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The information given in this document is not to be communicated either directly or indirectly to the Press or to any person not authorised to receive it.

USER HANDBOOK

for

STATION RADIO C41/R222 MK1/1

GROUND STATION

WARNING.

The voltages employed in this equipment are sufficiently high to endanger human life. The power MUST be switched off before changing valves or making internal adjustments. In case of electric shock see inside this cover.

PUBLISHED UNDER THE AUTHORITY OF
THE SIGNAL OFFICER-IN-CHIEF
THE WAR OFFICE
WHITEHALL S.W.1

MARCH 1963

WARNING

Non type-approved Mk. 5 plugs and sockets have been fitted to the first batch of production SR C41/R222 Mk. 1/1 equipments, Serial No. 001 to Serial No. 045 inclusive.

Users must not insert test prods into the centre of these plugs or sockets when making measurements.

ASSOCIATED PUBLICATIONS

Generating Set (Coventry Climax)	WO Code No. 970
Mast Lightweight	WO Code No. 12307
Aerial Array Yagi	WO Code No. 10697
Tele Set F	WO Code No. 1554
Tele Set J	WO Code No. 1530
ACT 1+3	WO Code No. 12004
ACT 1+4 Mk. 2	EMER Tels R160 to 164
ACT 1+4 No. 2 (4-wire)	WO Code No. 11425
Radio Relay Medium, Trucks 1 Ton	WO Code No. 11944

S Y N O P S I S

The Station Radio C41 Mk. 1/1 is a VHF, FM Radio Relay Set, for use in forward areas.

It is designed for use either as a terminal station or as an intermediate station in a radio relay chain.

Frequency coverage is 50 to 100 Mc/s. Selected frequencies within this range are governed by a choice of quartz crystals both for the transmitter and receiver.

The R222 Mk.1/1 receiver is designed for narrow or wide bandwidths for use with either 4 or 12-channel equipment respectively.

Intermediate Freq: 9.72 Mc/s (both wide and narrow-band)

Modulation Bandwidths: 300 c/s to 20 Kc/s narrow-band.
300 c/s to 70 kc/s wide-band.

NOTE: Wide-band transmissions should NOT be made at frequencies BELOW 65 Mc/s.

Performance:

Transmitter - High power 18-38 watts
Low power 4-10 watts

Peak Deviation - ± 60 kc/s narrow band
±180 kc/s wide-band

Range - 25 to 30 miles over near-visual paths. Range can be extended using intermediate stations as radio relays, but is limited to three links by noise.

Line - The equipment can be used with up to 7 miles of unloaded P3 quad cable for 12-channel operation, and with up to 12 miles of loaded P3 quad cable for 4-channel operation.

S Y N O P S I S (continued)

Engineering Circuit	-	Provides omnibus engineering circuit facilities between all radio stations within the system. In addition, terminals on the front panel give access to the phantom circuit of the cable connecting the terminal carrier and radio equipment.
Metering:		Metering for all operating circuits is provided by selector switches and meters in the transmitter and receiver units.
Power Requirements:		(See Associated Publications)
High Power Transmitter: Receiver:		2.4 Amps 1.3 Amps both at 240V AC
Test Oscillator:		Is provided as a test tone source to check the operation of an individual link, and also for fault finding.
NOTE:		System levels must be adjusted with a test tone provided by the Carrier equipment. See Signals Engineering Instruction).
Aerial Array:		Two are required for a complete station. Aerial Array Yagi No. 2, mounted on mast, 36-ft., steel, lightweight, DF No. 1. The array is mounted horizontally and fed by 75 ohms coaxial cable.

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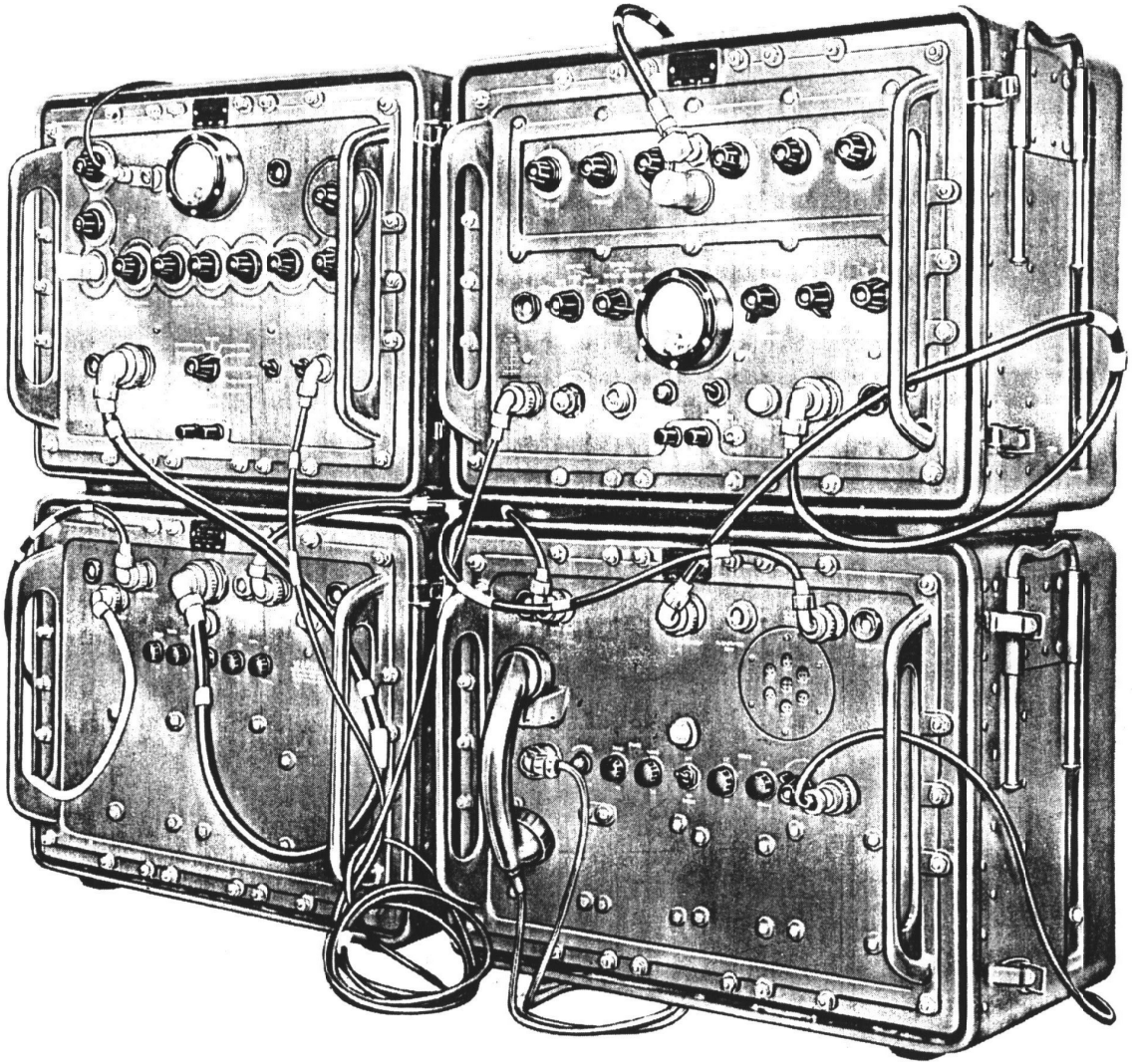


FIG I STATION RADIO C41/R222 MKI/I

CHAPTER I
INTRODUCTION

Section 1. Facilities

The SR C41 Mk. 1/1 is a broad-band VHF radio relay equipment, designed to provide reliable service over visual or near-visual ranges of 25 to 30 miles. The range can be extended by using two further stations as intermediate relays.

Power supply may be taken from the mains at 240V 50 c/s, or from standard field generating sets.

The equipment has internal metering, for setting signal levels, circuit checking and RF monitoring.

A test oscillator is incorporated to facilitate fault finding, and as a tone source for checking the individual links in a relay chain. The frequencies generated are 1.0 and 14.0 kc/s.

The Transmitter has master oscillator drive, continuously variable over the frequency range of the equipment. It is stabilised by reference to a crystal controlled standard in the AFC circuit. The Receiver operates on spot frequencies within the same frequency range as the Transmitter. A set of standard crystals for Transmitter and Receiver frequencies is provided with each station. The Transmitter crystals are marked "S" and the Receiver crystals "R". All crystals are marked with the operating frequency.

An omnibus circuit provides engineering facilities between all radio stations within the system.

The station can provide continuous twenty-four hour service for long periods and is designed to operate with multi-channel carrier telephone equipment, such as the ACT 1+4 No. 2 (4-wire) and ACT 12-Channel (Radio).

NOTE: Wide-band transmissions should NOT be made at frequencies BELOW 65.0 Mc/s.

Standard line impedances of either 150 ohms or 600 ohms are matched to the station by a switch on the receiver front panel. This caters for loaded P3 quad (4-channel) and unloaded P3 quad (12-channel). Equalisers in the C41 allow for up to 12 miles of loaded P3 cable (in four mile steps), and up to 7 miles unloaded P3 cable (in one mile steps).

The four units of the station are housed in identical cases, each consisting of an inner case, into which the unit proper is sealed and an outer case fitted with two fans and forming an air duct with the inner case. To secure the equipment into the two cases 22 nuts are spaced around the periphery of the front panel. Six of these nuts are painted white, these secure the outer case, the remainder are used to secure the equipment panel into the inner case. Fig. 2. A lid which fits over the front panel provides protection during transit. Sliding handles are attached to the sides of the outer case, these can be lowered so that they are flush with the top of the case when not required.

Weights and dimensions are as shown below:

TABLE 1 - Weights and Dimensions

Unit	Height in.	Width in.	Depth in.	Weight lb.
Transmitter C41	16	22	15	73
SUR 22	"	"	"	85
Receiver R222	"	"	"	78
SUR 23	"	"	"	84

The equipment is normally fitted into a vehicle, but it is equally suitable for use in a tent or dug-out, or, in emergency, in the open air.

Section 2. Purpose

The SR C41 Mk. 1/1 is designed for use in Radio relay systems forming part of an integrated communication network.

The working range of a C41 radio relay link using standard aerials over average country, is between 25 and 30 miles but this can be extended. Intermediate stations may be used as radio relays, two relay stations increasing the range to approximately 90 miles. It is not normally possible to use more than two additional radio relays owing to the increased noise level introduced by each successive stage.

Section 3. Siting

As with all VHF equipment, the aim should be to achieve line-of-sight working by choosing a suitable site. Since, however, the nominal working range of the SR C41 is slightly beyond line-of-sight, and very few 30-mile routes are free of all obstructions, every effort should be made to choose a signal path as clear as possible of obstacles which are known to restrict VHF communication especially within a mile or so of the sending and receiving aerials. Examples quoted could be: high ground, heavily wooded areas, large metal structures and towns.

By increasing aerial heights, or taking advantage of particularly favourable sites, it may be possible to increase working ranges considerably. (See Signals Engineering Instruction for greater detail).

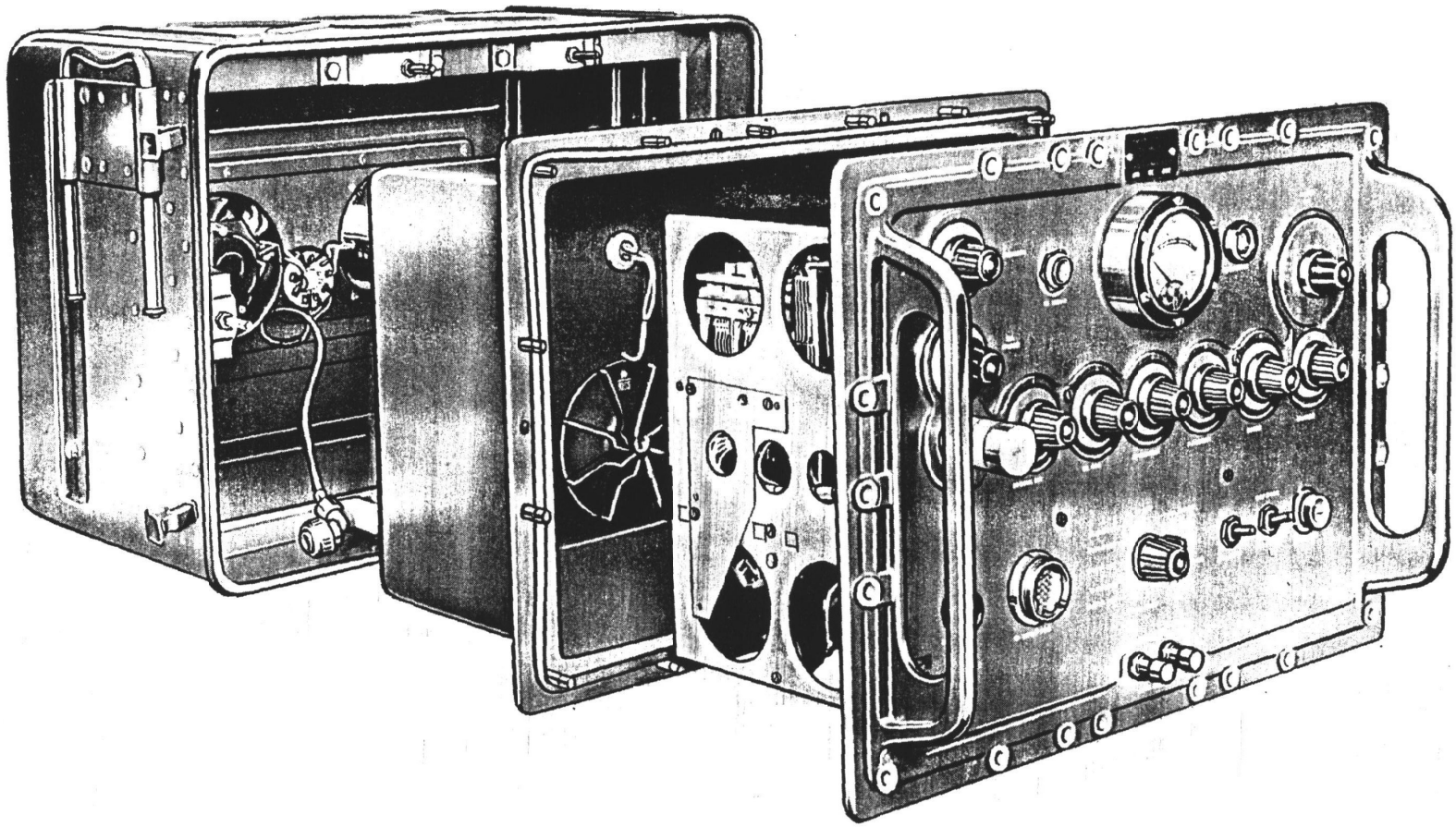


FIG.2 EQUIPMENT SHOWING INNER AND OUTER CASES

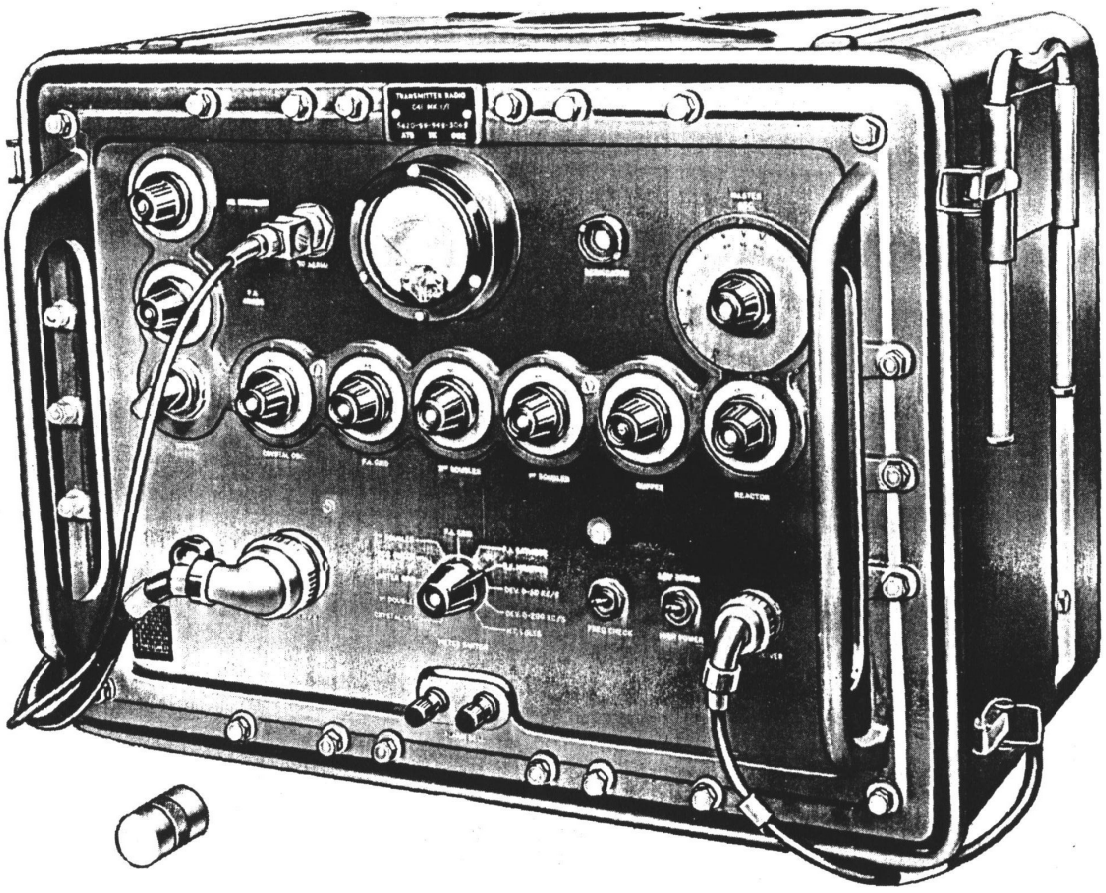


FIG.3 TRANSMITTER RADIO C41 MK1/1

CHAPTER 2
GENERAL DESCRIPTION

Section 4. Transmitter C41 Mk.1/1 (Fig. 3)

(1) Frequency Range

The frequency range of the transmitter is from 50 to 100 Mc/s, covered continuously by a master oscillator which is referred to plug-in quartz crystals used as frequency standards.

(2) Deviation

Peak deviation for 4-channel equipmen is 60 kc/s.
" " " 12- " " " 180 "

(3) Modulation Frequencies

Modulation frequencies normally used will be from 4-channel equipment with a maximum of 20 kc/s, or from 12-channel equipment with a maximum of 70 kc/s.

NOTE: The ACT 12-Channel should not be used with transmitter frequencies BELOW 65 Mc/s.

(4) Radiated Power

(a) Transmitter output power into a 72 ohm resistive load should be not less than the amounts shown in Table 2.

TABLE 2 - Radiated Power

Frequency in Mc/s	High Power (Watts) Min.
50	18
60	26
70	34
80	38
90	38
100	35

(b) The Low Power output should be not less than four watts, but not more than 60 per cent of the value on High Power.

(c) The power output required is selected by a switch on the front panel.

