FR12

TECHNICAL MANUAL

SIMPLIFIED OPERATING INSTRUCTIONS

NAVAL TRANSMITTER-RECEIVER

FR-12 SERIES

THESE INSTRUCTIONS MAY BE FOLLOWED ONLY AFTER THE UNIT HAS BEEN PROPERLY ADJUSTED ON THE OPERATING FREQUENCIES TO BE USED, IN CONJUNCTION WITH THE ANTENNA AND GROUND SYSTEM TO WHICH IT IS CONNECTED. DURING THESE PRELIMINARY ADJUSTMENTS, THE FOLLOWING CALIBRATION CHART SHOULD HAVE BEEN FILLED IN WITH THE FREQUENCIES AND CONTROL SETTINGS.

RECEIVER CALIBRATION

FREQUENCY	BAND SWITCH	TUNING DIAL
3650 kc	SW	20
3200 kc	SW	15
3500 kc	SW	25
4000 kc	....	8
.........kc	....	....

TRANSMITTER CALIBRATION

FREQUENCY	CHANNEL	COUPLING	LOADING	TUNING DIAL
........kc	1	....	....	....
........kc	2	....	....	....
........kc	3	....	....	....
........kc	4	....	....	....

TO OPERATE:

1. SET ALL TUNING CONTROLS TO POSITIONS CORRESPONDING TO THE FREQUENCY DESIRED AS DETERMINED FROM THE ABOVE CHART.
2. PUT THE UNIT IN OPERATION BY MOVING THE ON-OFF SWITCH TO ON.
3. PLACE THE SPEAKER-PHONES SWITCH IN THE SPEAKER POSITION AND ADJUST THE RECEIVER TUNING AND VOLUME CONTROLS FOR SATISFACTORY RECEPTION OF THE DESIRED SIGNALS. THE B-F-O SWITCH MAY BE MOVED TO ON FOR THE RECEPTION OF C-W SIGNALS.
4. PRESS THE KEY AND ROTATE THE TRANSMITTER TUNING DIAL BACK AND FORTH TO VERIFY ITS SETTING TO BE THAT WHICH CORRESPONDS WITH A MINIMUM CURRENT AS INDICATED BY THE METER ABOVE THIS DIAL. THIS CURRENT SHOULD NOT BE HIGHER THAN 100 MILLIAMPERES.
5. FOR C-W OPERATION OF THE TRANSMITTER:
   (a) ON CHANNELS 1 AND 2, MOVE THE SEND-RECEIVE SWITCH TO SEND AND PROCEED TO MANIPULATE THE KEY.
   (b) ON CHANNELS 3 AND 4, LEAVE THE SEND-RECEIVE SWITCH IN THE RECEIVE POSITION AND MANIPULATE THE KEY WHICH THEN AUTOMATICALLY PERFORMS THE SEND-RECEIVE OPERATION.
6. FOR M-C-W OPERATION, MOVE THE M-C-W SWITCH TO ON AND PROCEED AS FOR C-W. (WHEN RECEIVING M-C-W SIGNALS, THE B-F-O SWITCH SHOULD BE LEFT IN THE OFF POSITION.)

7. FOR <u>TELEPHONE OPERATION</u> OF THE TRANSMITTER, PLUG IN THE MONOPHONE HANDSET AND MOVE THE <u>SPEAKER-PHONES</u> SWITCH TO <u>PHONES</u>. PRESS THE BUTTON IN THE MONOPHONE HANDLE WHEN IT IS DESIRED TO TALK, RELEASING IT AGAIN TO LISTEN. THE SEND-RECEIVE SWITCH SHOULD BE LEFT IN THE <u>RECEIVE</u> POSITION. SIGNALS MAY BE RECEIVED IN THE LOUDSPEAKER INSTEAD OF IN THE MONOPHONE EARPIECE IF THIS IS PREFERRED.

8. FOR <u>STAND-BY OPERATION</u> OF THE RECEIVER, MOVE THE <u>ON-OFF</u> SWITCH TO <u>OFF</u> AND THE <u>NORMAL-STAND-BY</u> SWITCH TO <u>STAND-BY</u>. THIS MODE OF OPERATION CAN BE EMPLOYED ONLY IF AN EXTERNAL 180-VOLT SUPPLY HAS BEEN CONNECTED.

<u>ABBREVIATIONS</u>

B-F-O - BEAT FREQUENCY OSCILLATOR. (THIS IS TO PERMIT RECEPTION OF C-W SIGNALS.)

C-W - CONTINUOUS WAVES.

M-C-W - MODULATED CONTINUOUS WAVES.

<u>CAUTIONS</u>

1. THE CANVAS FLAPS COVERING THE VENTILATION LOUVRES AT THE SIDES OF THE CABINET SHOULD ALWAYS BE PROPPED OPEN WHILE THE UNIT IS IN OPERATION, OTHERWISE THE INTERNAL TEMPERATURE OF THE UNIT MAY BECOME EXCESSIVE.

2. DO NOT EXCEED THE <u>5 MINUTE TRANSMIT - 5 MINUTE RECEIVE</u> RATING OF THE UNIT. THE UNIT MAY, OF COURSE, BE OPERATED CONTINUOUSLY ON RECEIVE.

Canadian MARCONI Company,
Montreal, February 6, 1942.

INSTALLING AND OPERATING INSTRUCTIONS

NAVAL TRANSMITTER-RECEIVER

FR-12T 32-V. TYPE 85135-T
FR-12T 12-V. TYPE 85161-T

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INSTALLING AND OPERATING INSTRUCTIONS

NAVAL TRANSMITTER-RECEIVER

FR-12T 32-V. TYPE 85135-T
FR-12T 12-V. TYPE 85161-T

GENERAL DESCRIPTION

The FR-12T is a low-power transmitter-receiver unit designed for operation on marine frequencies on small ships, notably fishing vessels. It employs single-chassis construction, the chassis being housed in a rugged steel cabinet which is made transportable by the provision of carrying handles. Transmission of either c-w or m-c-w telegraph signals may be accomplished using a signalling key which is mounted as an integral part of the unit. A "press-to-talk" monophone handset for transmission and reception of voice signals, and a battery cable for connection of the unit to the d-c supply lines or batteries, are normally supplied with the unit as accessories, these being arranged to plug into conviently located receptacles.

