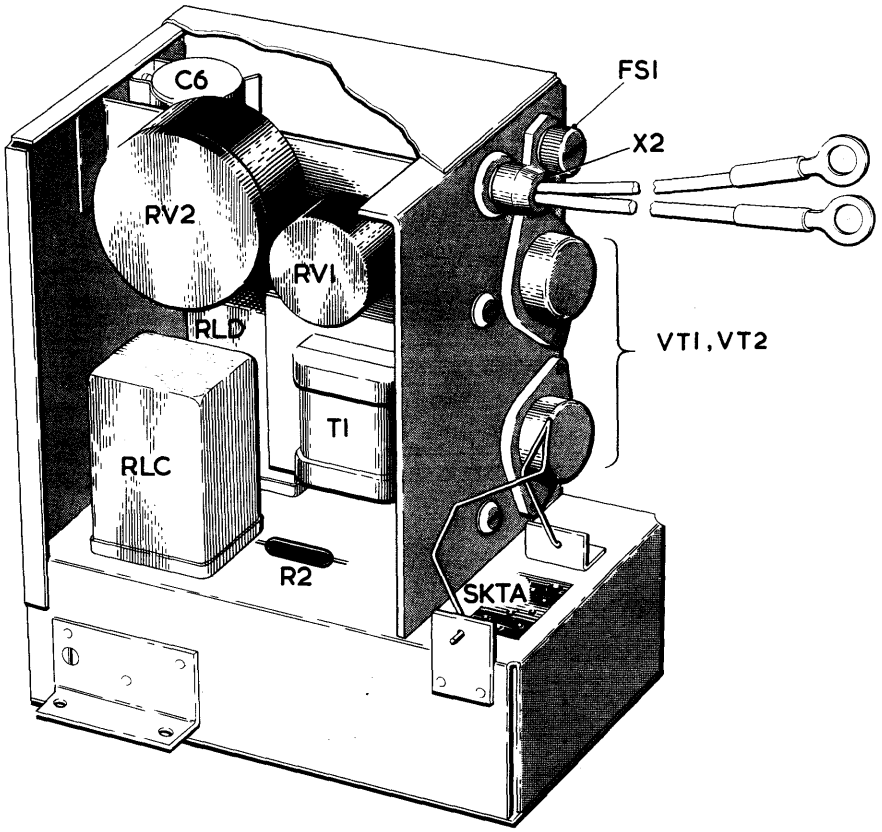


FIG.14. SUPPLY UNIT TRANSISTORISED
TOP VIEW OF CHASSIS