(5) Power Consumption

Power consumption under the conditions in Table 2 are given in Table 3 below:

TABLE 3 - Power Consumption

CONSUMPTION		
	Transmitter	Receiver
High Power	2.4A @ 240V AC	1.3A @ 240V AC
Low Power	@ 240V AC	1.3A @ 240V AC

(6) Working Range

Working ranges are as shown in Table 4 below. They are approximate and should be used only as a rough guide. For further information, the reader is referred to Chapter 1, Sections 2 and 3.

TABLE 4 - Working Ranges

High Power	30 miles
Low Power	20 miles

(7) Metering facilities are provided by the switch on the front panel which enables the built-in meter to be used as follows:

(a) As a tuning indicator for all operating circuits.

(b) As a voltmeter for checking HT supply to Transmitter

(c) To measure carrier deviation.

(d) As a continuous monitor of Transmitter RF output.

(8) Aerials

One type of aerial is used with the SR C41 Mk. 1/1, namely Aerial Array, Yagi, No. 2 and this is described in its own handbook. (See Associated Publications).

NOTE: Two aerials are required for the complete station, one for the transmitter and one for the receiver.

(9) Cooling

Two blower type fans, mounted on the inside of the outer case, circulate cool air around the cavity between the inner and outer cases. A further fan, mounted on the inside of the inner case, circulates the air inside the transmitter and prevents over-heating around any one component or valve. This also has the effect of continually changing the air in contact with the walls of the inner case and materially improving overall heat dissipation. The fan supplies are inter-locked with the supplies to the power supply unit in such a way that the transmitter cannot function unless the fans are connected.

Section 5. Supply Unit Rectifier No. 22 Mk. 1/1 (See Fig. 4)

(1) Input to the unit is at 240 volts 40-60 c/s and may be taken from standard field generating sets or from local supply mains.

(2) The two fuses to the left of the ON/OFF switch are of 5.0 amp rating, and are wired into both legs of the mains input to the unit. The two fuses to the right of the switch are wired into the 6.3V heater circuit and the negative line of the HT supply, and are rated at 1.0 amp and 500 mA, respectively.

(3) A pilot lamp on the front panel indicates when the power supplies are switched on.

(4) A socket on the front panel enables an operators lamp to be used with the transmitter.

(5) The DESICCATORS should normally be blue. If their colour has changed to pink, the sealing of the unit is impaired and the desiccators are saturated. The unit should be returned to workshops to be dried out and re-sealed.

(6) Cooling is effected in the same manner as in the transmitter, using two fans to circulate cool air around the cavity between the inner and outer cases. The fan supply voltages in the SUR 22 are inter-locked with the mains input circuit, ensuring that the power supplies to the transmitter cannot be switched on until the fans are connected.

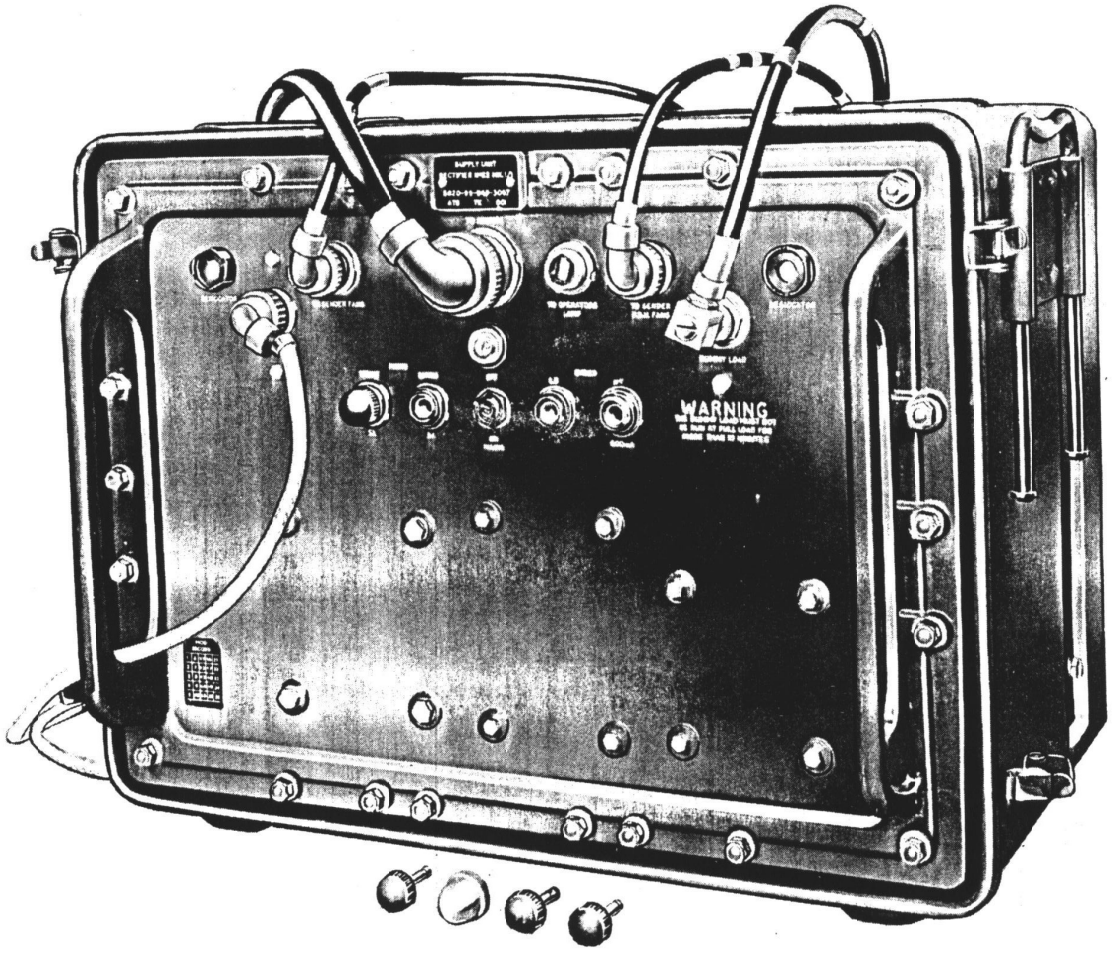


FIG.4 SUPPLY UNIT RECTIFIER No.22 MK1/1

(7) The dummy load fitted into the S.U.R. No. 22, is provided for setting up the transmitter without radiating a signal. It can be connected to the transmitter by fitting a short co-axial connector between the plug on the S.U.R. marked DUMMY LOAD and the plug on the transmitter marked TO AERIAL.

Section 6. Receiver Radio R222 Mk. 1/1 (See Fig. 5)

(1) The receiver and line unit together form one of the four sealed units of the station.

(2) The receiver is a broad-band crystal controlled single superheterodyne covering a VHF frequency range of 50 to 100 Mc/s. It will accept modulation frequencies as follows:

Narrow-band, 20 kc/s, peak deviation ± 60 kc/s

Wide-band 70 kc/s, " " ± 180 "

(3) Two separate IF amplifiers cater for equipment with differing modulation bandwidths. The narrow-band amplifier is used with equipment such as the ACT 1+4 No. 2 (4-wire), and the wide-band amplifier with the ACT 12-Channel (Radio).

(4) Sensitivity of the receiver is 5 to 6 µV for 10 dBs quieting, using the narrow-band IF amplifier, and 7 to 8 µV for 10 dBs quieting, using the wide-band IF amplifier.

(5) Metering facilities are provided by the switch on the front panel which enables the built-in meter to be used as follows:

(a) As a tuning indicator for all operating circuits.

(b) As a voltmeter for checking HT supply to Receiver.

(c) As a repeater, duplicating the reading of the Transmitter deviation meter.

(d) As a functional check on the first RF amplifier.

(e) In conjunction with the LINE ATTENUATOR controls as a transmission measuring circuit.

(6) Power consumption is 300 watts with either IF amplifier.

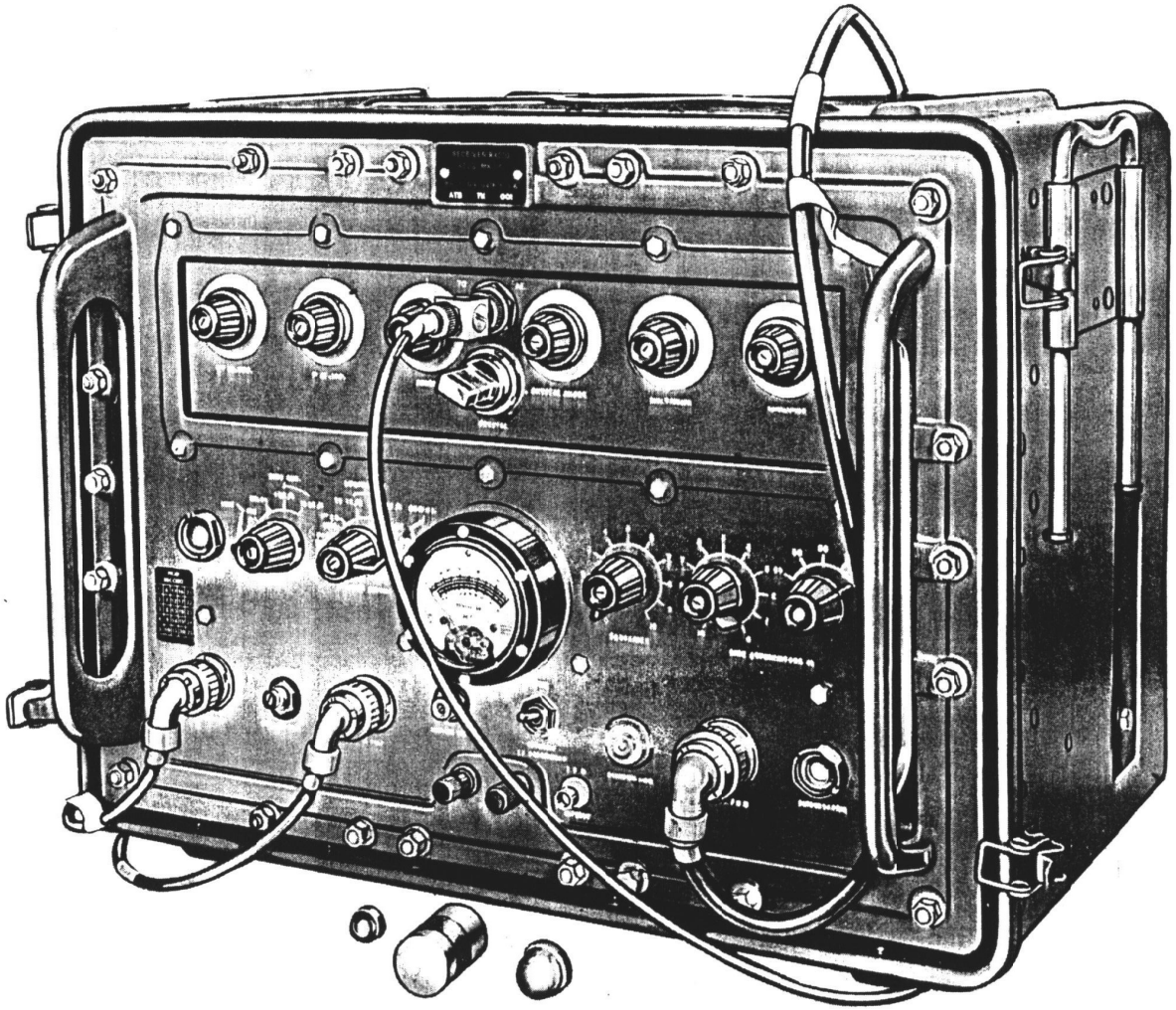


FIG. 5 RECEIVER R222 MK1/1

(7) Aerial Array, Yagi, No. 2 is used with the receiver. This is described in detail in its own handbook. (See Associated Publications). (A separate aerial of similar type is required for the transmitter).

(8) Two fans, mounted on the outer case, provide cooling for the receiver. This is effected by forcing air through the cavity between the inner and outer cases. The mains supply to the fans is inter-locked with the mains circuits of the supply unit rectifier, so that the receiver cannot operate until the fans are connected.

Section 7. Line Unit (In Receiver R222) (See Fig. 5)

(1) The line unit is built into the same case as the receiver radio R222. The LINE IN unit includes the line matching transformer for input impedances of 150 or 600 ohms, the coarse and fine attenuators for setting the transmitter deviation, equalisers which correct the frequency response of the line, and finally, a two-stage modulation pre-amplifier. Also associated with the LINE IN unit is the test oscillator, which produces audio tones of either 1.0 or 14.0 kc/s. It is used as a test tone source to check the operation of an individual radio link, and also for fault finding.

(2) The LINE OUT unit provides two routes for signals from the receiver:

(a) Via a variable gain amplifier and an impedance matching transformer at 150 or 600 ohms.

(b) Passed direct via the relay matching transformer in the RELAY position at fixed level.

In the former instance, output to line can be set to the required level using the metering facilities. In the latter it has been found in practice that the RELAY position is not entirely satisfactory under all conditions and its use therefore is not recommended.

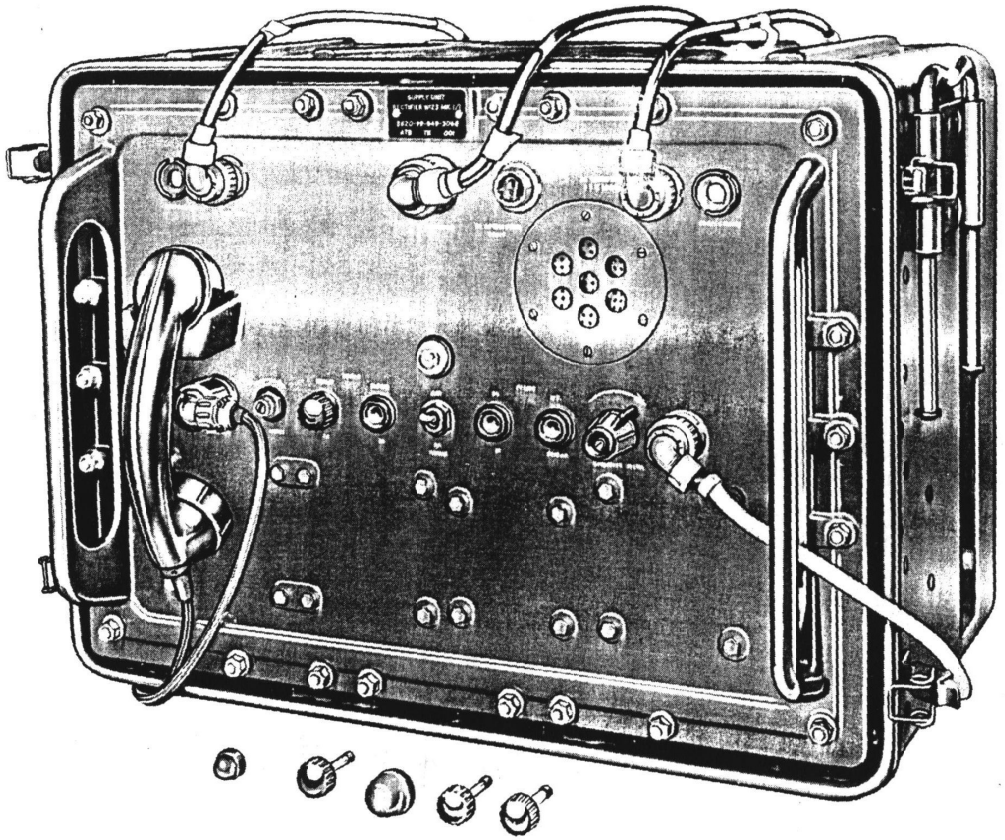


FIG 5 SUPPLY UNIT RECTIFIER No.23 MKI/1

Section 8. Supply Unit Rectifier No. 23 Mk. 1/1 (See Fig. 6)

(1) The SUR No. 23 Mk. 1/1 supplies power to the receiver and line amplifiers at 300V HT, and 6.3V AC for the heaters.

(2) The FUSES MAINS are wired into both legs of the mains input to the unit, and are rated at 2.0 amps.

The fuses marked LT and HT, are wired into the 6.3V heater circuit and the negative leg of the high tension supply, and are rated at 1.0 amp and 500 mA, respectively.

(3) Provision is made for connecting an operators lamp to the 6.3V AC supply by a two-pin socket on the front panel of the unit.

(4) The unit also houses the amplifiers, the handset (Telephones Hand S.I. No. 3) and the monitor loudspeaker associated with the main engineering channel. (See Section 9).

(5) Mounted on the front panel are two controls, one for setting the microphone input level, and the other the volume of sound from the loudspeaker. The MIC. LEVEL control setting should be checked and adjusted only by competent personnel with the necessary test gear available.

(6) The cast fitting on the front panel is provided as a rest for the handset when not in use.

(7) Cooling is effected by two fans in the same way as the other units. The voltages supplying the fans in the SUR No. 23, and in the receiver, are inter-locked with the supply mains to the SUR and the receiver cannot work until the fans are connected.

(8) The DESICCATORS should normally be blue. If their colour has changed to pink, the sealing of the unit has become impaired, and the unit should be returned to workshops to be dried out.

Section 9. Engineering Channels (In Line Unit and SUR No. 23) (See Fig. 6)

(1) The main engineering channel, operating on the voice frequency channel of 300 to 2,700 c/s, is provided to enable Radio Relay personnel to communicate with each other without disrupting traffic circuits. The reader is referred to the appropriate S.E.I. for full details of its application over a radio relay chain and for use in conjunction with carrier terminal equipment.

(2) Signalling is by Voice Calling over the engineering channel, communicatio: with any required station being initiated by lifting the handset and calling the station. The operator will hear the call through the monito loudspeaker in his SUR No. 23, and can answer using his own handset.

(3) The volume of sound from the loudspeaker can be adjusted to over-ride ambient noise by the control on the SUR No. 23 marked SPEAKER LEVEL.

NOTE: THE CONTROL SHOULD NOT BE TURNED TO ZERO AT ANY TIME OR IMPORTANT INSTRUCTIONS MAY BE MISSED

(4) The control on the SUR No. 23 marked MIC. LEVEL is pre-set at the factory to ensure correct injection levels to the Transmitter and Receiver.

NOTE: THE SETTING SHOULD BE RE-ADJUSTED ONLY BY COMPETENT PERSONNEL WITH THE NECESSARY TEST GEAR AVAILABLE.

(5) The loudspeaker is automatically muted when the handset pressel switch i: pressed. Note that the loudspeaker is inoperative until the handset is connected.

(6) Terminals on the front panel of the Receiver make provision for use of a Field Telephone set over a phantom circuit between the radio terminal an some types of carrier terminal equipment, and between the two receivers a radio relay station where the distance between them creates this need.

NOTE: THIS FACILITY IS NOT AVAILABLE WHEN THE SET IS IN THE RELAY CONDITION.