Two general types are available, as indicated by the heading, these being designed for operation from 32-volt and 12-volt supply lines respectively. The transmitter section of these two standard types is arranged to operate on a total of four crystal-controlled frequencies, two in the low-frequency range of 375 to 500 kc, and two in the high-frequency range of 1600 to 4500 kc. Modifications of these two general types are available to transmit on other combinations of frequencies as follows:

(A) Those having the suffix "A" added to the type number transmit on 3 low frequencies and 1 high frequency.

(B) Those having the suffix "B" added to the type number transmit on 3 high frequencies and 1 low frequency.

Selection of any one of these four transmitting frequencies is made by operation of a four-position channel switch and by subsequent readjustment of three transmitter tuning controls. The transmitter is capable of delivering from 12 to 15 watts of unmodulated radio-frequency power to the output tuning circuits. The amount of power delivered to the antenna will, of course, depend on the dimensions of the antenna in use.

Either of the above two main types of unit and their several derivatives may be supplied adapted for use with remote control equipment which will allow telephone operation of the unit, with "press-to-talk" control, from a remote point. This remote control equipment is fully described in Instructions 443. Units so adapted for use with this remote control equipment carry the further suffix "H"; e.g. FR-12TH type 85135TH or FR-12ATH type 85161ATH.

The receiver section of the unit employs a 5-valve superheterodyne circuit designed for reception of frequencies between 300 and 4200 kc in three bands. Automatic volume control is incorporated on all bands and is combined with the manually operated volume control in order that rapidly changing signal strengths will remain at an almost constant level in the built-in loudspeaker or in the earpiece of the monophone handset. A beat-frequency oscillator, set to give an audio beat note of 1000 cycles, is incorporated for reception of c-w signals.

Plate voltages required by the valves in both transmitter and receiver are supplied by a built-in dynamotor which is suitably filtered for both r-f hash and a-f ripple. This dynamotor bears a continuous rating when the unit is used on RECEIVE, but an intermittent rating when used on TRANSMIT of five minutes TRANSMIT - five minutes RECEIVE.

Special provision is made for operation of the receiver section of the unit without the transmitter section for "standby" use. This feature is intended to increase the life of the main batteries by using an external 180-volt "B" battery for receiver plate supply. This permits stopping the dynamotor, which operates at relatively poor efficiency at light loads.

A detailed description of all sections of the unit follows, during the study of which, reference to the diagram of connections is recommended. The appropriate diagram is contained under this cover.

CIRCUIT DESCRIPTION

Transmitter

The transmitter section employs four valves, all RVC type 6L6, which perform functions as follows. One 6L6 is used in an untuned crystal-oscillator circuit having the crystal connected between its grid and plate circuits. Plate voltage is supplied through one of two radio-frequency chokes, one for the high- and one for the low-frequency range. The proper choke for each crystal is selected by the channel switch. The choke used for the low-frequency range has a very high inductance and is shunted by a small mica condenser to provide a measure of reaction for the low-frequency crystals. To prevent excessive r-f voltage across the crystal, the plate voltage for this valve is reduced to approximately 125 volts by a series dropper comprising a resistance and the coil of the send-receive relay. The operation of this relay will be described in detail below.

Another 6L6 valve is used in the power-amplifier stage, this valve being capacitively coupled to the output of the crystal-oscillator stage. In addition to the usual cathode bias, part of the bias for this valve is obtained by the voltage drop produced by grid current flowing through the grid-leak resistor. To provide a suitable value of bias from this source the grid-leak resistor must have a fairly low value, and this acts as an appreciable load on the crystal oscillator stage. Since the output from low-frequency crystals is very much lower than from high-frequency crystals, a parallel circuit comprising a choke and condenser is connected in series with the p-a grid-leak resistor, this parallel circuit having constants which resonate close to the lowest frequency used in the unit, i.e. 375 kc. This has the effect of greatly increasing the r-f impedance of the grid circuit at low frequencies, but due to the shape of the resonance curve, has a negligible effect at high frequencies. The d-c grid resistance is, of course, unaltered, and the bias value is maintained as required. In this way, substantially constant p-a drive is obtained on all frequencies.

The p-a stage is panel tuned by a condenser and coil combination whose connections are changed for operation on the two ranges of frequencies by the channel switch. In the low-frequency channels the coil and condenser are connected to form a parallel resonant tank circuit, and a fixed mica padding condenser is connected in parallel with the variable condenser to result in a tank circuit tuning range of 375 to 500 kc. D-c voltage is supplied to the plate of the p-a valve through this tank coil. The low r-f voltage end of the coil is tapped at frequent points, these taps being connected to an eleven-point tap switch whose control is marked COUPLING on the front panel. The tapping arm of this switch is connected, through a condenser which blocks off the d-c plate voltage, to a section of the channel switch, and thence via flexible tap leads to one of several widely spaced taps on the large loading coil at the top rear of the chassis. Fine control of loading is provided by closely spaced taps at the other end of this loading coil which are connected to a second eleven-point tap switch whose panel control is designated LOADING. The tapping arm of this latter switch connects through the send-receive relay and the antenna ammeter to the antenna terminal on top of the cabinet.

From the foregoing, it will be seen that in the low-frequency channels the antenna circuit is tapped directly to the p-a tuning coil, and that the r-f potential thus obtained forces a current through the antenna tuning circuit which comprises merely a loading coil having fine and coarse taps with which to obtain an inductive reactance equal in magnitude but opposite in sign to the capacitive reactance reflected by the antenna.

In the high-frequency channels, the large loading coil above the chassis is short circuited and the r-f ground removed from the lower end of the p-a tank coil to form what is commonly known as an "L" network. In this tuning system the antenna is connected effectively in series with the p-a tank circuit, rather than in parallel with a portion of it. The main advantage of this form of circuit is its simplicity and high efficiency, since a minimum of power-consuming components are used, and since both p-a plate and antenna circuits are tuned simultaneously.