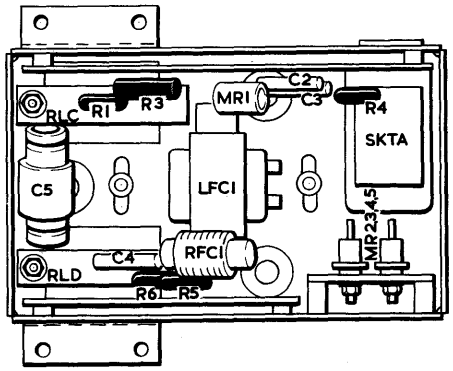
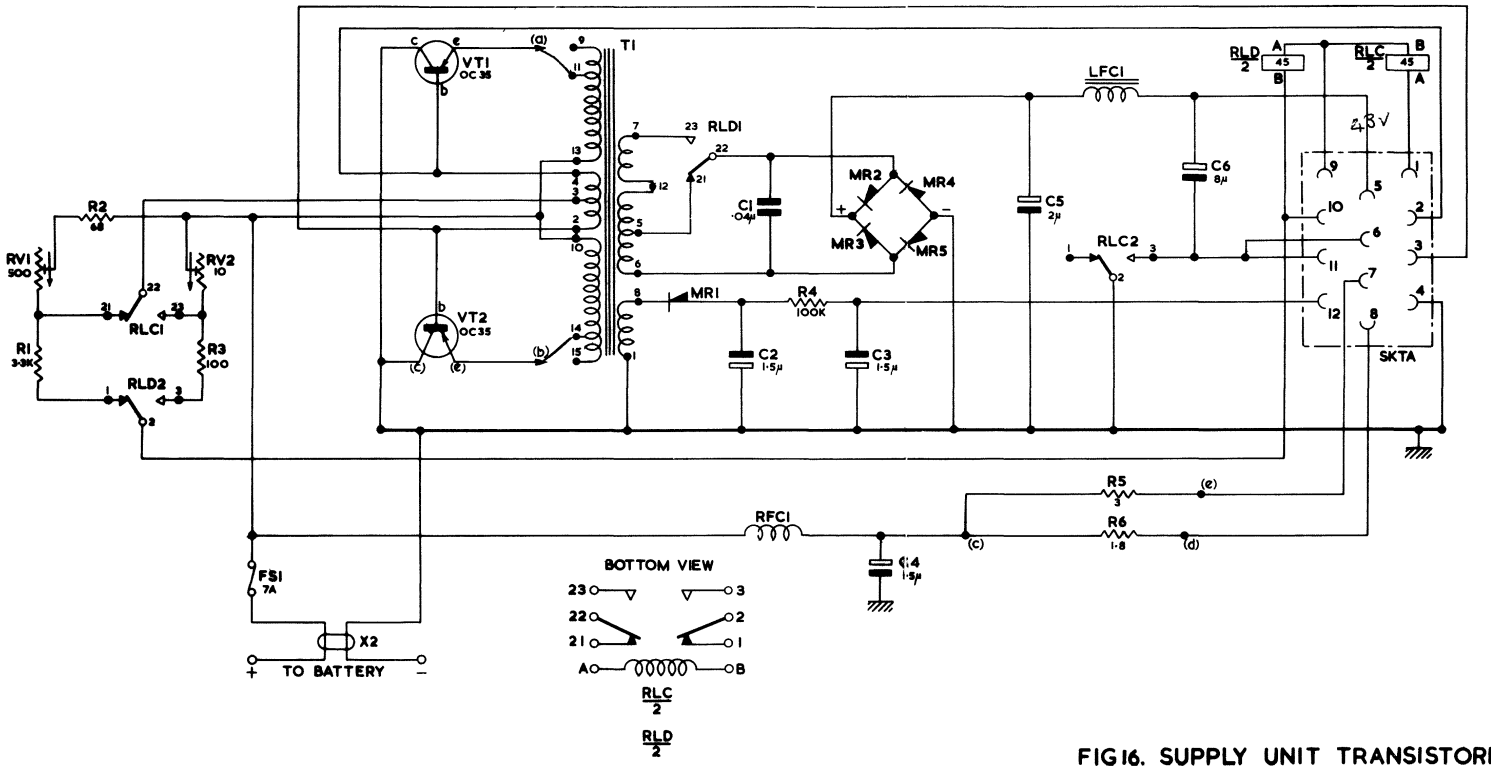