TABLE 5

(KEY TO FIG. 7)

Code	Location	Quantity	Remarks
A	Coaxial feeder	2	Receiver to aerial - Transmitter to aerial (Supplied in 100 ft. lengths)
B	Receiver to Transmitter	1	
C	Receiver to Terminal Box (connection to line system)	1	
D	Receiver SUR to Receiver Fans	1	Power supply to fans
E	Transmitter SUR to Transmitter	1	HT and LT to Transmitter
F	Receiver SUR to Receiver	1	HT and LT to Receiver
G	Connection to SUR fans	2	Power supply to fans
H	Operator Lamps on SUR's	2	Connector supplied with Lamp
J	Distribution Panel to SUR's	2	Power Input to Transmitter and Receiver SUR's
K	Connection between Transmitter alarm terminals to buzzer or lamp	As required	Twisted pair cable of required length
L	Connection of Field Telephone to Receiver "Phantom" terminals	As required	Cable, field, D10 of required length
M	Connection between handset and socket on Receiver SUR	1	Supplied with the handset
N	Connector between Distribution Panel and Power Supply	1	Suitable cable of required length
O	Coaxial Feeder	1	Transmitter to Dummy Aerial
P	Transmitter SUR to Transmitter Fans	1	Power Supply to Fans

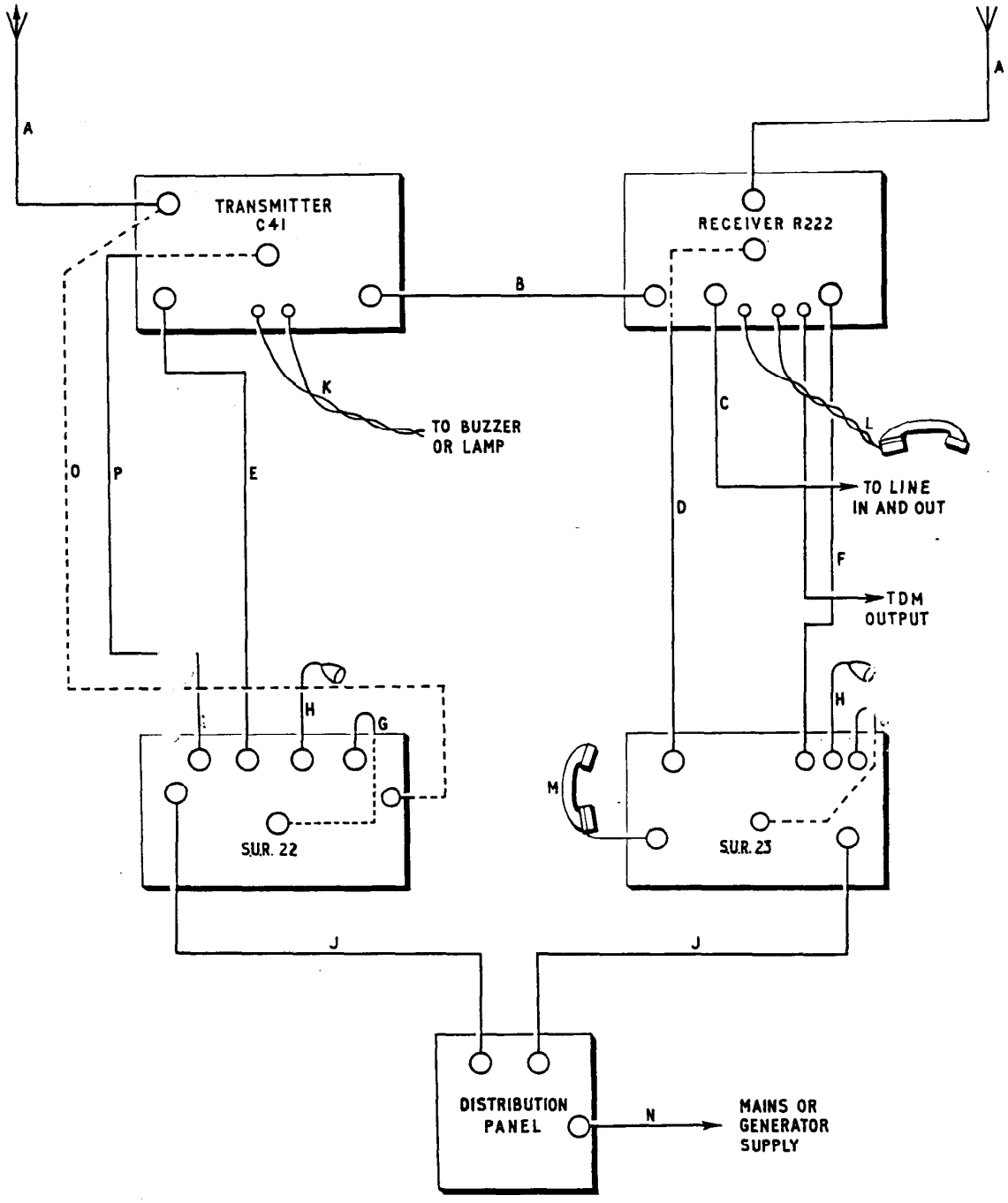


FIG. 7 DIAGRAM OF CONNECTIONS

CHAPTER 3
OPERATION

WARNING

The voltage produced by this equipment is sufficiently high to endanger human life. For first aid treatment in case of Electric Shock see inside front cover.

Section 10. Installation Check

(1) Check that all connectors are in place and that the locking rings are firmly tightened by hand. (See Fig. 7 on the opposite page for diagram of connections).

Section 11. Erecting and Tuning the Aerials

(1) The reader is referred to Handbooks W.O. Code No. 12307 and W.O. Code No. 10697 (see Associated Publications).

(2) Before erecting the masts, the transmitter and receiver aerial elements should be set to the correct length and spacing for the ordered frequency.

(3) The DC resistance of each aerial should be measured with an Avometer across the co-axial socket at the set end of the cable. This should not exceed five (5) ohms. If the DC resistance is greater than five ohms, all contact surfaces and connectors should be thoroughly cleaned then re-checked. End to end continuity of the elements should also be checked. During service, a periodical recheck is advised.

(4) After the masts have been erected, the aerials should be pointed roughly in the direction of the distant station to or from which they will be working.

(5) Both aerials should be directionally aligned for maximum signal strength after the Transmitter and Receiver have been tuned and set up.

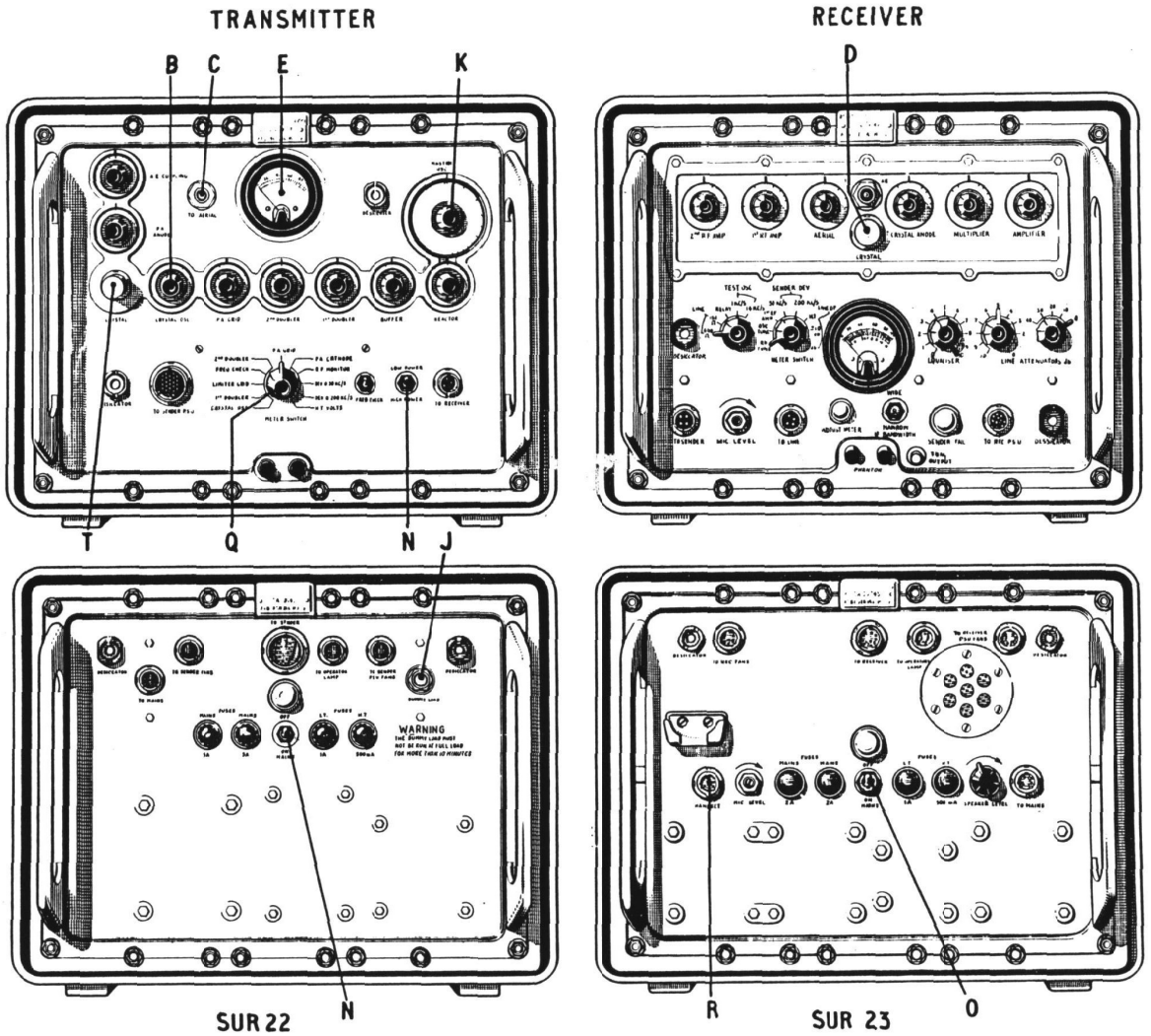


FIG. 8 CONTROLS

Section 12. Setting Up

(1) Check the colour of the DESICCATORS on the front panel of each of the four units. If the sealing of the units is unimpaired, and the units are completely dry, the DESICCATORS will be blue. Should the DESICCATORS have turned pink, they are saturated, and the units concerned should be returned to workshops to be dried out and re-sealed.

(2) Disconnect the aerial lead from the Transmitter, and fit the short co-axial connector between the aerial plug (C) on the Transmitter and the plug (J) on the SUR No. 22 marked DUMMY LOAD.

(3) Fit the plug on the handset line-cord into the socket (R) on the SUR No. 23 and tighten the locking ring firmly by hand. (The loudspeaker is inoperative until the plug is in position).

(4) Ascertain the operating frequencies and fit the appropriate crystals into the holders on the front panels of the Transmitter (T) and Receiver (D), taking care that only crystals marked "S" are used in the Transmitter and those marked "R" in the Receiver. The covers should be replaced and tightened firmly by hand.

(5) Switch on the power supply to the Transmitter (SUR No. 22) Fig. 8 (N) and Receiver (SUR No. 23 (O)), and allow not less than thirty minutes for the equipment to reach optimum working temperatures.

It is suggested that on arrival on site, power is applied and the sets are switched on before erecting aerials, etc.

Section 13. Tuning the Transmitter

(1) During initial tuning, or when changing frequency, the Transmitter is used to tune the Receiver. For this purpose the Transmitter should be tuned to the ordered receiving frequency.

After the Receiver has been tuned the Transmitter may then be tuned to the ordered transmitting frequency.

(2) Sequence of tuning operations:

(a) To tune the Receiver, first tune the Transmitter to the ordered receiving frequency as detailed in Section 13, paras (3) to (16) and (19).

(b) Tuning the Transmitter. Tune the Transmitter to the ordered transmitting frequency as detailed in Section 13, paras (3) to (20).

(3) Set the Transmitter High-Low Power switch on the Transmitter (N) to LOW, until tuning has been completed.

(4) If power supplies are not switched on see Section 12 (5).

(5) Check the transmitter HT by setting the METER switch (Q) to HT VOLTS. The meter will normally read not more than two divisions on either side of the red line on the scale.

(6) Set all controls to the ordered frequency, then proceed to tune as shown below. The MASTER OSC. control Transmitter (K) is extremely critical and must therefore be turned very slowly. Meter readings at other than the ordered frequency should be ignored.

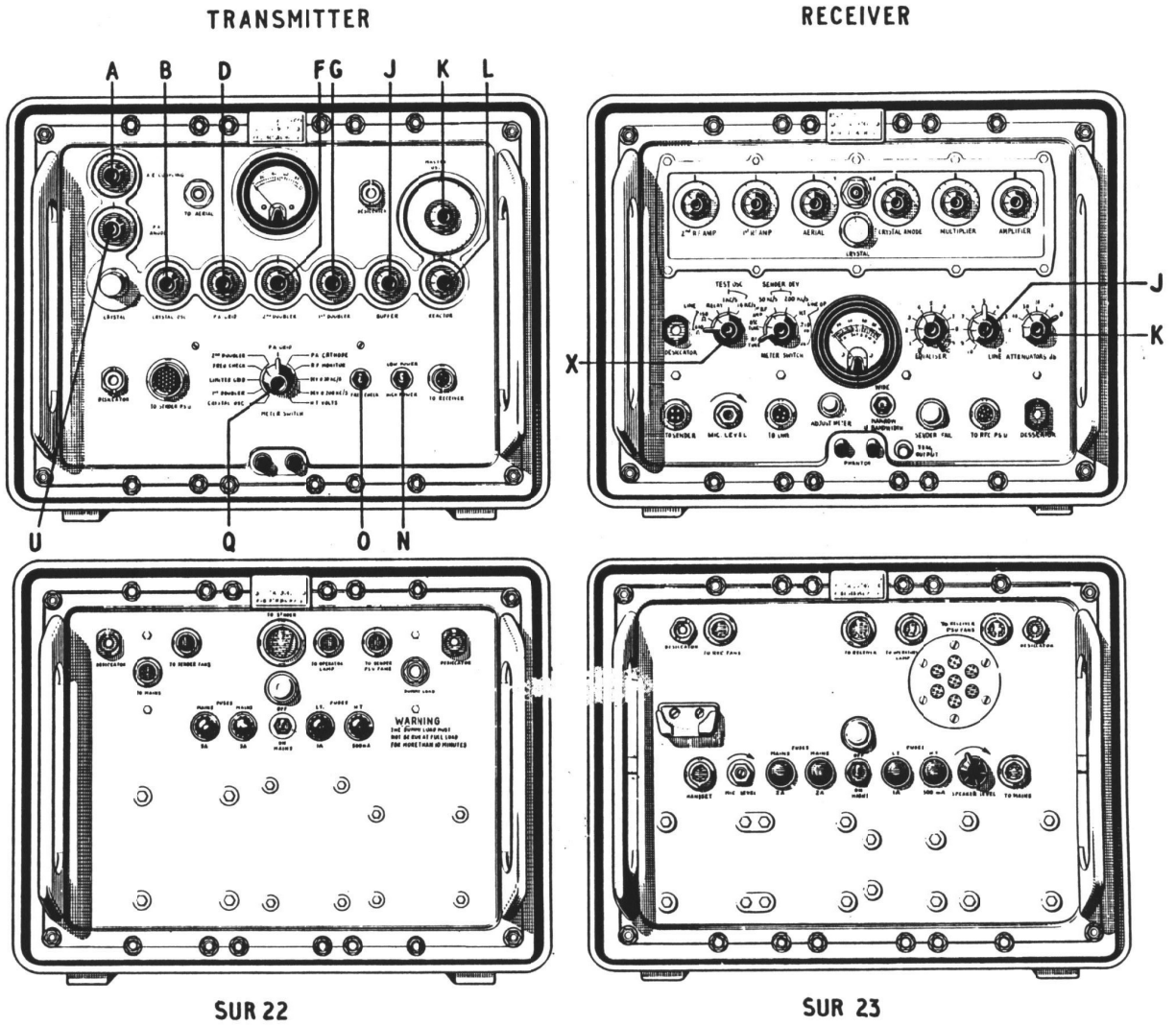


FIG. 9 CONTROLS

(7) Set the Transmitter METER SWITCH (Q) to CRYSTAL OSC. and adjust the CRYSTAL OSC. control (B) for maximum meter reading.

(8) Set the Transmitter METER SWITCH (Q) to 1st DOUBLER and adjust the 1st DOUBLER control (G) for maximum meter reading.

(9) Leave the Transmitter METER SWITCH as set, and tune the BUFFER control (J) for maximum meter reading.

10) Set the Transmitter METER SWITCH to LIMITER GRID, and tune the MASTER OSC. control (K) for maximum meter reading.

11) Set the Transmitter METER SWITCH TO FREQ. CHECK. Depress the FREQ. CHECK toggle switch (O) (to the right of the selector switch), and note the meter reading. Release the toggle switch and adjust the MASTER OSC. control (K) until the meter reads the same figure as when the toggle switch (O) was depressed. Only a very small movement of the MASTER OSCILLATOR is required, from the setting obtained in Section 13 (10). Press the FREQ. CHECK toggle switch (O) again to ascertain that the meter reading remains unchanged under the two switch conditions.

12) Return the Transmitter METER SWITCH to the position 1st DOUBLER, and retune the 1st DOUBLER control (G) for maximum meter deflection.

13) Leave the Transmitter METER SWITCH as set, and retune the BUFFER control (J) for maximum meter deflection.

14) Set the Transmitter METER SWITCH to 2nd DOUBLER, and tune the 2nd DOUBLER control (F) for maximum meter deflection.

15) Set the Transmitter METER SWITCH to PA GRID, and tune the PA GRID control (D) for maximum meter deflection.

16) Set the Transmitter METER SWITCH to RF MONITOR, and tune the PA ANODE and AE COUPLING controls (U) and (A) for maximum meter deflection. It will be necessary to re-adjust each control two to three times in turn to obtain the best possible meter reading.

17) Set the Transmitter METER SWITCH to DEV. 0-50 KC/S, and the Receiver Selector switch (X) to TEST OSC. 14 KC/S. Adjust the Receiver LINE ATTENUATORS dB (J) and (K) until the Transmitter meter reads approximately half scale, then tune the Transmitter REACTOR control (L) for maximum deviation of the meter. This adjustment requires some care to obtain the correct maximum reading of the meter.

The Transmitter deviation meter reading can be repeated at the Receiver (see Section 14 (9). "NOTE".

(18) Turn the Receiver SELECTOR SWITCH (X) to LINE 150.

(19) Repeat 13 (11) to 13 (16) inclusive.

(20) Disconnect the dummy load and reconnect the aerial. Set the Transmitter HIGH/LOW POWER switch (N) to the power required. Readjust the PA ANODE and AE COUPLING controls (A) and (U). These will always require slight re-adjustment after changing the setting of the HIGH/LOW POWER switch.

NOTE: Leave SELECTOR SWITCH (X), in the Receiver, set to LINE 150.