In order to permit the coverage of a wide frequency spectrum and also to allow the use of a wide variety of antennas with this circuit, it is necessary that the values of capacity and inductance be adjustable for each new condition of frequency and antenna. To this end, the p-a coil is provided with three coarse taps connected to studs set into its former. One of these taps must be selected by a flexible tap lead for each high-frequency channel. Having thus chosen a rough value of inductance, the switch designated COUPLING provides panel control of inductance in relatively fine steps. Also, the mica padding condenser which was connected permanently across the p-a tank on the low-frequency channels is now normally disconnected, but may be returned to the circuit, if its use is required, by the suitable connection of another flexible tap lead for each high-frequency channel. In this way, both the inductance and capacity of the output circuit are made variable over quite wide limits. The tapping arm of the COUPLING switch remains connected to the antenna circuit, as for low-frequency operation, except that the low-frequency loading coil is short circuited, as was previously mentioned. Plate voltage is supplied to the p-a valve through an r-f choke when the unit is operating in the high-frequency range.

To prevent the accumulation of a static charge on the antenna when the unit is in the sending condition, resistor R36 is provided to allow any such charge to leak off to ground. This resistor has a high value of resistance, and will not consume appreciable r-f power when the unit is connected to a normal antenna. If the antenna is very short, however, the resistor may overheat somewhat at the lower end of the high-frequency range. If this occurs, it may be removed quite safely as the charge that the antenna could accumulate would not be at all dangerous.

The p-a stage is plate modulated through a modulation transformer by a pair of 6L6 valves connected in push-pull. These valves are driven directly from the microphone section of the monophone handset through a high voltage-gain microphone transformer. In order to keep the d-c supply circuit clear of ground, as is desirable in all marine equipments, it is not convenient to utilize this supply for a source of microphone current. This current is therefore obtained from the cathode circuit of the modulator valves; that is, the modulator plate current flowing in the common cathode circuit of these two valves is routed through the primary of the microphone transformer and through the microphone to ground. In this way the microphone circuit forms part of the cathode biasing resistor for the modulator valves. It will be seen that when the monophone is removed from its connector in the front panel, the modulator cathode circuit is broken and plate current cannot flow. This provides the advantage that the dynamotor load is automatically reduced when the monophone is not connected, and so, due to the regulation of the dynamotor, results in a somewhat higher plate voltage for the r-f valves on c-w operation and, therefore, a higher output power.

For m-c-w operation of the transmitter the modulator stage is made to oscillate at a frequency of approximately 1000 cycles, this note being readily audible. Oscillation is produced by feeding back a portion of the output voltage from the modulation transformer secondary to the primary of the microphone transformer. The feedback connection is made by the MCW switch on the front panel, this switch also breaking the monophone connection and inserting a resistor in the cathode circuit of the modulator valves to take the place of the return circuit through the monophone.

As previously mentioned, the send-receive relay coil is connected in series with the crystal-oscillator plate voltage dropper to the high-tension output of the dynamotor. No current normally flows through this circuit, however, since the oscillator valve cathode is open circuited through the send-receive switch and the key (or the monophone press-to-talk switch). The relay thus stays unoperated, and its contacts connect the dynamotor output and the antenna to the receiver. If, however, the key is now pressed, the oscillator valve cathode circuit is closed, and the valve draws plate current. This simultaneously starts the crystal oscillating and energizes the send-receive relay which operates to transfer the antenna and the dynamotor output to the transmitter section. When the key is released, plate current ceases, the crystal stops oscillating, and the relay drops back to the receive position. Break-in keying is thus provided; that is, the distant operator can interrupt a message at any time since his signals can be received between characters of the local transmission. This system of keying can be used in the high-frequency range only, since low-frequency crystals are too slow in starting to oscillate to be keyed.

Keying is accomplished in the low-frequency range by first moving the send-receive switch to SEND. This permanently connects the oscillator valve cathode to ground, and transfers the key to a break in the p-a cathode circuit. Thus, on switching to SEND, the relay operates, transferring the power supply and the antenna to the transmitter and also sets the crystal in oscillation. No p-a plate current flows, and hence no power is radiated, until the key is pressed. At the conclusion of a transmission the send-receive switch is returned to RECEIVE, and the relay again drops back to the receive position.

Since the press-to-talk switch in the monophone handle is permanently connected in parallel with the key jack, the functions described above for the key can equally well be performed by the press-to-talk switch. However, since this switch is normally used only for telephone transmission where the send-receive speed does not approach that used in telegraph keying, the send-receive switch may be left in the RECEIVE position for either high- or low-frequency operation on telephony.

Receiver Circuit Description

The receiver section of the unit consists of one tuned r-f pre-selector stage, tuned converter stage, one iron-cored i-f transformer stage coupled to an iron-cored diode transformer stage, one stage of audio amplification, and a power output stage. The dual-purpose valves employed are the converter valve which is also used for the tuned conversion oscillator, the i-f valve which is also used for the a-f amplifier, and the diode detector valve which is also used for the beat-frequency oscillator circuit.

Referring to the diagram of connections, it will be seen that the r-f tuned circuits are connected through the r-f section of switch S1 to the grid of the 6K7 r-f valve. From the plate of this valve, the necessary detector coils for the range required are selected and connected to the signal grid of the 6A8 conversion valve. The triode section of the latter valve performs the function of the conversion oscillator, and operates through the oscillator section of the band switch S1 with the appropriate tuned oscillator circuit. The converter plate feeds through the first i-f transformer T1, which is peaked at 260 kc, to the tetrode grid of the 6F7 i-f valve. In turn, the 6F7 plate feeds through the second i-f transformer T2, which is also peaked at 260 kc, to the diode plates of the 6R7 valve where the i-f signals are demodulated and converted to audio frequencies. These audio signals, which appear across the diode load resistances R12 and R13, are passed back to the triode section of the 6F7, amplified, and finally passed to the grid of the 6K6G amplifier valves. The output signals appearing across the secondary winding of transformer T3 are switched, either to the loudspeaker directly, or to the monophone earpiece and the auxiliary headphone jack J2 through suitable attenuating networks, by the SPEAKER-PHONES switch S3. In units whose type number includes the suffix "H", the latter switch is provided with a third position designated REMOTE. In this position the output signals are applied through an added isolation transformer T6 to the auxiliary phones jack J2. For details regarding the function of T6, reference should be made to Instructions 443 which cover the remote control equipment.