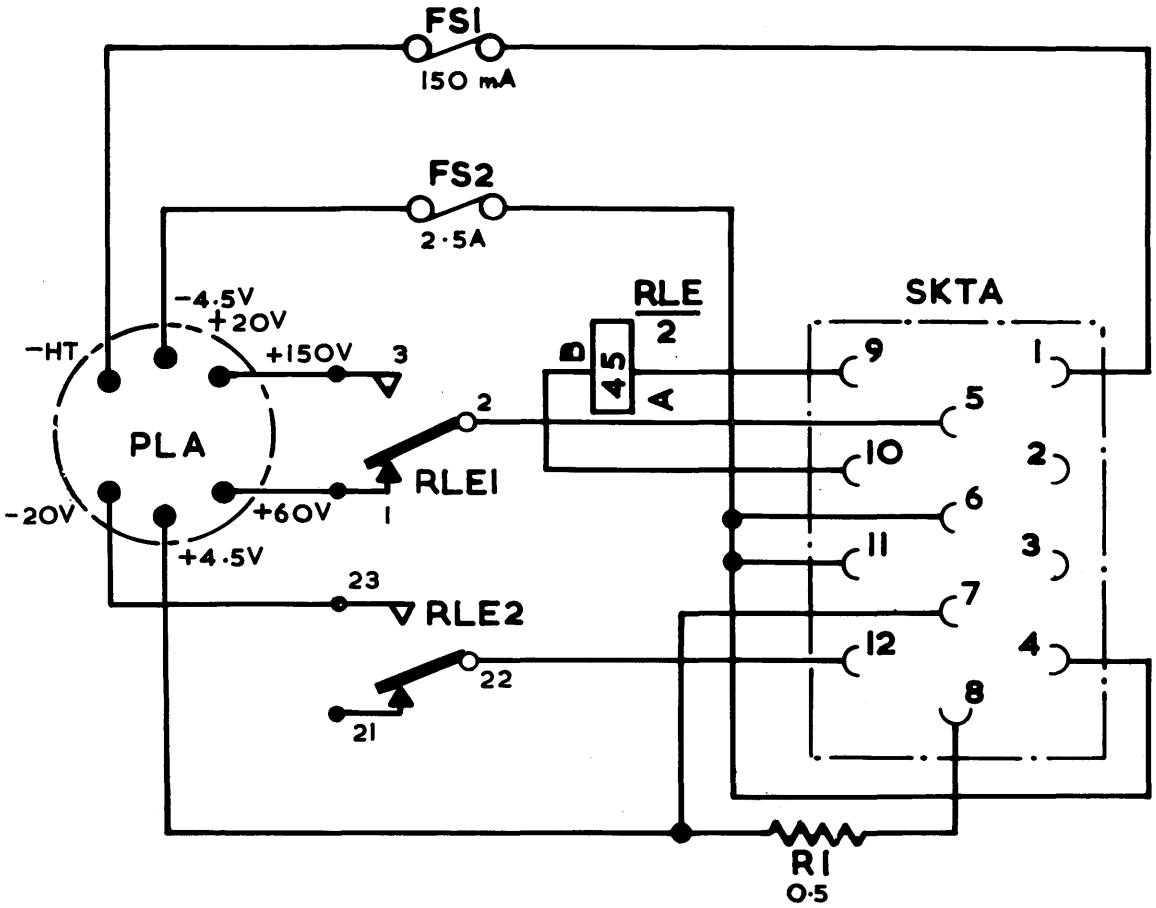
FIG.15. SUPPLY UNIT TRANSISTORISED
UNDERSIDE VIEW OF CHASSIS



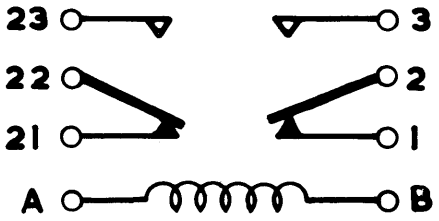
NOTES

WHEN USED WITH TYPES ZVP19 OR NPZ4 ACCUMULATORS, POINTS (a) AND (b) ARE CONNECTED TO TRANSFORMER TAGS 11 AND 14 RESPECTIVELY, AND POINTS (c) (d) AND (e) ARE SHORT-CIRCUITED