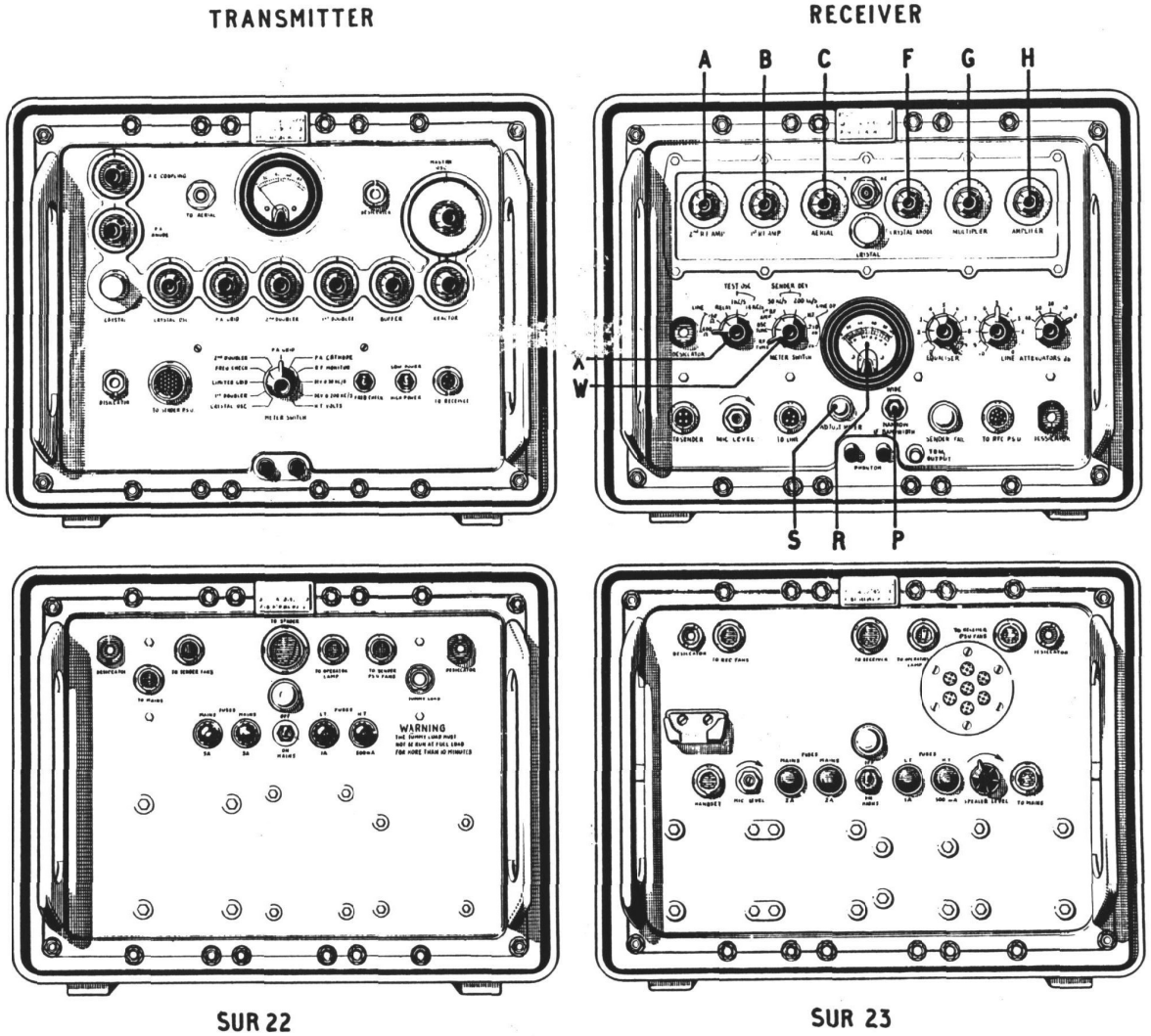
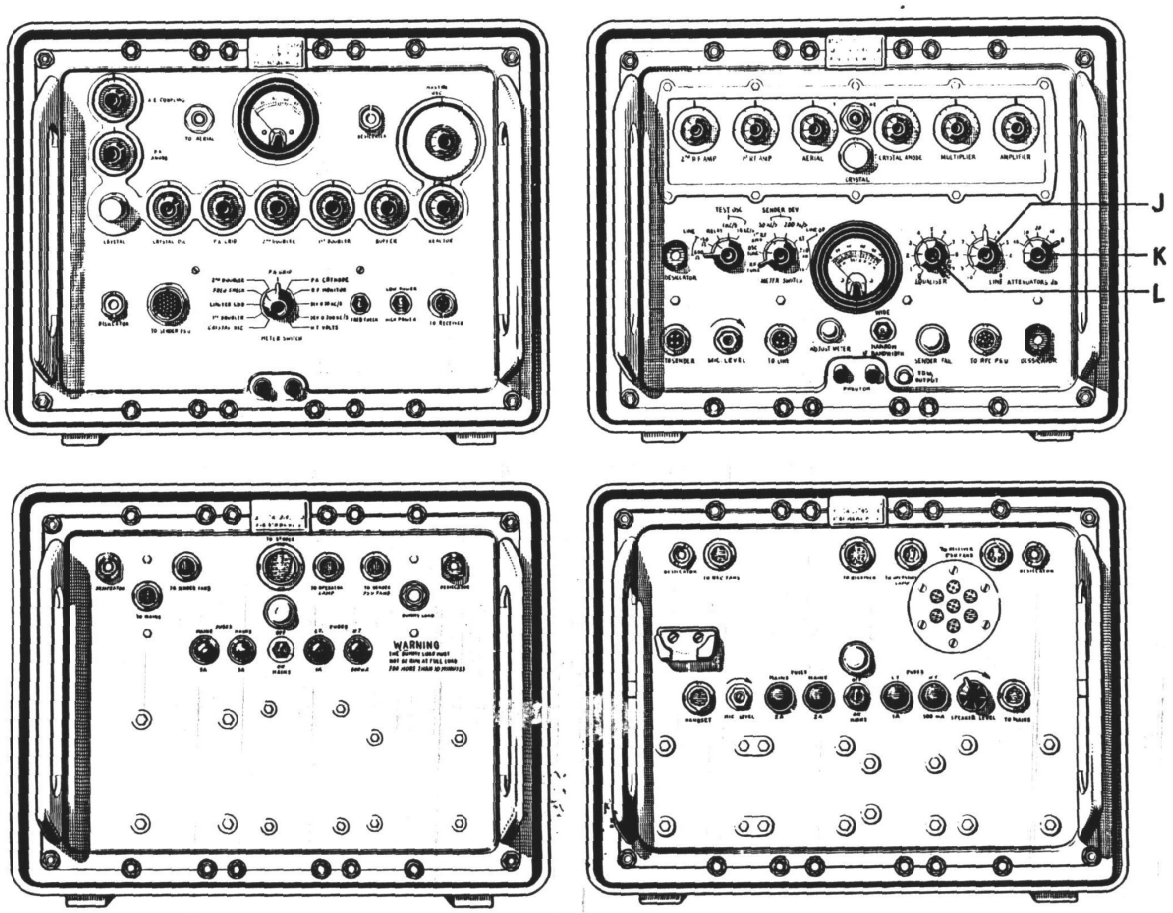


FIG.10 CONTROLS

TRANSMITTER

RECEIVER



SUR 22

SUR 23

FIG.11 CONTROLS

(2) Using Table 6, set the Receiver EQUALISER (L) and LINE ATTENUATOR (K) and (J) controls to the figure shown.

TABLE 6 - Line Output Levels

Cable Length (miles)	FOR P3 QUAD CABLE ONLY			
	Set Equaliser control to:-		Set Line Attenuator controls to:-	
	4 channel system	12 channel system	4 channel system	12 channel system
0	0	0	42	36
1	0	4	39	32
2	1	5	36	28
3	1	6	33	24
4	1	7	30	20
5	1	8	27	16
6	2	9	24	12
7	2	10	21	8
8	2		18	
9	2		15	
10	3		12	
11	3		9	
12	3		6	

NOTE (1) No further adjustment of the EQUALISER control should be made after the initial setting.

(2) Final setting of line attenuators will be made during system line up (see S.E.I.).

NOTE: At this stage, if adjacent stations are ready, it should be possible to speak to them using the engineering channel facilities (see Section 17 on page 27).

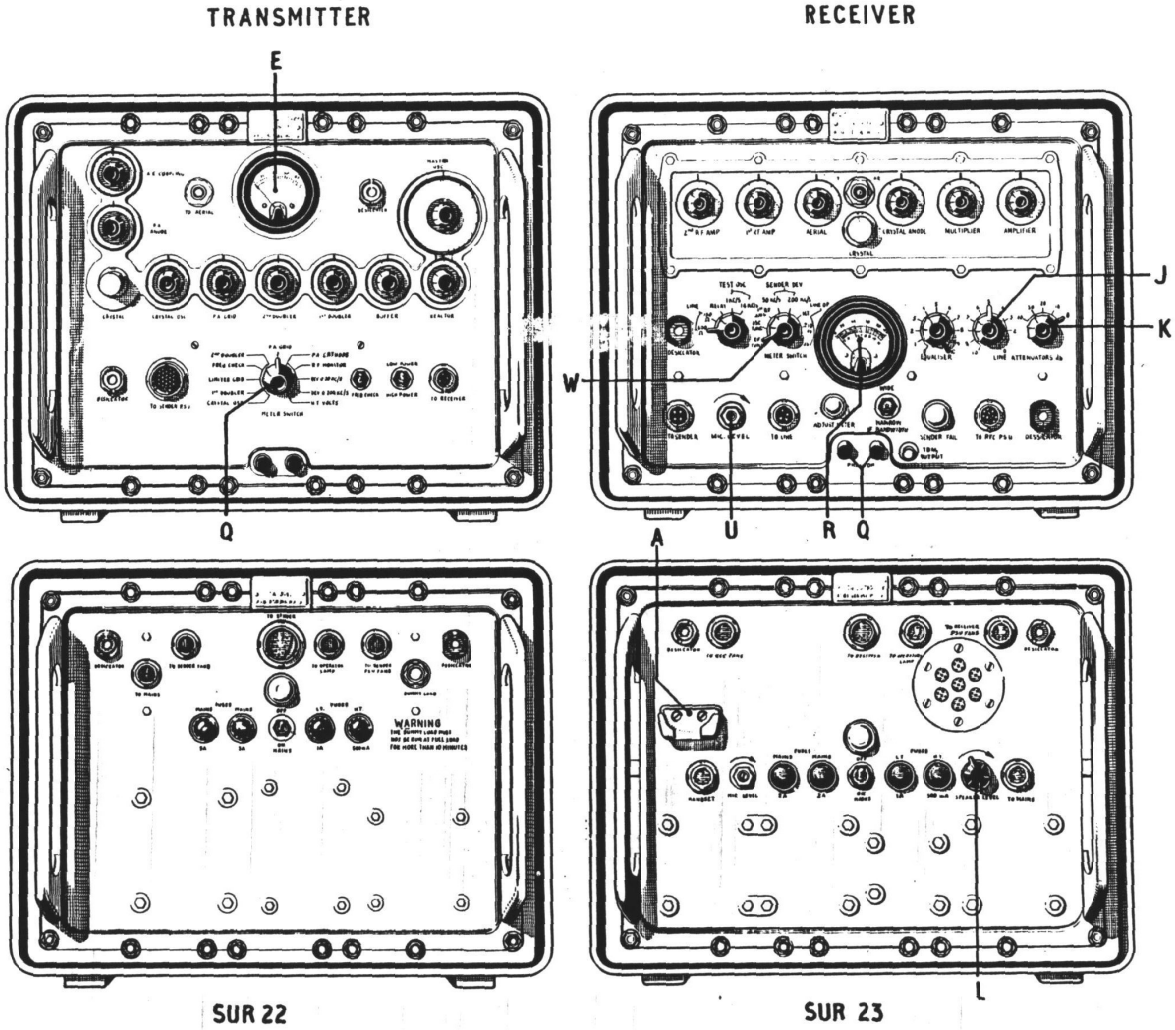


FIG.12 CONTROLS

(3) Setting Deviation

During overall adjustment of the SR C41 system, it will be necessary to make final adjustment of deviation. To do this set Transmitter meter switch (Q) to DEV 0-50 kc/s, and adjust line attenuators (J) and (K) in Receiver until meter reads required deviation.

NOTE: The meters (E) and (R) in the Transmitter and Receiver, have dials calibrated 0 to 100. Therefore, in the DEV. 0-50 kc/s position of the meter switches, if the meter reads 60, the actual deviation will be half that figure, or 30 kc/s.

(4) Setting Line Output Level

During overall adjustment of the SR C41 system, it will be necessary to make final adjustment of line output level. To do this set Receiver meter switch (W) to dB, and adjust receiver line output potentiometer (U) until the meter (R) reads the required level. (Lower scale).

Section 16. Setting Up the System

(1) Once the links have been established, and before commencing normal operation, each Transmitter and Receiver in the chain should be finally adjusted for correct deviation and level to line respectively, in accordance with instructions in the relevant Signals Engineering Instruction.

Section 17. The Engineering Channels

(1) To use the engineering channel, lift the handset from its rest (A) on SUR No. 23, press the switch in the handle, and speak clearly into the microphone. If the volume of sound from the earpiece and loudspeaker is not sufficient, it can be increased by adjusting the SPEAKER LEVEL control (L) also on the SUR No. 23.

(2) If requested by System Control to use phantom circuits between sets at a relay station (if separated by a length of quad cable) or between channelling and radio equipment, connect Tele F or J set to phantom terminals (Q) on the front panel of the Receiver. Calling, on this type of circuit, is by hand generator on the Tele F or J set.

NOTE: The phantom facility is not available if the equipment is in the RELAY condition.

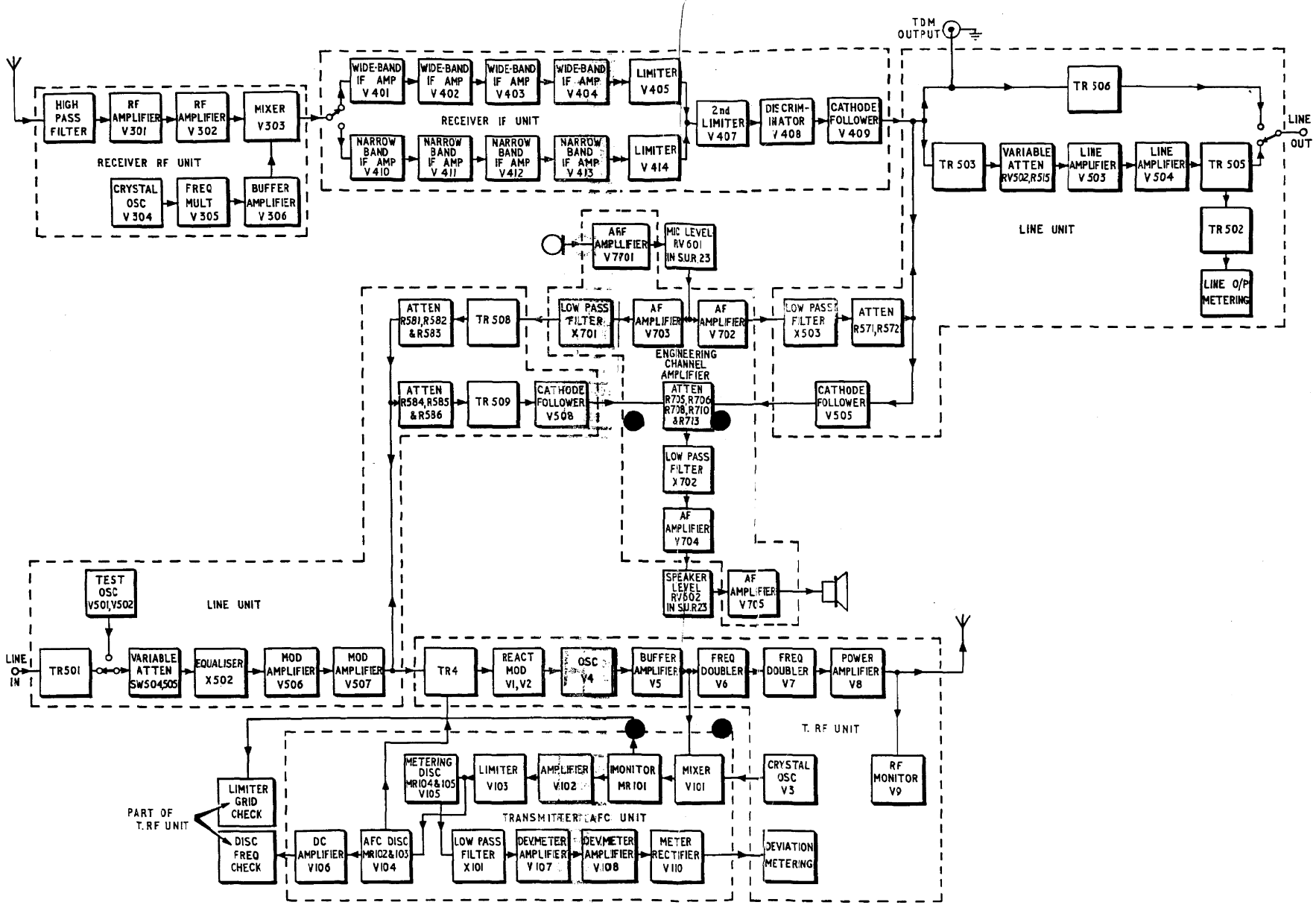


FIG.13 SR C41/R222 MK1/1, BLOCK DIAGRAM

CHAPTER 4
BRIEF TECHNICAL DESCRIPTION

Section 18. Transmitter

(1) The master oscillator (V4) covers a frequency range of 6.25 to 12.5 Mc/s, and is designed as a Hartley oscillator. The anode circuit operates at double the frequency of the grid circuit, and is heavily damped to provide adequate bandwidth for the modulation frequencies.

(2) Frequency modulation is applied to the master oscillator by a reactance modulator consisting of two valves (V1 - V2) whose grid circuits are fed in push-pull, and whose anode circuits are wired in parallel. When the reactor grid circuit is correctly tuned, the RF voltage at the grids of the two valves (fed back by link coupling from the master oscillator tank circuit to the reactor grid circuit) is in quadrature (90° out of phase) with the voltage at the master oscillator grid. In the absence of modulation the reactor valves are balanced. When modulating signals are applied to the grids of the reactors, the balance is disturbed and current is drawn from the master oscillator circuit, which is 90° out of phase with the grid voltage, and has the apparent effect of placing a varying reactance across the master oscillator tuned circuit. The magnitude of the variation will be proportional to the voltage or amplitude of the modulating signals.

(3) The buffer-amplifier (V5) isolates the master oscillator from succeeding stages of the transmitter, and operates in the same frequency range as the anode circuit of the master oscillator, (12.5 to 25 Mc/s).

(4) The first frequency doubler (V6) follows the buffer-amplifier. The grid circuit tunes the same frequency range as the buffer-amplifier, and the anode circuit to twice the frequency (25 to 50 Mc/s).

(5) The grid circuit of the second doubler (V7) tunes the same frequency range as anode circuit of the first doubler (25 to 50 Mc/s) and the anode circuit to twice the frequency of the grid circuit (50 to 100 Mc/s).