General characteristics and data relative to the receiver section are listed below for quick reference.

VALVES	1 - RVC 6K7 - tuned r-f stage 1 - RVC 6A8 - tuned converter stage 1 - RVC 6F7 - i-f and 1st audio 1 - RVC 6R7 - diode detector and b-f-o 1 - RVC 6K6G - power output
FREQUENCY RANGE	LW - 300 to 615 kc BC - 550 to 1600 kc SW - 1580 to 4200 kc
I-F FREQ.	260 kc
ANTENNA INPUT	High impedance for "Marconi" type antenna
OUTPUT IMPEDANCE	80 ohms for monophone or speaker
MAXIMUM OUTPUT	400 milliwatts undistorted 1 watt maximum
SENSITIVITY	440 kc - 7 uv for 50 mw out 890 kc - 4 " " " " " 2500 kc - 5 " " " " "
SELECTIVITY	440 kc - 60 db down at 11.5 kc off resonance 890 kc - 60 " " " 12.0 " " " 2500 kc - 60 " " " 13.0 " " "
IMAGE RESPONSE	440 kc - 75 db down 890 kc - 72 " " 2500 kc - 51 " "
SIGNAL TO NOISE RATIO	440 kc - 15 db 890 kc - 10 " 2500 kc - 20 "
I-F INTERFERENCE RATIO	440 kc - 55 db down 890 kc - 67 " " 2500 kc - 62 " "

A-V-C	Combined with sensitivity control; on at all times. Holds the output within 13 db when input varies 80 db.
AUDIO CHARACTERISTIC	Within plus or minus 2 db from 200 to 4000 cycles.

APPROX. CALIBRATION

Dial Divisions	SW	BC	LW
0	4250 kc	1600 kc	615 kc
10	4050 "	1510 "	600 "
20	3600 "	1320 "	560 "
30	3220 "	1180 "	520 "
40	2870 "	1020 "	482 "
50	2520 "	890 "	440 "
60	2120 "	775 "	400 "
70	1990 "	690 "	365 "
80	1810 "	625 "	336 "
90	1680 "	580 "	315 "
100	1580 "	550 "	297 "

Dynamotor Circuit Description

The high voltages required for the operation of the unit are normally supplied by a single built-in dynamotor which operates from the 12- or 32-volt supply for which the unit is intended.

From the panel connector, the d-c input voltage is fed through the main ON-OFF switch and through the supply fuse to the valve heater circuit. To this point also connects the dynamotor input circuit, which includes chokes and condensers for the suppression of r-f hash generated at the dynamotor brushes. The output circuit of the dynamotor includes an r-f choke and condenser for suppression of secondary circuit hash, and also a large electrolytic condenser to smooth out the commutation ripple. This point is connected by the send-receive relay either to the transmitter plate supply circuit directly, or to the receiver plate supply circuit through a voltage-dropping resistor and an additional smoothing condenser.

All filter networks in the dynamotor input and output circuits are connected in the shortest manner to a common ground point on the chassis of the unit. This precaution is essential in the minimizing of hash interference with the receiver.

The fuse is mounted in a special holder which permits it to be extracted from the front panel.

Special instructions covering the maintenance of the dynamotor are included under this cover (Inst. 311).

Standby Power Supply

For "standby" operation of the receiver, a 180-volt battery may be connected to the leads of the battery cable so designated, the main ON-OFF switch left in the OFF position, and the NORMAL-STANDBY switch moved to the STANDBY position. This connects the receiver valve filaments to the 12- or 32-volt supply leaving the transmitter valve filaments disconnected, and transfers the receiver high-tension supply to the external battery.

This feature is particularly desirable when it is required to leave the set in operation for long periods to listen for a call, but it is also desired to conserve drain on the main batteries as much as possible.

ANTENNA AND GROUND

The receiver will operate with almost any size of "Marconi" antenna, but the size of the antenna into which the transmitter will operate is limited by the frequencies on which it is desired to transmit. If the set is to be used on an average-size fishing vessel where the antenna capacity is quite high, an antenna having an overall length of approximately fifty feet (including lead-in) will usually be satisfactory if it is constructed using two or more parallel connected wires having a uniform spacing between them of approximately six inches throughout the greater part of their length. If at all possible the antenna should be longer, since a greater part of the output power of the transmitter will then be radiated. However, the length should always be slightly less than one-quarter wavelength at the highest operating frequency, as otherwise antenna tuning would not be possible with the facilities incorporated in the unit. It is recommended that 7/18 stranded phosphor-bronze wire be used for the antenna.

If the equipment is to be used in a steel ship, the ground wire should be bolted to one of the frame members. If used in a wooden ship, the ground wire must be connected to a large metal plate secured to the hull below the waterline. If this is necessary, the equipment should be located where the ground wire will be as short as possible.

SETTING UP

In addition to the main transmitter-receiver unit, the following accessories should be on hand to permit the complete operation of the unit:

Monophone Assembly type 86662
Battery Cable Assembly type 90572

The additional accessories to permit remote control of units bearing the suffix "H" are as follows:

Local Unit 93901
Remote Unit 93902
Inter-Unit Cable 93903
Monitor Headset 90573
Remote Monophone Assembly 95263

After placing the transmitter-receiver unit in the selected operating position, the battery cable may be fitted into the receptacle at the right-hand side of the front panel. The lugs on the two heavy leads at the end of this cable should be bolted to a source of d-c voltage as indicated by the unit nameplate. Since neither side of this supply circuit is grounded to the unit, operation will not be materially affected by the existence or absence of ground connections on the supply itself. CARE MUST BE OBSERVED, HOWEVER, THAT THE POLARITY OF THE SUPPLY IS MAINTAINED IN AGREEMENT WITH THE LEAD POLARITY AS STAMPED ON THE CABLE LUGS. The two small wires in this cable should be connected to a 180-volt dry battery or to any other available source of 180 volts d-c, care again being observed to keep the polarity as indicated on the tags.

The antenna should be connected to the insulator projecting through the top of the cabinet, and the ground wire to the ground bolt in the side of the cabinet.