FIG 16. SUPPLY UNIT TRANSISTORISED CIRCUIT DIAGRAM



BOTTOM VIEW



RLE
2

FIG.17 CIRCUIT OF PLUG & RELAY UNIT

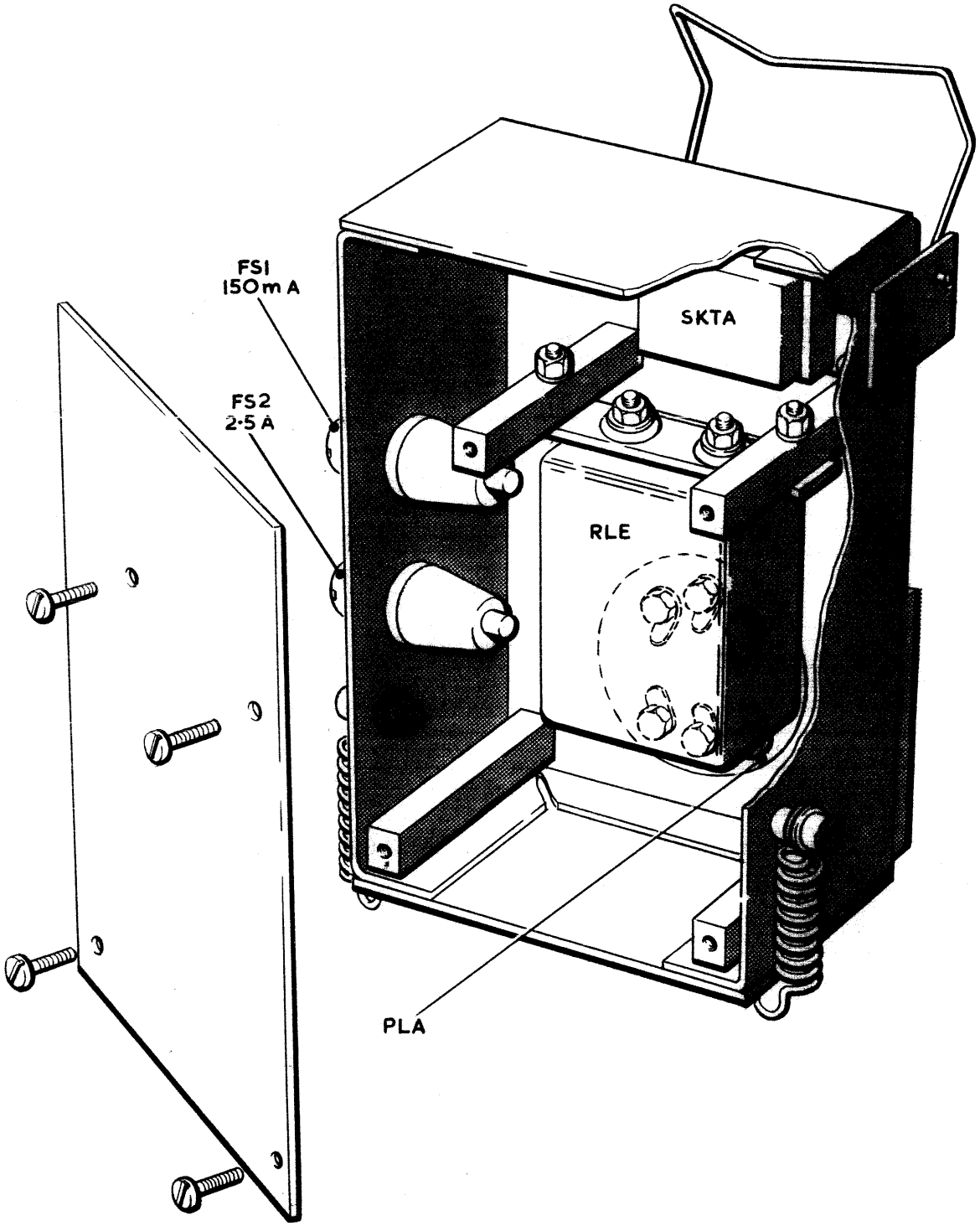