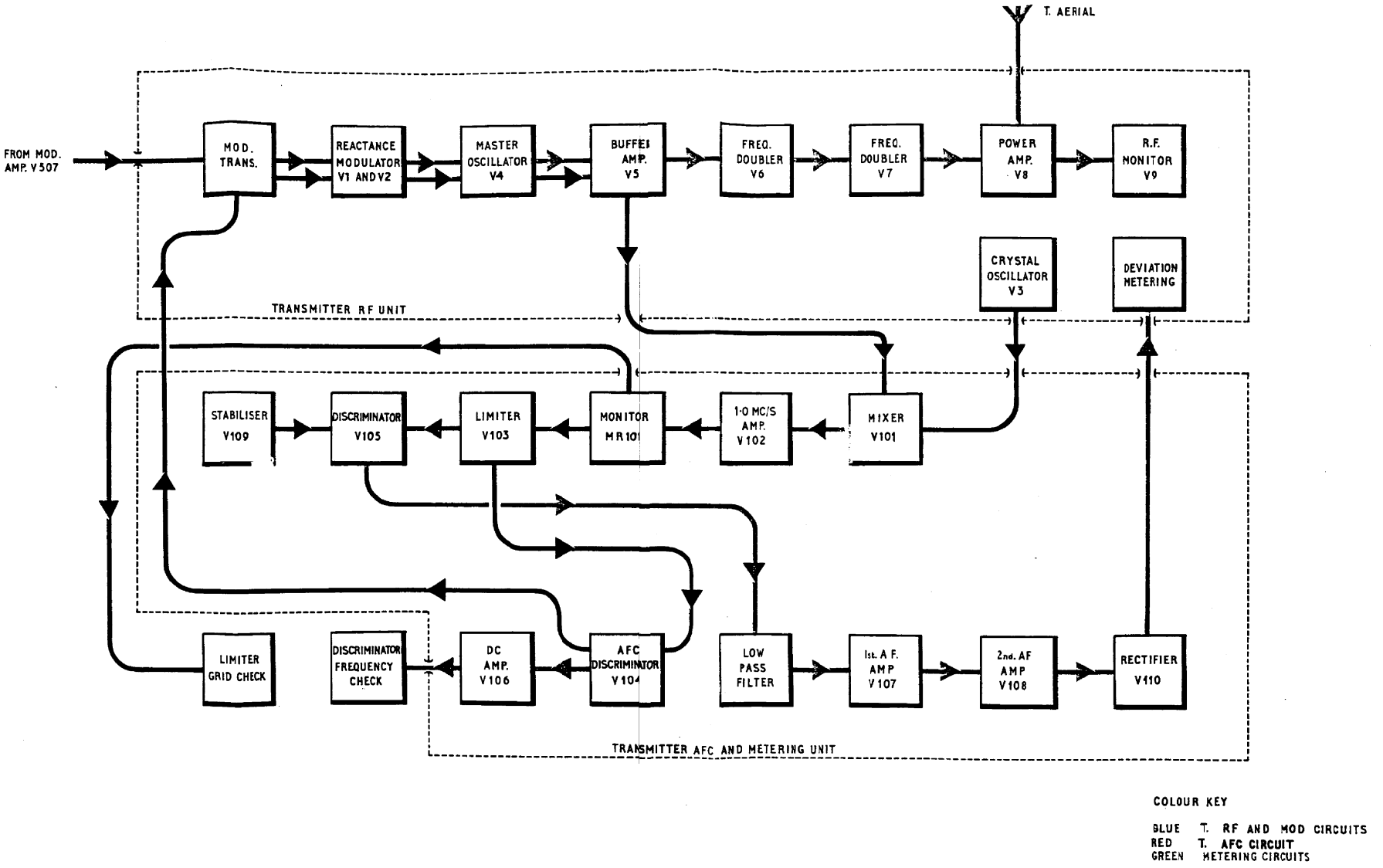


FIG. 14 TRANSMITTER C41 MKI/1 BLOCK DIAGRAM

(6) The PA stage (V8) is a double RF tetrode driven from the second doubler, and aththe same frequency. The anode supply is taken from the 500V HT line, and the screen grid supply from the 300V HT line. The grid circuits are returned to earth via a 40V negative supply, which provides fixed bias in addition to that developed across the grid resistors. The anode circuit is coupled to the aerial via a 75 ohms coupling coil.

(7) Continuous monitoring of the power output from the transmitter is provided by the RF monitor (V9). This circuit operates from RF voltages tapped directly from the transmitter aerial circuit. Indication of output is provided by a meter which reads the monitor grid current. The PA valve is protected against possible damage from overload, failure of drive or anode HT supply, by a relay in the anode circuit of the RF monitor valve. Should a fault occur which puts the PA valve out of action, the meter will cease to read (assuming it to be switched to RF Monitor) and one pair of relay contacts will close, ringing an alarm bell. In the meantime, another pair of relay contacts has opened, introducing increased resistance into the HT supply to the PA screens, thus reducing the screen grid voltage to a safe level. A further pair of contacts makes the circuit to the SENDER FAIL lamp on the Receiver front panel.

(8) A thermal cut-out housed in the transmitter is provided as a safeguard against overheating. It is connected in series with the primary winding of the HT transformer, and cuts off the HT supply at approximately 85°C. The transmitter must be removed from its case to re-set the cut-out.

(9) Automatic frequency control of the transmitter is referred to a crystal controlled oscillator V3 in which the screen grid functions as the anode of the crystal oscillator. The crystals used are in the frequency range 4.5 to 8.66 Mc/s. The fundamental crystal frequency is trebled in the anode circuit resulting in a frequency range from 13.5 to 26 Mc/s. The crystal oscillator output is passed to a mixer valve V101 to beat with RF signals tapped from the buffer-amplifier V5 in the frequency range 12.5 to 25 Mc/s. This action produces a difference frequency of 1.0 Mc/s in the mixer anode circuit. From the mixer valve the 1.0 Mc/s signal is passed toaa limiter valve (V103) via an amplifier V102 and a limiter grid monitor MR101. The amplifier has a pass-band of 300 kc/s. A small fraction of the output from the amplifier is rectified by the limiter grid monitor to operate the meter and provide a visual means of adjusting the transmitter master oscillator to approximately the correct frequency, that is, to the frequency which results in an output from the mixer of approximately 1 Mc/s.

(10) The limiter valve V103 anode and screen HT supplies are taken from a fixed potentiometer which is fed from a voltage stabiliser valve V109. The anode circuit of the limiter is formed by the primary of a transformer tuned to 850 kc/s. The secondary of the same transformer is tuned to 1,150 kc/s, giving an overall bandwidth of 600 kc/s at 6 dBs down. From here the signals take two paths, one to the AFC Discriminator (MR102-103-V104), the other to deviation metering (X101-V107-108-110). Through the action of the limiter valve V103, the 1.0 Mc/s signal, at a constant amplitude, is passed to the Foster-Seeley AFC discriminator circuit (V104-MR102/3.) The primary of the discriminator transformer forms the anode load of V104, while the secondary

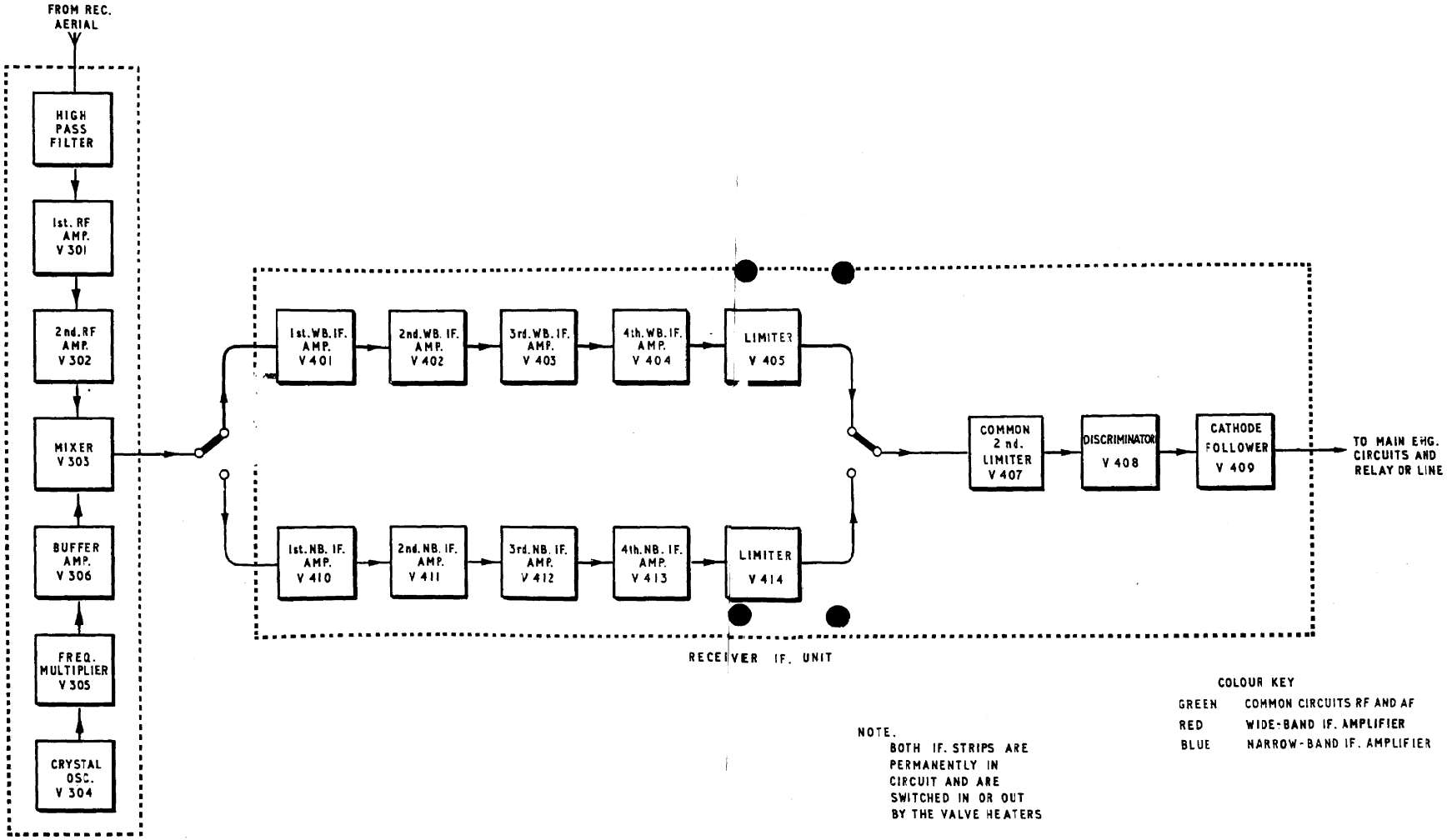


FIG.15 RECEIVER R222 MK1/1, BLOCK DIAGRAM

feeds the 1.0 Mc/s signal in push-pull to the two crystal diodes (MR102-103). The 1.0 Mc/s signal is also fed to the crystal diodes via the zero potential centre of the discriminator circuit in phase quadrature. The output from the diodes is passed to the grids of the reactor valves (V1-2) via the split secondary of the modulation transformer, and the grid circuits of the reactors. If the signal is exactly 1.0 Mc/s, there will be no DC output from the discriminator. Should the master oscillator tend to wander off frequency, however, the DC output, positive or negative going according to the direction of drift, will be applied to the reactor grids. The reactor valves will pass the DC to the master oscillator in the form of a changing reactance, and in correct phase to oppose any change of frequency. The discriminator characteristic is approximately 200 kc/s wide between peaks, and the AFC capture range not less than ± 800 kc/s at 70 Mc/s.

(11) The Foster-Seeley discriminator is followed by an amplifier V107 which is directly coupled to the DC output from the crystal diodes. The changing DC potential applied to the grid will be reflected in the cathode circuit of the amplifier as a change of current. The meter when switched to FREQ. CHECK is placed in a bridge circuit composed of resistors in the amplifier cathode and screen circuits. The bridge is adjusted so that the meter reads half-scale with zero grid volts (and zero output from the AFC discriminator). It is possible therefore to bring the master oscillator back to correct frequency by adjusting the MASTER OSC. control until the meter reads approximately half-scale. A spring loaded switch on the front panel provides a cross-check on the meter reading by setting the grid of V107 to zero volts. The screen grid of the DC amplifier V107 is taken to the stabilised 150V supply. V105 also a Foster-Seeley, receives part of the 1.0 Mc/s signal from V103. The anode circuit of V105 is formed by the primary of the discriminator transformer. The secondary of the transformer feeds the two crystal diodes MR104/5 in quadrature to the signal in the primary. The discriminator characteristic is approximately 300 kc/s wide between peaks. The demodulated signal from the metering discriminator, passes to the amplifier valves V107 and V108 via a matching pad and low-pass filter. From here the amplified signal is converted to DC by the meter rectifier V110. The meter is switched across the diode load, in which the current flowing is proportional to the deviation. Two positions of the metering switch cater for two deviation bandwidths, namely 0-50 kc/s and 0-200 kc/s.

Section 19. Receiver

(1) The receiver is designed to work from a 75 ohm aerial, and employs a high pass filter to reject unwanted signals below approximately 45 Mc/s.

(2) The frequency range is 50 to 100 Mc/s.

(3) Two RF stages (V301-302), independently tuned, follow the high pass filter and provide an approximate gain of 30 dB. Resistive damping across the tuned circuits ensures adequate bandwidth for the modulation frequencies used.

(4) The local oscillator (V304) is a crystal controlled Pierce, functioning between the grid and screen grid of the valve. The fundamental frequency of the crystal lies between 4.86 and 9.72 Mc/s, and this is doubled or trebled in the oscillator anode circuit. The following stage (V305) multiplies the signal a further three, or four, times. From this combination a multiplying factor of six, eight or twelve times the crystal freque can be obtained with a minimum number of crystals, providing a difference frequency range from 40.28 to 90.28 Mc/s.

(5) A buffer amplifier (V306) is interposed between the multiplier and mixer stages. Injection of the local oscillator signals into the cathode of the mixer valve (V303) is accomplished by tapping the cathode into the buffer amplifier tuning inductance via a short length of co-axial cable. The mixer stage (V303) is a normal RF pentode. The RF signal is fed into the grid circuit, and the difference frequency from the local oscillator, into the cathode circuit, as already described. The IF at 9.72 Mc/s appears across the tuned circuit in the mixer anode, and is fed to the IF amplifiers and discriminator (V408) by low impedance link coupling.

(6) The meter in the line unit is also used as a tuning indicator for the Receiver. When tuning the AERIAL, 1st RF AMP and 2nd RF AMP, the meter is switched to read the change in grid current of the first limiter stage, which varies with the RF tuning. In the case of the CRYSTAL ANODE, MULTIPLIER & AMPLIFIER, the meter reads the voltage change across the mixer cathode bias resistor. The 1st RF AMP position of the METER SWITCH is provided as a functional check of the first RF amplifier valve.

(7) The IF circuits are duplicated to provide narrow and wide-band amplifiers. The narrow-band amplifier (V410 to 414) is used with modulation frequencies up to 20 kc/s (4-channels), and the wide-band amplifier (V401-405) 70 kc/s with 12-channels. Each unit consists of four pentode amplifiers with ten tuned circuits followed by a pentode limiter (V405 and V414). The input and output of both units are connected in parallel, the amplifier required being selected by switching the heaters. IF bandwidths at the first limiters are approximately as follows:

TABLE 7

IF AMPLIFIER BANDWIDTHS		
	6 dBs down	60 dBs down
Narrow-band	180 kc/s	900 kc/s
Wide-band	500 kc/s	2,400 kc/s

The IF transformers in both circuits are iron-dust core tuned, and centred on a frequency of 9.72 Mc/s. The bandwidths shown above are obtained by resistive damping across the individual tuned circuits.

(8) The first limiters (V405 and V414), one in each of the IF amplifiers, both work into a common anode load formed by a single wide-band circuit which is tuned by iron dust core to 9.72 kc/s. The grid circuit of the first limiter in both IF amplifiers passes to chassis via a resistance potentiometer across which the limiter grid current develops a voltage. This voltage is used to operate the meter when tuning the receiver RF stages. The voltage is also connected through RC filter networks, to the grid circuits of the valves preceding the limiters. During normal signal conditions, the voltage developed is too low to have any appreciable effect upon the performance of the valve, but with signals of increasing strength, the limiter develops increasing grid current, and a correspondingly greater voltage will be applied to the grid circuit of the pre-limiter valve resulting in AGC action which materially assists the limiters. The first limiter common anode circuit is capacitively coupled to the grid of the final common limiter (V407) which in conjunction with the full limiting action described, produces a constant output voltage from aerial input variations of 20.0 μV to 100.0 mV. The anode and screen supplies to the final limiter are held at a fixed potential by a gas-filled stabiliser valve.

(9) A Foster-Seeley type discriminator (V408) follows the final limiter, and has a sensitivity of 5.3 mV per kc/s deviation. Both the primary and secondary of the discriminator transformer are heavily damped by resistive loading to provide the necessary bandwidth. The discriminator is isolated from the line circuit by a cathode follower (V409), which enables the audio output to be passed direct to line without undue loading.

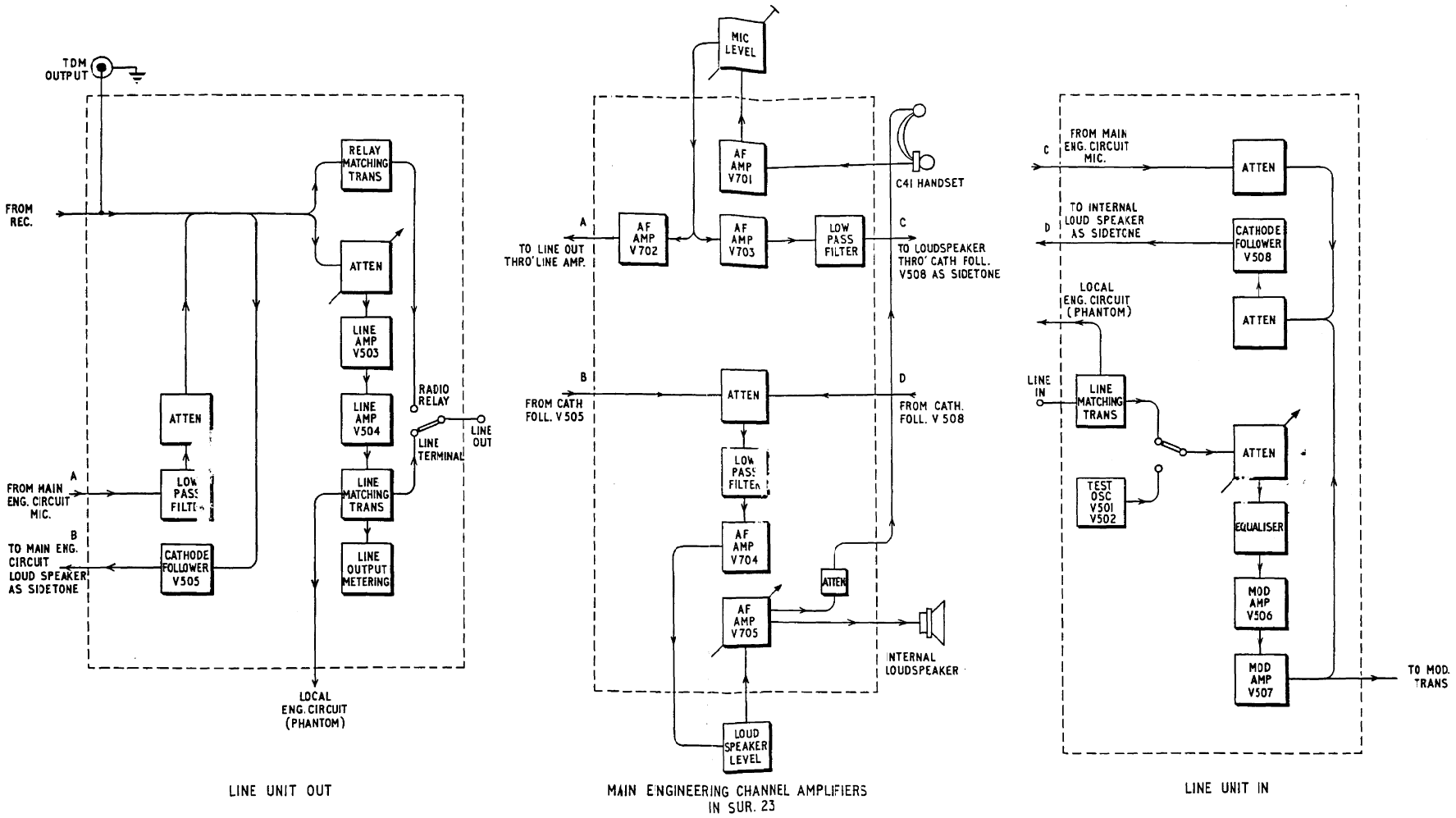


FIG. 16 BLOCK DIAGRAM – LINE UNITS AND ENGINEERING CHANNEL AMPLIFIER

Section 20. Line Unit (Fig. 16)

(1) The Line Unit is divided into two circuits. One (Line Out) routes the output from the RF receiver to line. The other, (Line In) the signal from line to the transmitter modulators.