The key may be released from its clip, swung down, and pushed forward into the guide bracket to hold it securely. If telephone transmissions are desired, the plug on the monophone cable may also be fitted into its receptacle located at the lower right-hand side of the front panel.

Providing the crystals are in place inside the unit, and the preliminary adjustments to be described in the following section have been made, the unit is now ready for operation.

PRELIMINARY ADJUSTMENT

The unit is put into operation by moving the ON-OFF switch to ON. The other toggle switches should be left in their normal positions; viz. RECEIVE, MCW OFF, BFO OFF, SPEAKER, and NORMAL. As soon as the valves have reached operating temperature, the receiver should first be checked.

The required frequency range is selected by means of the RANGE switch: the position marked LW (Long Wave) covers frequencies between 300 and 615 kc; that marked BC (Broadcast) covers between 550 and 1600 kc; and that marked SW (Short Wave) from 1580 to 4200 kc.

Individual frequencies within the range required are selected by means of the RECEIVER TUNING dial to the left of the speaker. This dial is calibrated in figures from 0 to 100, of which the 0 represents the highest frequency of each range, and 100 the lowest. The approximate relation between dial numbers and frequency in each range will be found in the table at the end of the section headed "Receiver Circuit Description" on page 8.

Loudness of the signals in the speaker or in the earpiece of the monophone is controlled by the VOLUME control, which is so connected that the automatic volume control will tend to maintain the signals at a constant volume around the average level for which this manual control is set.

The beat-frequency oscillator is turned on by the switch designated BFO, and is set so that a 1000 cycle audio note is obtained when the receiver r-f circuits are in resonance with the incoming signal. The note, however, may be varied by manipulation of the main tuning control to obtain any desired pitch.

When the unit is first installed, it is a good practice to check the adjustments of the receiver antenna circuits. At the factory these antenna circuits are adjusted with a universal dummy antenna, but since the ship's antenna may depart markedly from the characteristics of the dummy, it is desirable that the three antenna circuits in the receiver be trimmed for maximum sensitivity with the particular antenna in use. A weak signal or the noise level may be used for the purpose of judging antenna resonance. The adjustments are made as follows:

It is first necessary to remove the chassis from the cabinet. This is done by removing the four knurled panel screws holding the chassis in place, and then by lifting the lower edge of the front panel out of the groove in which it rests. The chassis will then slide out, the antenna connection to the chassis being made by a spring contact which breaks automatically when the unit is withdrawn.

The wire to the antenna should then be connected to the antenna contact fastened to the stud of the antenna ammeter.

The receiver tuning condenser dial should then be adjusted to a position around 15 divisions, and the volume control set so that a weak signal or noise is heard in either the loudspeaker or the monophone earpiece.

On the LW range, adjust condenser C3 for resonance, i.e. maximum output.
On the BC range, adjust condenser C4 for resonance.
On the SW range, adjust condenser C5 for resonance.

These three condensers are located behind holes in the side of the small shielded compartment at the left-hand end of the chassis, each condenser being stamped with its part number.

The receiver is now ready for operation, but before replacing the chassis in the cabinet the internal adjustments on the transmitter section should be made.

Assuming that the crystals have been shipped separately, these should first be plugged into their appropriate sockets which are located in a row along the right-hand front edge of the chassis. The number of the channel into which each crystal socket is wired is stamped on the chassis. The frequency range for which each channel is wired is listed below:

Unit Type No.	L-F (375 - 500 kc)	H-F (1500 - 4500 kc)
85135S	Channels 1 and 2	Channels 3 and 4
85161S	" 1 and 2	" 3 and 4
85135AS	" 1, 2 and 3	" 4
85161AS	" 1, 2 and 3	" 4
85161BS	" 1	" 2, 3 and 4
85135BS	" 1	" 2, 3 and 4

After suitably locating the crystals, proceed to adjust the low-frequency channels as follows. The semi-fixed loading taps must first be set to provide approximately the correct antenna loading on each frequency for the antenna to be used. As a first approximation, connect the semi-fixed loading tap leads, which are fastened to the insulators beside the right-hand end of the large loading inductance on top of the chassis, to loading coil terminals which appear likely to provide the required loading inductance. This will probably be approximately half inductance for frequencies about 500 kc, and approximately maximum inductance for frequencies about 375 kc, with intermediate frequencies at intermediate positions. The channel number corresponding to each loading tap lead is stamped on the chassis beside each insulator.

After switching the set on and allowing the valves to reach operating temperature, set the CHANNEL switch to the position corresponding to the lowest frequency, and the COUPLING and LOADING switches to tap 1. Press the key and quickly rotate the TRANSMITTER TUNING dial to obtain p-a resonance, as indicated by a minimum current reading on the p-a plate current meter immediately above the tuning dial. Now advance the COUPLING control one or two notches and rotate the LOADING tap switch, watching for a marked rise in p-a plate current.

If the plate current rise occurs at either end of the loading control range, or if no such rise is obtained, it will be necessary to move the appropriate semi-fixed loading tap lead to another terminal. If the rise is greatest at loading switch position 1, it will be necessary to decrease the amount of the loading coil winding in circuit. Conversely, if the rise is greatest at position 11, the tap lead should be moved to a terminal which will include more of the loading coil winding. The p-a circuit must be kept in tune during this procedure by keeping the tuning dial at a setting corresponding to minimum plate current.

After obtaining such a position of antenna resonance, the actual value of the p-a plate current should be noted. When operating correctly, this current (at p-a resonance) will have a value of between 60 and 90 milliamperes. The unit should not be operated for long periods with a plate current reading in excess of 100 ma, as this may permanently damage the p-a valve. If the observed plate current is lower than the values stated, the COUPLING control switch should be advanced, following which the plate tuning and antenna loading adjustments should again be checked.

During this procedure a reading should appear on the antenna ammeter, and when properly adjusted as above should reach a maximum. The exact value of this reading cannot be stated since it is dependent upon the characteristics of the antenna in use. For the same reason, this reading cannot be used as a measure of the power being transmitted unless the antenna characteristics are known.

Having obtained correct operation as outlined above, the switch and dial readings should be noted to permit returning to them, and the channel switch then moved to select another low-frequency channel, the adjustments for which should be carried out in the same way as for the first channel.