FIG. 18. PLUG & RELAY UNIT
INTERNAL VIEW

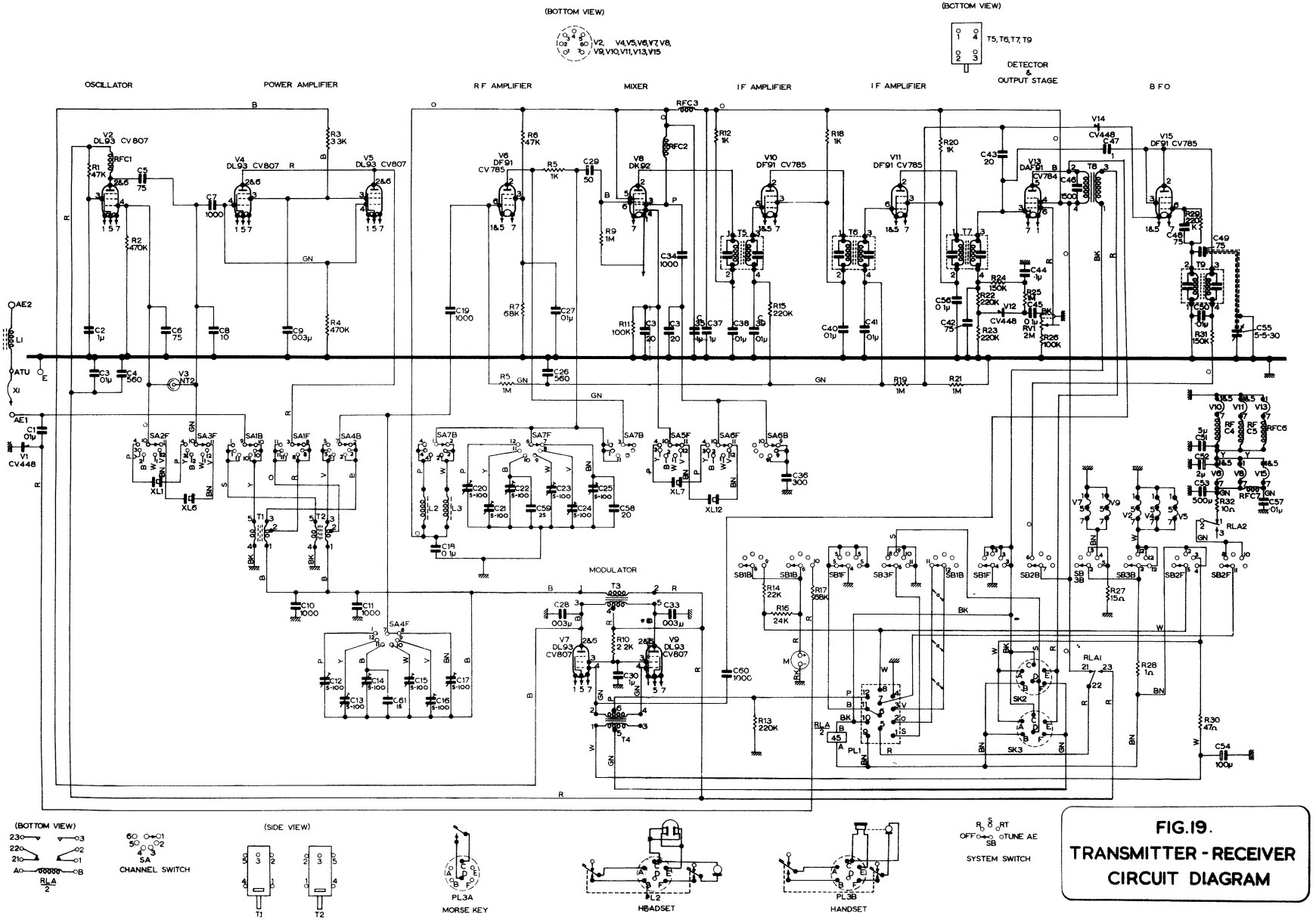


FIG.19.
TRANSMITTER - RECEIVER CIRCUIT DIAGRAM