(2) The LINE OUT section provides a choice of routing, depending upon the purpose for which the station is being used, namely terminal or relay.

(3) When acting as a terminal station, the output from the receiver is routed through a variable gain amplifier consisting of V503 and V504, and a matching transformer, to line. The variable gain control adjusts the output level.

(4) When set to the relay condition, signals from the RF receiver are routed via an impedance matching transformer to line. The latter converts the cathode follower impedance of the receiver output, to the 150 ohm line impedance.

(5) The LINE IN section deals mainly with correction factors before final modulation of the transmitter. The variable attenuators adjust the level of the received signal, and the equaliser is used to correct the frequency response of the P3 quad cable. A fixed gain amplifier (V506-507), (the modulation amplifier) connects the equaliser to the Transmitter.

(6) A test oscillator (V501-502) is incorporated which enables frequencies of either 1.0 or 14.0 kc/s to be applied to the modulation amplifier at the same time disconnecting the signal from line. It is used as a tone source to check the operation of an individual radio link, and also for fault finding.

Section 21. Engineering Circuits (Fig. 16)

(1) Send Path

(a) When the handset pressel switch is operated, speech signals from the microphone are amplified by the variable gain amplifier circuit V701 V702 and V703. The gain of this amplifier is adjusted at the MIC LEVEL control on the SUR No. 23, which determines the injection level into subsequent circuits.

(b) Amplifier V702 and V703 isolate the RF send-receive paths and prevent cross-talk between the two circuits, they also divide the speech signals equally and pass them through low pass filters, which clip everything above 3,000 c/s, to LINE OUT and Transmitter modulation, respectively.

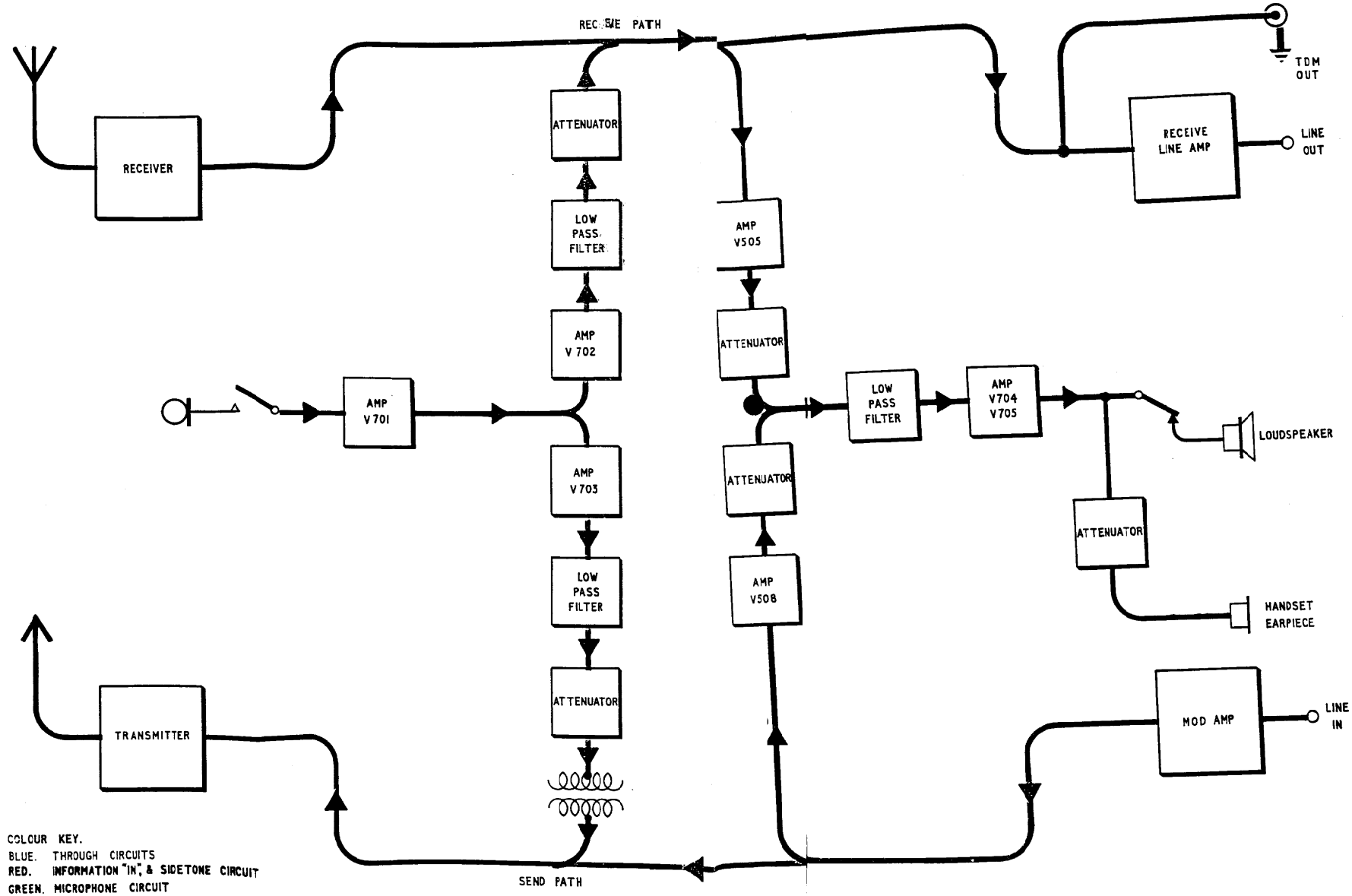


FIG. 17 BLOCK DIAGRAM ENGINEERING CHANNELS

(c) Attenuators following the low pass filters, set the final injection level to the two circuits.

(d) The transformer in the transmitter modulation path converts the unbalanced microphone circuit to the balanced modulator circuit.

(2) Receive Path

(a) Isolating amplifiers V505 and V508 prevent cross-talk between the RF Transmitter and Receiver circuits, and direct the speech signals through "equalising" attenuators, a low pass filter which accepts only the engineering channel frequencies. and a variable gain amplifier (V704-705), to the monitor loudspeaker (when the handset is not in use), and the handset earpiece.

(b) The gain of the loudspeaker amplifier V704 and V705 is controlled by the SPEAKER LEVEL control on the SUR No. 23.

Section 22. SUR No. 22 Mk. 1/1 (Transmitter SUR)

(1) The primaries of the two transformers take their 240V supply through interlocks associated with the fans in both the transmitter and the SUR, ensuring that neither unit can operate until the fans are connected.

(2) In addition, the primary circuit of the HT transformer is made through contacts on the thermal cut-out in the transmitter unit. The cut-out operates at approximately 85°C, switching off the transmitter HT supplies and preventing possible damage from over-heating. (The cut-out is inaccessible and can only be re-set after removing the Transmitter from its case).

(3) The unit provides five supply voltages as follows: 525V +ve for the PA anodes, the Buffer-amplifier, and the two doublers; 300V +ve for the PA screen grids, the RF monitor, the master oscillator, and the reactance modulators; and a further 300V +ve for the AFC unit. These are all derived from the same source, namely, four half-wave rectifiers (V201-2-4 and 5) connected two in parallel and for normal full-wave rectification. The two 300V supplies are taken through suitable dropping resistors from the 525V supply. A further supply of 42 volts DC ± 4 volts, is derived

from a second half-wave valve rectifier V203 circuit and feeds the PA grids as negative bias. The remaining 6.3 volts supplies power for all the transmitter valve heaters, the panel lamp, the operators lamp, and the bias rectifier heater.

(4) The circuits are protected by four fuses, two of which directly precede the on/off switch in the mains input circuit, a third in the earth return lead from the 525V transformer secondary, and a fourth in the 6.3V/40V transformer primary.

Section 23. SUR No. 23 Mk. 1/1 (Receiver SUR)

(1) The primaries of the HT and LT transformers obtain their 240V supply through interlocks associated with the fans in both the Receiver and the Power Supply Unit, ensuring that neither can operate until the fans are connected.

(2) The unit provides 300V HT and 6.3V LT for the receiver and line units in the R222, and for the engineering circuits amplifiers in the SUR No. 23.

The 300V HT is derived from two separate half-wave rectifiers (V601 and V602) working in a normal full-wave circuit.

(3) A 5.0 Amp fuse in each leg of the mains input provides overall protection for the unit, while the transformers are protected individually by a 1.0 Amp fuse in the primary of the LT transformer, and a 500 mA fuse in the centre tap to earth of the HT transformer secondary.

(4) The unit also contains the engineering circuit amplifiers, monitor loudspeaker and the socket for connecting the handset into circuit. The pressel switch in the handle of the handset disconnects the loudspeaker when the handset is being used. (The loudspeaker is operative only when the handset is connected).

(5) The SPEAKER LEVEL control adjusts the volume of sound from both the earpiece in the handset and from the loudspeaker. The volume from the former is fixed well below that of the loudspeaker by permanent series resistors.

(6) The MIC. LEVEL control adjusts the microphone injection level to the transmit and receive paths.

NOTE: THIS CONTROL IS NORMALLY ADJUSTED AT THE FACTORY OR IN WORKSHOPS, AND MAY BE RE-ADJUSTED ONLY BY COMPETENT PERSONNEL WITH THE NECESSARY TEST-GEAR IMMEDIATELY AVAILABLE.

CHAPTER 5
SERVICING

WARNING

The voltage produced by this equipment is sufficiently high to endanger human life. For first aid treatment in case of Electric Shock see inside front cover.

Section 24. General

(1) No equipment can be expected to work properly unless it is kept in first class condition by regular servicing, conscientiously carried out. This is the responsibility of the NCO or man who is in direct charge of the equipment and responsible for its operation, and NOT of workshop or repair staffs, though workshop personnel may be called upon to carry out certain servicing tasks.

(2) To guide the NCO or man responsible for servicing, and to ensure that it is carried out, it has been ruled that signals equipment will be serviced on the task system, and that completion of each task will be recorded on Army Form B2661 - Unit Servicing Log.

(3) A copy of the log is reproduced on page 48. Completion of servicing tasks will be recorded by initialling the spaces provided on the front of the form; all repairs and replacements being recorded on the reverse. The form lasts 24 weeks, and supplies can be obtained on indent in the normal way.

(4) The servicing tasks are listed in Section 26, and the frequency with which each task is carried out will be detailed by the Unit Commander concerned.

Section 25. Opening Sealed Equipment

The four units of the Station Radio C41 Mk.1/1 are hermetically sealed may be opened in forward areas only under exceptional circumstances.

Operators must not attempt in any way to open the sealed units.

Control knobs should be treated reasonably to avoid damage to the shaft sealing glands.

When internal adjustment or replacement of components becomes necessary unit should be sent to a workshop where drying apparatus is available.

Royal Signals radio technicians may open a unit for servicing so far as technical ability and the spares in their possession allows, but subject only the following conditions:

(i) On the initiative of a technician when it is absolutely necessary to restore essential communications.

(ii) On the authority of the Officer Commanding.

Units should be opened only where the risk of damp or dust entering the cases is as remote as possible. Even then they should be sent to workshops the earliest opportunity to be re-sealed and for drying out where necessary

Section 26. Operators Daily Servicing

(1) Daily Tasks

(a) General

(i) Check that all switches are in their correct positions:

High/Low power switch (Transmitter)
Equaliser and attenuator (Receiver)
Wide/Narrow IF bandwidth (Receiver)
Line Impedance (Receiver)
Line Output Control (Receiver)
Loudspeaker Level (SUR No. 23)

(ii) That all plugs and sockets are correctly fitted, with the locking rings tightened firmly by hand.

(iii) That the DESICCATORS are blue not pink.

(b) Sender Performance

(i) Check Transmitter tuning (see Section 13 (9) to 13 (14) inclusive)

(ii) Note and record RF TUNE meter readings.

(iii) Check that the fans are running normally. (Also in the SUR No. 23).

(c) Receiver Performance

(i) Check Receiver tuning. (See Section 14 (4) and 14 (5)).

(ii) Note and record OSC. TUNE meter reading.

(iii) Note and record RF TUNE meter reading.

(iv) Check that fans are running normally. (Also in SUR No. 23).

(d) Engineering Channel Performance

(i) Note deviation reading (0-50 DEV.) on Transmitter meter.

(ii) Note dB reading on Receiver meter.

(iii) Speak to stations on both sides, listening for possible decrease in speech strength, and for reports of weak speech.

Section 27. Operators Elimination of Faulty Units or Connectors

(1) Transmitter and SUR No. 22

(a)	No RF MONITOR reading, HT normal, panel lamp on.	Check tuning and meter readings, all positions.	
(b)	RF Monitor reading has greatly increased.	(a) Report to Control and check aerial and connector. (b) Check tuning, and meter reading all tuning positions.	
(c)	No RF Monitor reading, no HT, panel lamp on.	Switch off and change fuse.	Switch on and check for HT Volts, and RF Monitor reading.
(d)	No RF Monitor reading, no HT, panel lamp off.	Switch off and change LT fuse.	Switch on and recheck RF Monitor, HT Volts, and panel lamp.
(e)	No RF Monitor reading, no HT, panel lamp off, fans not running.	Switch off and change mains fuses.	Switch on and recheck RF Monitor, HT, and panel lamp.
(f)	No RF Monitor reading, no HT, panel lamp on, but no HT with new fuse.	Switch off and change power lead between Transmitter and Receiver	Switch on and check for RF Monitor reading and HT.
(g)	No RF Monitor reading, panel lamp off, no HT with new fuse.	Switch off and change power lead between Transmitter and Receiver.	Switch on and recheck HT and Monitor reading
(h)	No RF Monitor reading, panel lamp off, fans not running, still no HT.	Switch off and change the mains input lead or leads to fans in Transmitter and SUR No. 22.	Switch on and recheck for HT, etc.
(j)	Still no RF Monitor.	Switch off and change the Transmitter.	Switch on and recheck RF Monitor after re-tuning.
(k)	No RF Monitor, still no HT, panel lamp on.	Switch off and change the SUR No. 22.	Switch on and recheck HT and RF Monitor.

(l)	No RF Monitor, no HT.	Cut-out may have tripped.	Change Transmitter
(m)	Panel lamp off.	Bulb burnt out.	Change lamp.

2) Receiver and SUR No. 23

(a)	Large increase in background noise, OSC. TUNE normal.	Check aerial and feeder. If normal report to control.	-
(b)	Large increase in background noise, panel lamp on, fans running, but no OSC. TUNE.	Check oscillator tuning, and retune if necessary.	-
(c)	Large increase in background noise, panel lamp on, but still no OSC. TUNE.	Change crystal retune receiver, report to control	-
(d)	As (c) above.	Change receiver and retune to the ordered frequency.	-
(e)	No RF TUNE, no OSC. TUNE, panel lamp on, fans running in both units.	Switch off and change HT fuse.	Switch on, check HT, OSC. TUNE, and RF TUNE.
(f)	No RF TUNE, no OSC. TUNE, no HT, panel lamp off, fans running in both units.	Switch off and change LT fuse.	Switch on, and re-check HT, panel lamp, OSC. and RF TUNE.
(g)	Set dead	Switch off and change mains fuses.	Switch on and re-check panel lamp, HT, and OSC. and RF TUNE.
(h)	Set still dead	Switch off and change power lead between Receiver and SUR No. 23.	Switch on and re-check panel lamp HT, and RF and OSC. TUNE.

(j)	Set still dead.	Switch off and change fan lead to receiver and/or to SUR No. 23.	Switch on and re-check panel lamp, HT, and RF and OSC. TUNE.
(k)	Set still dead.	Switch off and change mains lead.	Switch on and re-check panel lamp, HT, and RF, and OSC. TUNE.
(l)	Set still dead.	Switch off and change SUR No. 23.	Switch on and re-check panel lamp, HT, and RF and OSC. TUNE.

(3) Engineering Circuit

(a)	No radio noise from handset, or loud-speaker with SPEAKER LEVEL control in normal position, RF and OSC. TUNE normal.	Speak to Ops on both sides.	-
(b)	As (a), and no reply.	Check meter readings dB and DEVIATION.	-
(c)	As (b) but Mic. circuit normal.	Change SUR No. 23.	Switch on and re-check.
(d)	Receiving but not being heard to reply.	Check meter readings dB and DEVIATION.	-
(e)	As in (d) but no dB or DEVIATION readings.	Change handset.	Recheck as before.
(f)	As (e) but still not being heard to reply.	Change SUR No. 23.	Recheck as before.
(g)	Engineering circuit send leg to Receiver correct, but not to Transmitter or vice versa.	Change the 12-way lead between Receiver and SUR No. 23.	Recheck as before.

(h)	Engineering circuit correct to Receiver but not to Transmitter.	Check by 14.0 KC/S TEST OSC. and note deviation.	-
(j)	If no deviation.	Change 4-way lead Transmitter to Receiver	Recheck as before
(k)	Still no deviation	Change SUR No. 23	Recheck as before.

(4) Line Unit

(a)	Receive normal, Eng. circuit normal, no output to line.	Faulty line amplifier, change the receiver.	Retune the Receiver to the ordered frequency, and set up as described earlier.
(b)	Transmitter normal, no deviation on test tone, no Eng. circuit in one direction.	Switch to 14.0 KC/S and check deviation meter reading.	-
(c)	As (b) but no deviation reading.	Check Eng. circuit to Transmitter.	
(d)	As (c) but Eng. circuit normal.	Change the Receiver.	Tune Receiver to ordered frequency and set up as described earlier.
(e)	Still no results.	Change 4-way lead Receiver to Transmitter.	