After having obtained correct operation on all low-frequency channels, proceed to adjust the high-frequency channels as follows. First turn the chassis up on end and check that the flexible tap lead, or leads, which are provided for the purpose of connecting in the fixed mica padding condenser are all connected to the dummy terminal set into the small bakelite panel beside the channel switch, i.e. padding condenser out of circuit. Also connect the flexible tap lead, or leads, that are provided for connection to the taps on the p-a plate coil to terminal 3 on this coil, i.e. the centre of the three terminals.

Now setting the CHANNEL switch to select one of the high frequencies, also set the transmitter tuning dial at 0 on its scale. Press the key, and quickly rotate the COUPLING switch from position 1 to position 11, watching for a decrease in the reading of the p-a plate current meter. If no such decrease is observed, move the tap lead that corresponds to this channel to tap 2 on the p-a coil, and again rotate the COUPLING switch from position 1 to position 11. Proceed to tap 1 on the coil, if necessary, in the same manner.

Having found a position that causes a current decrease, further advance the COUPLING switch one step at a time, but now manipulating the main tuning dial after each step to minimize the p-a plate current. It will be noted that as this process continues, the scale reading of the tuning dial will become higher and higher, and at the same time the plate current at resonance will also increase. The correct operating range for the p-a plate current is between 60 and 90 ma, as before, and when this condition has been reached the adjustments may be considered correct. If, during this adjustment, the COUPLING switch reaches position 11 and the p-a plate current is still under the required minimum, the flexible tap lead on the coil should be moved to the coil terminal of the next lower number, and the COUPLING switch returned to position 1. Similarly, if the apparent tune point occurs at a tuning dial setting of 100, the fixed mica padding condenser may be connected into circuit using the appropriate tap lead.

For high-frequency operation the LOADING switch will normally be left in position 1, but for some frequencies it may be found that a higher antenna current will be obtained if this switch is set at some other position. This is due to self-resonance of the large loading coil which, although short circuited, may still consume some small portion of the output power if this self-resonant condition occurs. Retuning should be carried out after changing the position of the LOADING switch or after changing the position of the flexible loading tap leads on the loading coil.

The other high-frequency channels may now be adjusted as described above. It may be noted that the reason for commencing these adjustments with the full p-a coil in circuit is to insure against the possible tuning of the network to the second harmonic of the crystal.

After having obtained correct operation on all active channels, the chassis may be returned to the cabinet. Upon re-checking transmitter operation on all channels, it will probably be found that the presence of the cabinet has a slight detuning effect on the resonant transmitter circuits. The variation should not be great, however, and it should be simple to amend the control settings previously determined. It is recommended that a record of all tuning control settings be made at this time for future reference.

The preliminary adjustments are now complete and should not change appreciably unless the length or disposition of the antenna is changed.

ROUTINE OPERATION

Having made the adjustments outlined in the foregoing section for a given antenna, routine operation of the unit is very simple.

After having set the unit up as outlined in the preceding section headed "SETTING UP", the unit is started by operating the main ON-OFF switch. The receiver range switch is set to the band in which reception is desired, and the receiver tuning dial adjusted for the desired frequency in that band. The b-f oscillator section may be switched in if required, either for the reception of c-w code signals or to aid in the location of a telephone station.

If a calibration was made of the transmitter tuning control settings for each transmitting frequency, these controls can now be set at their pre-determined positions for the frequency desired. If c-w transmission in the high-frequency range is required, it is merely necessary to operate the signalling key. When c-w transmission in the low-frequency range is required, switch to SEND before starting to key, and switch back to RECEIVE when the transmission has been completed. If m-c-w transmission on either range is required, switch to MCW and then proceed as for c-w operation. When phone transmission is required, plug in the monophone handset, leave the MCW switch in its OFF position, and the SEND-RECEIVE switch on RECEIVE. The SPEAKER-PHONES switch may be moved to PHONES if desired. To talk, press the button in the monophone handle, releasing it again to listen.

Note that when transmitting, the unit is rated for intermittent operation of five minutes TRANSMIT - five minutes RECEIVE. This rating should not be disregarded as otherwise the dynamotor is liable to overheat. Continuous operation on RECEIVE is, of course, permissible.

For standby operation of the receiver, leave the main ON-OFF switch in the OFF position, and move the switch from NORMAL to STANDBY. The receiver will now operate as before, except that the pilot lamp on the transmitter portion of the panel will not light.

SERVICING INSTRUCTIONS

Receiver Section

A good check on the operation of the receiver section of the FR-12 unit is provided by voltage measurement at various points in the circuit. All voltage measurements should be taken against ground with a 1000-ohms-per-volt meter, and should be within 10% of the values listed below for a supply voltage as listed on the unit nameplate.

Junction of R19 and C42	- 170 volts	(b-f-o off)	155
" " R19 and C42	- 155 "	(b-f-o on)	145
" " R9 and C25	- 80 "		65
Pin 3 of 6K6G valve (plate)	- 155 "		155
" 6 " 6A8 valve (osc. plate)	- 125 "	(osc working)	110
" 6 " 6A8 valve (osc. plate)	- 90 "	(osc not wkg)	
" 4 " 6F7 valve (triode plate)	- 55 "		47
Junction of R7 and R8	- 45 "	(at max volume)	48
" " R7 and R8	- 55 "	(at min volume)	56
Pin 8 of 6K7 valve (cathode)	- 1.2 "		.65
" 8 " 6A8 valve (cathode)	- 2.2 "		1.4
" 6 " 6F7 valve (cathode)	- 1.6 "		1.3
" 8 " 6K6G valve (cathode)	- 12 "		15

When checking voltages at other points in the circuit, allowance should be made for voltage drop through resistances and transformer coils.

Complete Alignment

For complete alignment of the receiver it is necessary to have an accurately calibrated signal generator and a 2000-ohms-per-volt a-c voltmeter. The voltmeter should be connected between ground and the junction of R38 and SPEAKER-PHONES switch. This latter switch should be placed in the PHONES position and the monophone assembly left disconnected from its panel receptacle.

I-f Alignment

Connect the high side of the signal generator to the grid of the 6A8 valve through a .1- or .05-uf condenser, leaving the present grid cap in place. The ground side of the signal generator should be connected to the chassis at some convenient point. The controls should be as follows:

Range switch on SW
Volume control full clockwise
Tuning dial at 0 divisions
B-f o switch in OFF position

With the signal generator set to a frequency of 260 kc, adjust the four small trimmers, two in each i-f can, until the meter indicates maximum output. The overall sensitivity of the i-f circuits for 1-volt output will be 180 microvolts, if the signal generator is reliable and the output meter matched to the output transformer. The selectivity of the i-f amplifier should be 40 db down at 10 kc off resonance.

For purposes of checking the audio circuits, the signal generator input may be connected to the 6F7 i-f amplifier grid, leaving the grid cap on. An input of 11,000 microvolts should produce an output reading of 1 volt.

After the i-f amplifier has been accurately adjusted, the b-f oscillator should be switched on and the trimmer in the top of the b-f oscillator transformer can adjusted to give a beat note of 1000 cycles with the incoming i-f signal. The modulation on the signal generator should be turned off during this adjustment.

R-f Alignment

Connect the high side of the signal generator to the antenna terminal through a 250-uuf condenser when adjusting LW or BC ranges, or through a 400-ohm resistor for the SW range, or use a universal dummy on all ranges if one is available. Adjust the signal generator to the frequency corresponding to 15 divisions on the tuning dial, and then, by means of the output meter, adjust the r-f, detector, and oscillator trimmers to give maximum output. The tuning dial is then set at 85 divisions and the signal generator frequency adjusted to give a reading on the output meter. The tracking condenser should now be adjusted for maximum output while rocking the tuning condenser back and forth across the signal. These trimming and tracking adjustments should be repeated until adjustment of any trimmer does not affect the adjustment of the tracker when they are tuned to maximum output. Usually, if the receiver has been correctly trimmed, the signal generator may be dispensed with when tracking, as the noise level will provide an adequate indication of resonance.

The following table shows the frequencies and adjustments for all ranges:

Range	Dial Setting	Sig. Gen. Frequency	Adjust For Max. Output	Sensitivity For 1-v Out
LW	15	580 kc	C3,C15,C18	5 uv
LW	85	325 kc approx	Tracking C21	8.7 uv
BC	15	1410 kc	C4,C16,C19	4 uv
BC	85	600 kc approx	Tracking C22	6 uv
SW	15	3800 kc	C5,C17,C20	8 uv
SW	85	1720 kc approx	Tracking C23	6 uv

The above table shows the dial divisions and the frequencies which should be adhered to as much as possible. The sensitivities, however, will vary depending upon the type of signal generator used, so that if the sensitivities are approximately as listed, the receiver should be considered correctly adjusted.

Replacing Valves

When changing valves which are used in any part of the circuit that has a tuning adjustment associated with it, that particular adjustment should be checked for maximum sensitivity, this being done, if no signal generator is available, by adjusting for maximum noise level. If, however, the 6A8 conversion valve is changed, it will be necessary to trim the three ranges at 15 divisions to their calibration frequencies to compensate for any variation in valve capacity.

Transmitter Section

Very little trouble should be experienced with the transmitter section as the tuned circuits incorporated therein are all adjusted from the panel front, and day to day variations can readily be taken up. The only components which are at all subject to failure are the valves. These can be checked periodically by replacing them with ones known to be good and noting the resulting operation for possible improvement.

If crystal failure is at any time suspected, one of the leads to the p-a plate current meter can be disconnected and a 0-25 milliampere d-c meter connected across the signalling key, leaving the contacts of the latter open. With the SEND-RECEIVE switch in the RECEIVE position, the meter will indicate current in the cathode circuit of the oscillator valve which has a normal value of from 18 to 24 ma. Moving the switch to SEND moves the meter to the cathode circuit of the p-a valve. Since the plate supply circuit was opened by the disconnection of one of the meter leads, the only current in this cathode circuit will be that flowing through the grid circuit. This current normally has a value of from 4 to 8 ma, depending on the frequency, and will not be present if the crystal is not oscillating. Absence of grid current at this point may, of course, also be due to a defective oscillator or p-a valve, or to the failure of a circuit component. The latter possibility can usually be eliminated by ordinary circuit testing methods.

The static drain resistor R36 may overheat if a very short antenna is used. If this occurs, the resistor may be removed from the circuit since its presence is not essential.

PARTS LIST

Symbol	Description	Maker	Type No.
Condensers			
C1	250 uuf, mica	Aerovox	1468
C2	.1 uf, 400 v	Marconi	82897
C3	3-30 uuf)		
C4	3-30 uuf)	Marconi	87744
C5	5-70 uuf)		
C6	13-442 uuf)		
C7	13-442 uuf)	Marconi	86640
C8	13-442 uuf)		
C9	7.5 uuf, mica	Aerovox	1468
C10	250 uuf, mica	"	1468
C11	.002 uf, mica	"	1467
C12	.1 uf, 400 v	Part of C2	
C13	50 uuf, mica, +-5%	Aerovox	1468
C14	100 uuf, mica	"	1468
C15	13-50 uuf)		
C16	4-25 uuf)	Marconi	95171
C17	13-50 uuf)		

Symbol	Description	Maker	Type No.
C18	95-200 uuf)		
C19	13-50 uuf)	Marconi	95170
C20	13-50 uuf)		
C21	170-600 uuf)	"	82548
C22	170-600 uuf)		
C23	900-1800 uuf	"	91471
C24	.1 uf, 400 v	Part of C2	
C25	.1 uf, 400 v)		
C26	.1 uf, 400 v)	Marconi	82897
C27	.1 uf, 400 v)		
C28	.002 uf, mica	Aerovox	1467
C29	.01 uf, paper	"	284
C30	10 uf, 25 v, electrolytic	"	PR-25
C31	250 uuf, mica	"	1468
C32	7.5 uuf, mica	"	1468
C33	250 uuf, mica	"	1468
C34	.1 uf, 400 v	Part of C2	
C35	10 uf, 50 v, elect.	Aerovox	PR-50
C36	10 uf, 50 v, elect.	"	PR-50
C37	.1 uf, 400 v	Part of C25	
C38	.1 uf, 600 v, paper	Aerovox	684
C39	Not used		
C40	.01 uf, mica	Aerovox	1467
C41	10 uf, 450 v, elect.)	Mallory	FP-Dual
C42	10 uf, 450 v, elect.)		