WARNING

The voltage produced by this equipment is sufficiently high to endanger human life. For first aid treatment in case of Electric Shock see inside front cover.

Section 28. Technician's Servicing

The following servicing notes are intended FOR USE IN EMERGENCY ONLY, when it is absolutely necessary to restore communication, and where workshop facilities are not readily available.

It is assumed that only spare valves will be available not fixed components of any kind.

The Technician concerned is referred to Section 25, Opening Sealed Equipment.

Voltages in all the tables were taken with an Avometer Model 8S, other types of meters may therefore give different readings.

Before opening any unit while investigating a fault, an external check should be made using the operator's servicing notes (Section 27) as a guide.

As a temporary measure, it should be possible to change any valve without necessitating internal re-alignment. Possible exceptions to this rule being V1 and V2 (the reactance modulators) and V4 (the master oscillator).

Transmitter

1) If a fault is diagnosed in the Transmitter, first ensure that the power is switched off and the mains connector has been removed; then undo and take off six white painted nuts around the edge of the control panel, withdraw the equipment and inner case from the outer case. Remove the remaining sixteen nuts and withdraw the front panel from the inner case.

2) Having located the faulty circuit, the valve is the first suspect, and may be changed. It should be noted however, that the valve itself may be the victim of a component fault, and unless that fault is corrected it can ruin the new valve. On the other hand if the fault was in the valve it may have badly over-loaded its associated components. If a faulty valve has been changed therefore the associated components, more especially resistors, should be examined before deciding that the Transmitter is fully serviceable.

3) Figs. 18 and 20 show the positions of the valves and test points, and Tables 8 and 9 the voltages to be expected at these points.

TABLE 8 - TRANSMITTER R.F. UNIT

VALVE CODE NO.	TEST POINT	FUNCTION	TEST POINT VOLTAGE LOW POWER
V1 CV 118 V2 CV 118	T.P.1	Reactance Modulator	2.8 - 4.2 V.D.C.
V3 CV 138	T.P.3	Crystal Oscillator	2.4 - 3.6 V.D.C.
V4 CV2127	T.P.4 T.P.5	Master Oscillator	3.5 - 5.2 V.D.C. 6.0 - 35.0 µA *
V5 CV2127	T.P.6	Buffer Amplifier	3.2 - 4.4 V.D.C.
V6 CV 391	T.P.7	1st Doubler	23.0 - 31.0 V.D.C.
V7 CV 391	T.P.8	2nd Doubler	30.0 - 40.0 V.D.C.
V8 CV2797	-	Power Amplifier	No Test Point
V9 CV 138	-	R.F. Monitor	No Test Point

* Depending on Aerial Frequency

H.T.1 - LP and HP 530V ± 30.0

H.T.2 - LP and HP 300V ± 15.0

Reliable Valve Types:

CV 138	=	CV4014	CV 118	=	Nil
CV2127	=	CV4055	CV 391	=	Nil
			CV 424	=	CV2797

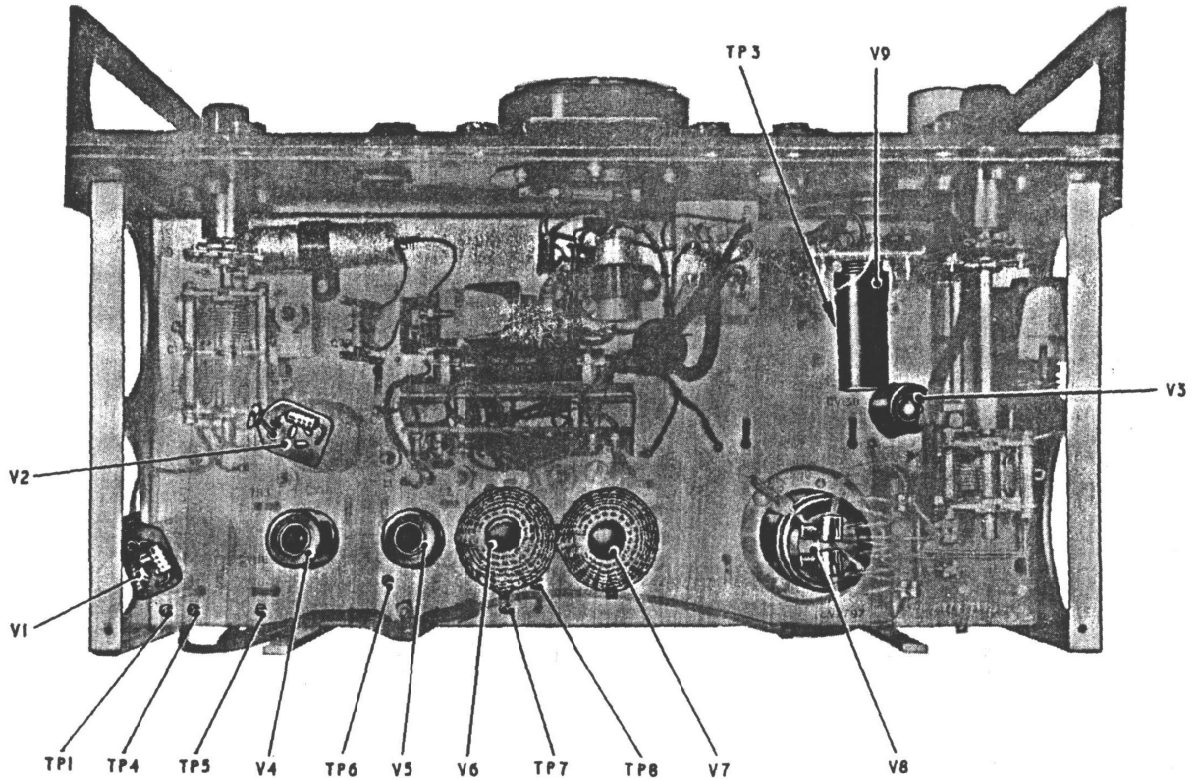


FIG.18 TRANSMITTER RF UNIT

TABLE 9 - TRANSMITTER AFC UNIT

VALVE CODE NO.	TEST POINTS	RELIABLE TYPES	FUNCTION	TEST POINT VOLTAGE LOW POWER
V.101 (CV 138)	TP101	CV4014	Mixer	3.1 - 4.7 V.D.C.
V.102 (CV 138)	TP102	"	Amplifier (1 Mc/s)	1.7 - 2.3 V.D.C.
V.103 (CV 138	TP103	"	Limiter	4.0 - 6.0 µA.D.C.
V.104 (CV 138)	TP104	"	Discriminator	1.7 - 2.6 V.D.C.
V.105 (CV 138)	TP105	"	Discriminator	1.7 - 2.6 V.D.C.
V.106 (CV 138)	TP106	"	Cathode Follower	1.4 - 2.1 V.D.C.
V.107 (CV 138)	TP107	"	D.C.Amplifier	0.8 - 1.2 V.D.C.
V.108 (CV 138)	TP108	"	A.F.Amplifier	0.8 - 1.2 V.D.C.
V.109 (CV 287)	TP109	Nil	Voltage Regulator	NIL
V.110 (CV 140)	TP110	CV4025	Rectifier	NIL

Thermal Cut-out

The thermal cut-out will be found on the side member of the chassis as shown in Fig. 19. It is re-set by depressing the white button.

NOTE: The cut-out operates only through internal overheating of the Transmitter. Should it be necessary, therefore, to reset the cut-out, the internal fan and valves MUST be carefully examined and tested for faults or damage.

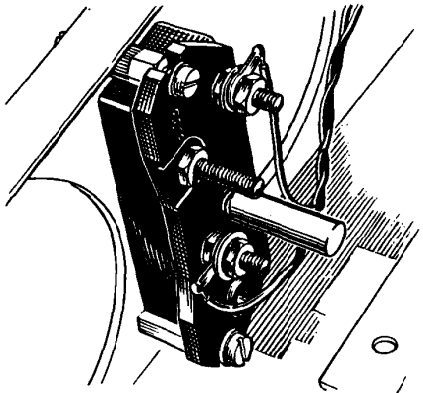


FIG. 19 THERMAL CUT-OUT

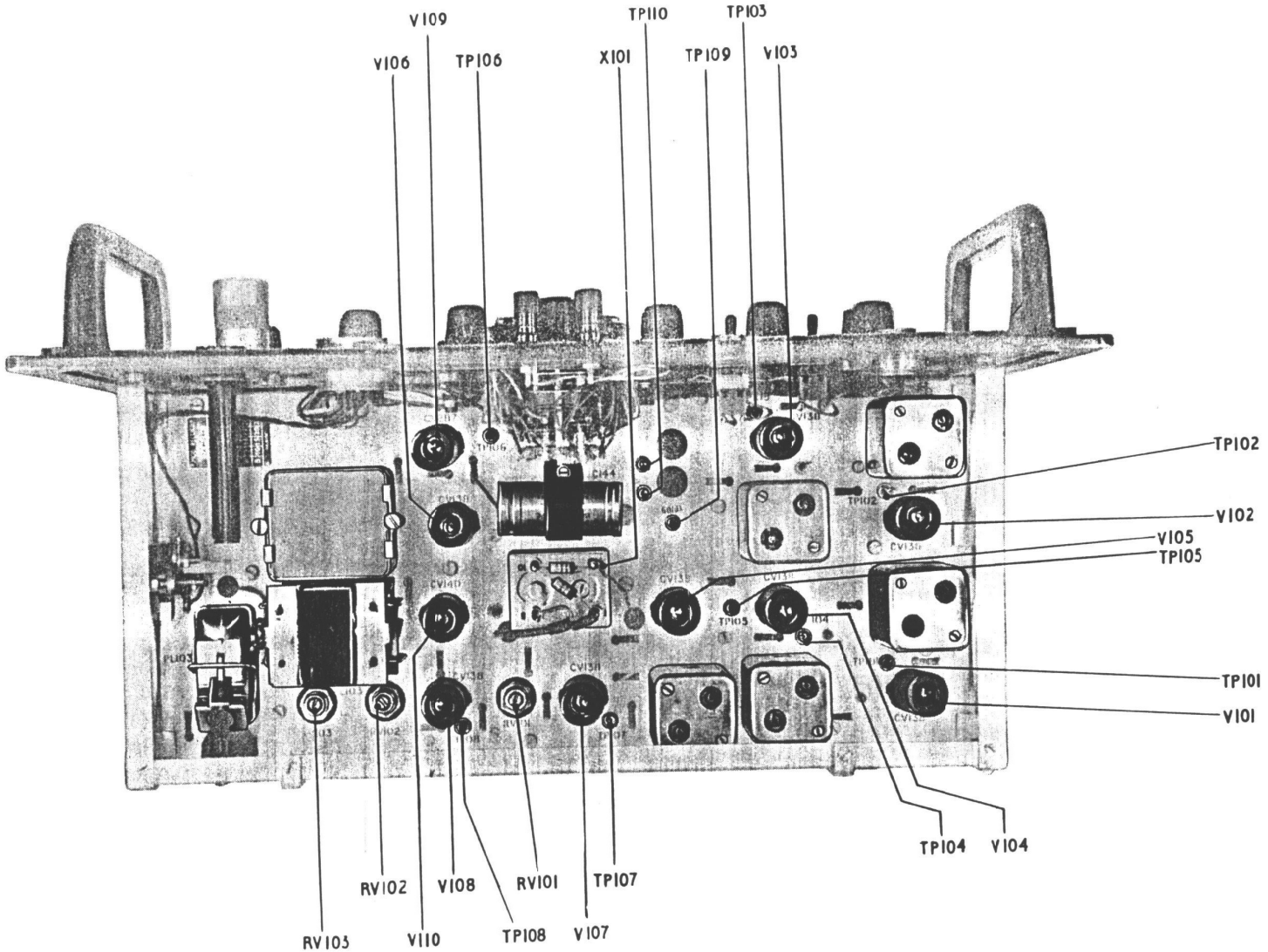


FIG. 20 TRANSMITTER AFC UNIT

SUR No. 22 Mk. 1/1

(1) Before opening the SUR No. 22, check that the fuses are not responsible for the failure, and that all the connectors are in position, with the locking rings firmly tightened by hand.

(2) Also bear in mind the fact that the mains input to the SUR No. 22 is inter-locked with the supply to the fans in both Transmitter and SUR No. 22, so that if one of the wires inside the appropriate connector is defective, the fans may be operative but not the set. The connectors can be checked for continuity (after removal from both units) using the low ohms range of the Avometer. The connector should be gently flexed near the plugs while testing, in case of intermittent contact.

(3) If the fault persists, switch off the power, undo and remove the six white painted nuts around the edge of the front panel, disconnect the mains and fan connectors, and withdraw the equipment and inner case from the outer case. Remove the remaining sixteen nuts around the front panel and withdraw the front panel from the inner case.

(4) Reconnect the mains and fan connectors and switch on the power.

(5) Check the voltages at the spigots on the back of the 25-way output socket. Any marked variation from the figures shown should provide a lead to the faulty circuit, and again, the valves associated with the circuit are the first objects of suspicion.

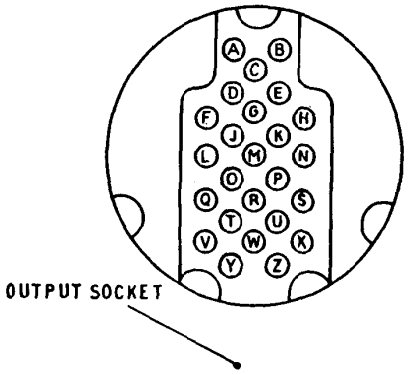
(6) Of the five valves grouped in one corner of the chassis, the smaller one is the 40V negative bias rectifier, (CV493 V203), the other four connected two two's in parallel for full-wave rectification, are CV 2235, V201, V202, V204, and V205. It should be noted that if one of these valves is changed, the valve connected in parallel with it should also be changed, or at least tested, in case it has been seriously overloaded.

(7) The DUMMY AERIAL can be checked using the low ohms range of the Avometer. Its DC resistance should be 75 ohms.

(8) Fig. 22 shows the positions of the valves.

TABLE 10 - Output voltages SUR 22

Across Pins	Volts On Load	Remarks
A-B	240 AC	PA Fan Supply
H-earth	365 DC ± 20.0	HT supply - AFC unit
L-earth	300 DC ± 15.0	HT 2 supply - RF unit
C-earth	530 DC ± 36.0	HT 1 supply - RF unit
Q-R-S earth	6.6 AC ± 0.3V	Heater supply (AFC and RF units
O-earth	-42.0V ± 4.0V	Permanent bias supply



FI)21 OUTPUT SOCKET

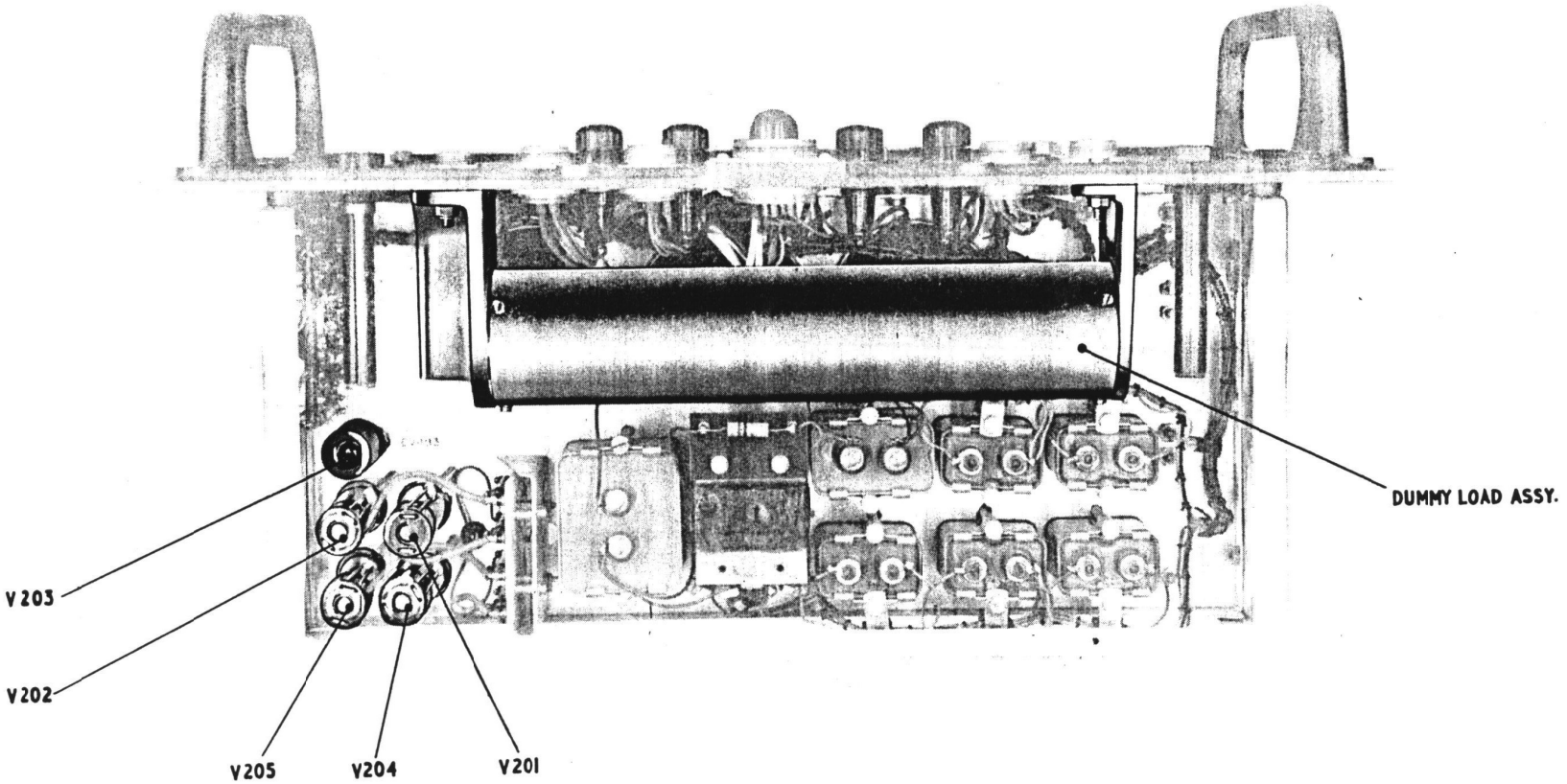


FIG. 22 S.U.R. 22

Receiver Type R222 Mk.1/1

(1) Before opening the Receiver, check that the fuses in the power supply unit are not faulty, and that all connectors are in position, with the locking rings tightened firmly by hand.

(2) Test for HT supply using the meter switch on the front panel of the unit.

(3) If the fault appears to be a power failure in the equipment, it is possible that the fault lies in one of the fan connectors since the mains supply to the SUR is interlocked with the mains supply to the fans in both the Receiver and its power supply unit. The connectors can be checked for continuity using the low ohms range of the Avometer. The connectors should be gently flexed near the ends while testing, in case of intermittent contact.

(4) If the fault persists switch off the power at the SUR No. 22, undo and remove the six white painted nuts around the edge of the receiver front panel, disconnect the mains lead and withdraw the equipment from the outer case. Remove the remaining sixteen nuts and withdraw the front panel from the inner case.

(5) Reconnect the mains connectors, switch on the mains supply at the SUR No. 22, and check potentials at the various test points shown in Fig. 23 and Table 11.

(6) The faulty circuit, if not already known, can also be found by following the tuning instructions until a stage is reached where normal results are no longer obtained. The valve in this stage may then be changed, especially if potentials at the test point vary considerably from the figures given.

TABLE 11 - Receiver RF and IF Units

RF Unit readings taken with set untuned and without crystal

Location	Valve Code No.	Test Points	Function	Test Point Voltage
RF Unit	V.301 (CV 138)		1st RF Amplifier	No Test Point
	V.302 (CV 138)	TP302	2nd RF Amplifier	1.4 - 1.9 V.D.C.
	V.303 (CV 138)		Mixer	No Test Point
	V.304 (CV 138)	TP304	Crystal Oscillator	3.0 - 3.8 (Not Oscill.)
	V.305 (CV 138)	TP305	Frequency Multiplier	3.4 - 4.2V
	V.306 (CV 138)	TP306	Buffer Amplifier	2.3 - 2.9V
Wide Band	V.401 (CV 138)	TP401	1st IF Amplifier	1.3 - 1.8V
	V.402 (CV 138)	TP402	2nd IF Amplifier	1.3 - 1.8V
	V.403 (CV 138)	TP403	3rd IF Amplifier	1.3 - 1.8V
	V.404 (CV 138)	TP404	4th IF Amplifier	1.5 - 1.9V
	V.405 (CV 138)		1st Limiter	No Test Point
Common	V.406 (CV 287)		Voltage Regulator	No Test Point
	V.407 (CV 138)		2nd Limiter	No Test Point
	V.408 (CV 140)	TP408	Discriminator	Nil
	V.409 (CV 138)	TP409	Cathode Follower	78 - 98V
Narrow Band	V.410 (CV 138)	TP410	1st IF Amplifier	2.6 - 3.2V
	V.411 (CV 138)	TP411	2nd IF Amplifier	2.6 - 3.2V
	V.412 (CV 138)	TP412	3rd IF Amplifier	2.6 - 3.2V
	V.413 (CV 138)	TP413	4th IF Amplifier	2.3 - 3.0V
	V.414 (CV 138)		1st Limiter	No Test Point

Reliable types: CV 138 = CV4014 CV 140 = Nil CV 287 = Nil

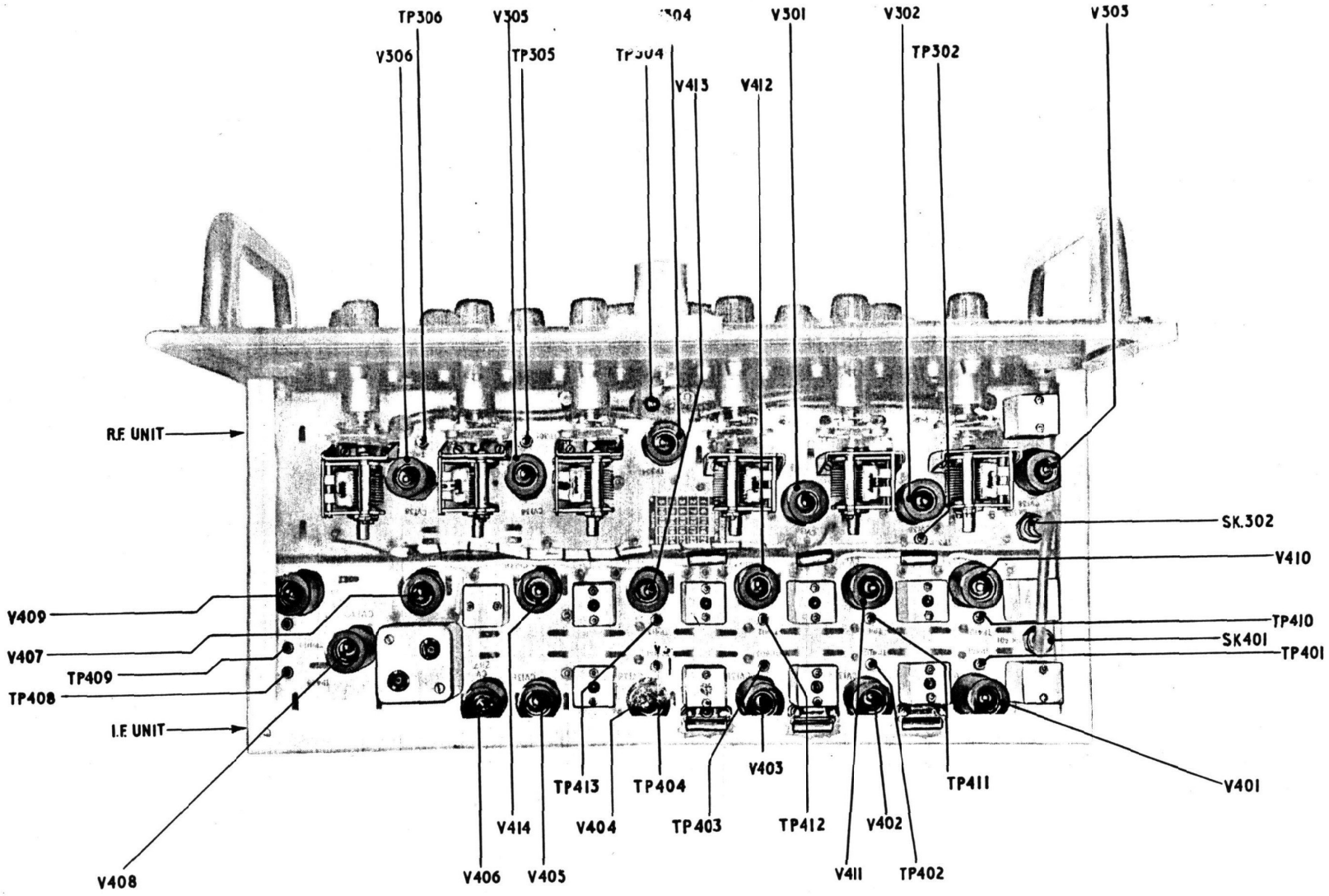


FIG. 23 R222 RF AND IF UNITS

The Line Unit

(1) Before opening the receiver case for a suspected line unit fault, check that the controls are correctly set and the carrier quad cable is connected.

(2) Should the fault be diagnosed as definitely in the line unit, switch off the mains input at the SUR No. 23, and remove the unit from the case.

(3) Switch on the mains at the SUR No. 23, allow five minutes to warm up and check potentials at the test points shown in Fig. 24 and Table 12.

TABLE 12-R222 Line Unit

(Readings taken with no signal input to line unit)

Valve Code No.	Test Points	Function	Test Point Voltage
V.501 (CV 140)		Oso. Plate Regulator	No Test Point
V.502 (CV 138)		Test Tone Oso.	No Test Point
V.503 (CV 138)	TP 503	Line Amplifier	3.0 - 3.7 V.D.C.
V.504 (CV 309)	TP 504	Line Amplifier	13.0 - 17.0 V.D.C.
V.505 (CV 138)	TP 505	Cathode Follower	36.0 - 48.0 V.D.C.
V.506 (CV 138)	TP 506	Modulator Amplifier	1.5 - 1.9 V.D.C.
V.507 (CV 138)	TP 507	Modulator Amplifier	1.6 - 2.0 V.D.C.
V.508 (CV 138)	TP 508	Cathode Follower	38.0 - 48.0 V.D.C.

LT = 6.5 ± 0.3V

HT = 300V On Load ±30.0V

Reliable Types CV 138 = CV4014
CV 140 = Nil
CV 309 = Nil

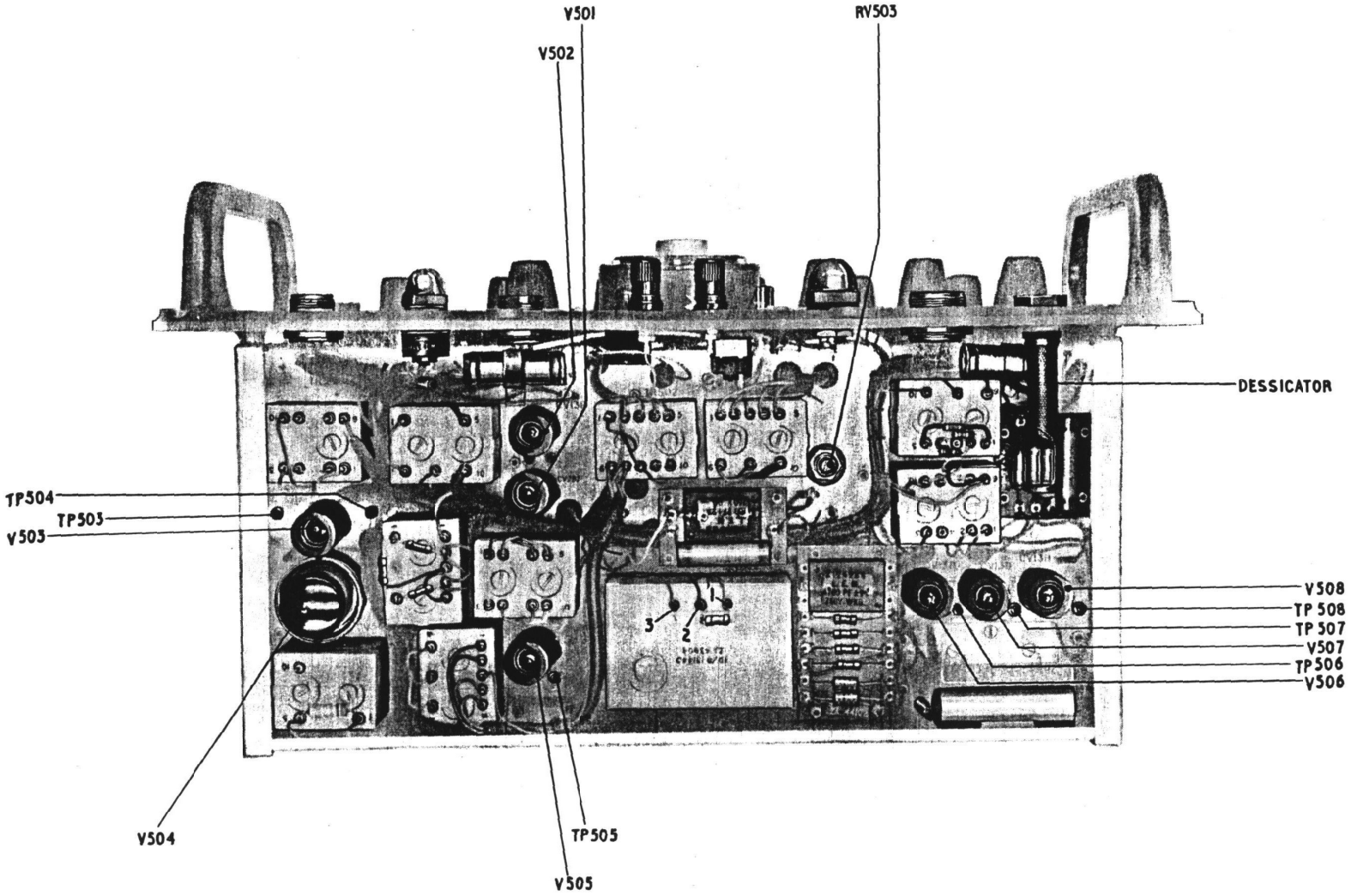


FIG. 24 LINE UNIT (R222)

SUR No. 23 Mk. 1/1

(1) Before opening the Receiver SUR No. 23, ascertain that the fuses and connectors are not the cause of the trouble, and that all connectors are in place with locking rings firmly tightened by hand.

(2) If the fault is diagnosed as definitely in the SUR No. 23, switch off the mains supply and disconnect the mains and fan connectors, undo and remove the 22 nuts around the edge of the front panel, and withdraw the unit from its case.

(3) Reconnect the mains supply and fan connectors, switch on the mains supply, and allow the units five minutes to warm up.

(4) Referring to Fig. 27 and Table 13, check the voltages at the spigots of the socket marked TO RECEIVER.

(5) There are only two valves in the power supply section of the SUR No. 23, the HT rectifiers V601 and V602.

TABLE 13 - SUR 23 (SK607) (Output Voltages)

Across Pins	Volts On Load	Remarks
CD to GH	6.5V ± 0.3V	
M to GH	300.0 ± 30.0V	(GH = chassis)
(Remainder are signal points only)		

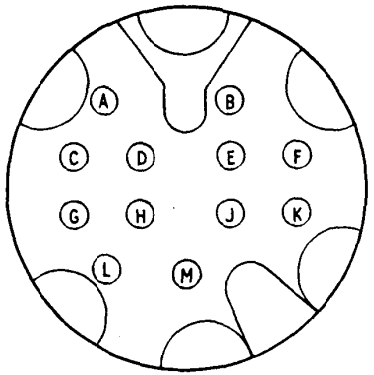


FIG.25 OUTPUT SOCKET

Engineering Channel Amplifier

(1) The Engineering Channel Amplifier is housed in the same case as the SUR No. 23, and can be removed by undoing four screws in the corners of its chassis. Connections are made through SK608 which is shown in Fig. 26. The values in the following tables are with the Engineering Channel Amplifier disconnected from the SUR 23.

(2) Table 16 provides cathode bias voltages which will normally be obtained at the test points.

(3) Tables 14 and 15 though both applicable to the same socket are separated to differentiate between voltage and ohmic values.

TABLE 14 - SK608 (Voltages)

Across Pins	Volts On Load	Remarks
1-8, 9, 10 (F)	6.5 AC $\pm$ 0.3V	LT Supply
4-8, 9, 10 (E)	300 DC $\pm$ 30.0V	HT Supply

TABLE 15 - SK608 (Resistance Values)

Across Pins	Resistance (Ohms)	Remarks
6-Earth	50 K	MIC-LEVEL control
15-Earth	0 to 50 K	MIC-LEVEL control varied
18-Earth	3.3 K	Handset pressel operated
16-Earth	250 K	SPEAKER LEVEL control
17-Earth	0 to 250 K	SPEAKER LEVEL control varied
7-Earth	40 ohms	Handset pressel operated

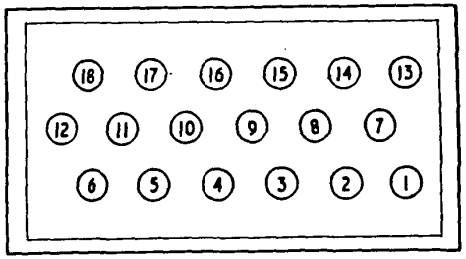


FIG.26 OUTPUT SOCKET (SK608)

TABLE 16 - Engineering Channel Amplifier (in SUR 23)

With no signal input:

Valve Code No.	Test Points	Function	Test Point Voltage
V.701 (CV 138)	TP701	Talk Amplifier	2.5 - 3.2 V.D.C.
V.702 (CV 138)	TP702	" "	2.3 - 2.8 V.D.C.
V.703 (CV 138)	TP703	" "	2.1 - 2.5 V.D.C.
V.704 (CV 138)	TP704	Listen "	2.6 - 3.0 V.D.C.
V.705 (CV 138)	TP705	" "	2.0 - 2.4 V.D.C.

Reliable Types CV 138 = CV4014

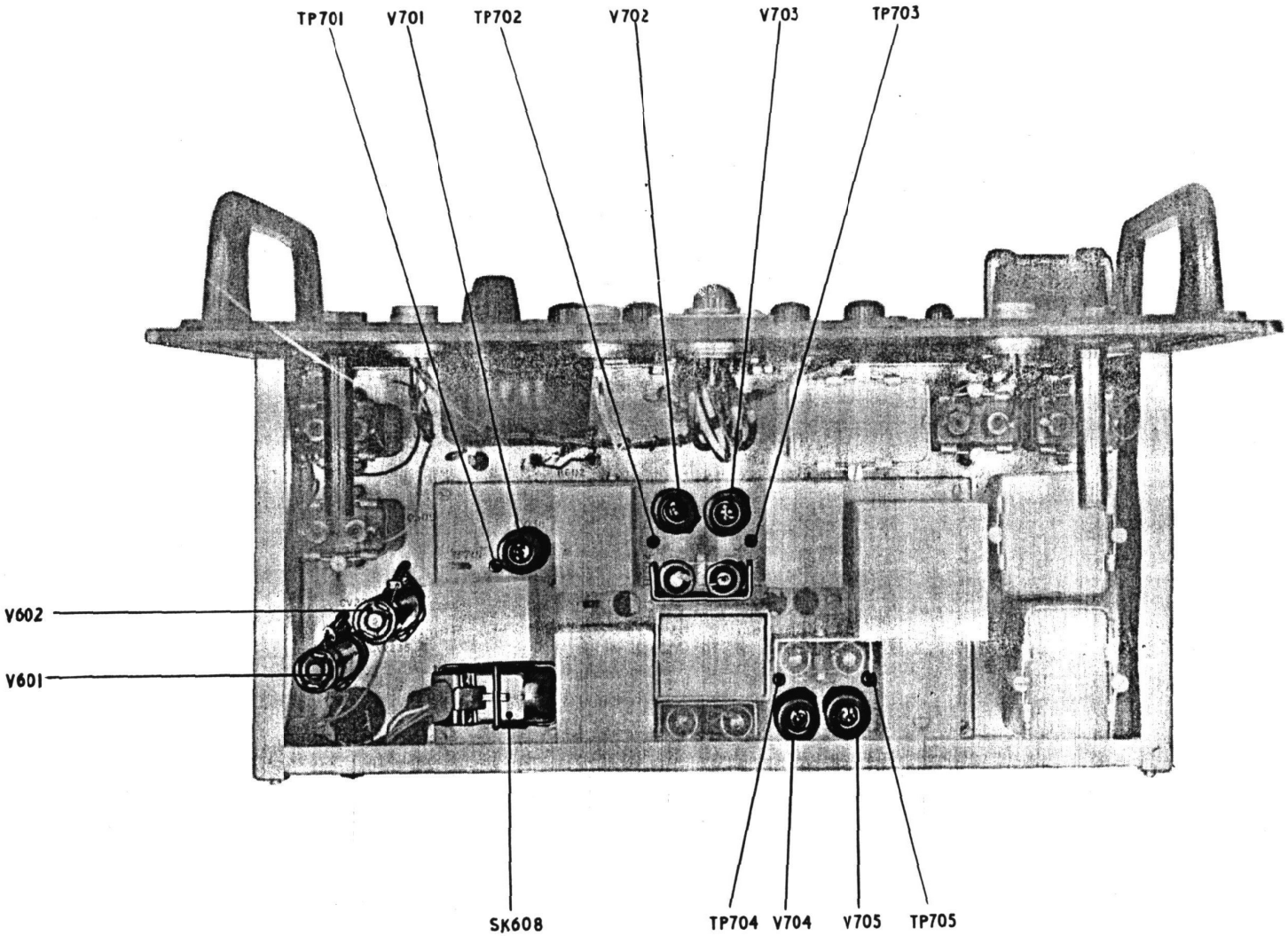


FIG. 27 ENGINEERING CHANNEL AMPLIFIER (IN SUR 23)