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Symbol	Description	Maker	Type No.
C43	1 uf, 200 v, paper	Aerovox	284
C44	35 uf, mica	"	1468
C45	.01 uf, mica	Cornell-Dubilier	1-W
C46	.002 uf, mica	C-D	1-W
C47	.002 uf, mica	"	1-W
C48	.01 uf, mica	"	1-W
C49	.1 uf, 400 v, paper	Aerovox	484
C50	.002 uf, mica	"	1456
C51	.02 uf, mica	" or C-D	1651 9-21020
C52	500 uuf, variable	Hammond	8150
C53	400 uuf, mica	Aerovox or C-D	1652 9-23040
C54	.002 uuf, mica	Aerovox or C-D	1651A 9A-22020
C55	.1 uf, 600 v, paper	Aerovox	684
C56	.1 uf, 600 v, paper	"	684
C57	15 uuf, mica	"	1468
C58	500 uuf, mica	"	1468
C59	Not used		
C60	.5 uf, 200 v, paper	Aerovox	284
C61	.5 uf, 200 v, paper	"	284
C62	225 uuf, mica	"	1468
C63	25 uuf, mica	"	1468
C64	.5 uf, 200 v, paper	"	284
C65	In standard units: .1 uf, 200 v, paper In "H" type units: 4.0 uf, 50 v, paper	" Sprague	284 CA-275

Symbol	Description	Maker	Type No.
C66	10 uuf, mica	Aerovox	1468
C67	.25 uf, 200 v, paper (Used in 32-v models only)	"	284
C68	500 uuf, mica	"	1468

Inductances

Symbol	Description	Maker	Type No.
L1	R-f choke	Marconi	82569
L2	LW r-f coil	"	D-86450
L3	BC r-f coil	"	82555
L4	SW r-f coil	"	95250
L5	LW detector coil	"	D-86457
L6	BC detector coil	"	82557
L7	SW detector coil	"	95251
L8	LW oscillator coil	"	D-86460
L9	BC oscillator coil	"	D-86461
L10	SW oscillator coil	"	95252
L11	B-f oscillator coil assy	"	86466
L12	Coil assy	"	83449
L13	R-f choke	I.C.A.	2277*
L14	R-f choke	"	2282 6017A 195Ω 125 mA
L15	R-f choke	"	2277*
L16	Not used		
L17	Not used		
L18	P-a coil assy	Marconi	93412
L19	R-f choke	I.C.A.	2277*
L20	R-f choke	"	2277* 2½ MH 25Ω 150 mA

Symbol	Description	Maker	Type No.
L21	Loading coil assy	Marconi	90109
L22	Coil assembly	"	83449
Meters			
M1	0-150 ma d-c	Simpson	127-S
M2	0-1.5 amp r-f	"	137-S
Resistors			
R1	1 megohm, 1/2 watt	I.R.C.	BT
R2	100 ohms, 1/2 watt	"	BT
R3	1 megohm, 1/2 watt	"	BT
R4	200 ohms, 1/2 watt	"	BT
R5	50,000 ohms, 1/2 watt	"	BT
R6	15,000 ohms, 1/2 watt	"	BT
R7	Sensitivity control	Marconi	D-86451
R8	35,000 ohms, 1 watt	I.R.C.	BT
R9	20,000 ohms, 1 watt	"	BT
R10	200 ohms, 1/2 watt	"	BT
R11	1 megohm, 1/2 watt	"	BT
R12	250,000 ohms, 1/2 watt	"	BT
R13	250,000 ohms, 1/2 watt	"	BT
R14	50,000 ohms, 1/2 watt	"	BT
R15	Not used		
R16	100,000 ohms, 1/2 watt	"	BT
R17	500,000 ohms, 1/2 watt	"	BT
R18	1,000 ohms, 1/2 watt	"	BT

Symbol	Description	Maker	Type No.
R19	5,000 ohms, 20 watts	I.R.C.	DG
R20	100 ohms, 1/2 watt	"	BT
R21	100 ohms, 1/2 watt	"	BT
R22	50 ohms, 1 watt	"	BW-1
R23	200 ohms, 10 watts	"	AB
R24	10,000 ohms, 1 watt	"	BT
R25	25,000 ohms, 2 watts	"	BT
R26	5,000 ohms, 10 watts	"	AB
R27	400 ohms, 1 watt	"	BT
R28	100,000 ohms, 1/2 watt	"	BT
R29	5,000 ohms, 1 watt	"	BT
R30	300 ohms, 10 watts	"	AB
R31	10,000 ohms, 2 watts	"	BT
R32	10 ohms, 10 watts (used in 32-v models only)	"	AB
R33	1,000 ohms, 1/2 watt	"	BT
R34	10 ohms, 20 watts (used in 32-v models only)	"	DG
√ R35	15 ohms, 10 watts (used in 12-v models only)	"	AB
R36	100,000 ohms, 1/2 watt	"	BT
R37	25 ohms, 1/2 watt	"	BT
R38	100 ohms, 1/2 watt	"	BT
R39	100 ohms, 1/2 watt	"	BT
R40	250 ohms, 1 watt (used in 32-v models only)	"	BT
R41	250 ohms, 10 watts (used in 32-v models only)	"	AB
R42	200 ohms, 1/2 watt	"	BT

Symbol	Description	Maker	Type No.
Transformers			
T1	First i-f	Marconi	D-86470
T2	Second i-f	"	D-86478
T3	Output	"	D-85999 457-0100
T4	Microphone	"	79008
T5	Modulation	"	79007
T6	Isolation transformer (used in "H" type units only)	"	97625
Switches			
S1	Receiver band	Marconi	86469
S2	B-f oscillator	"	86655
S3	Speaker-Phones	"	86654 (#95278 in "H" type units)
S4	15 amp, 125 volts	A.H. & H.	80302
S5	M-c-w	Marconi	86654
S6	Channel	"	93753
S7	Loading	"	90150
S8	Coupling	Centralab	2503
S9	Send-Receive	Marconi	86654
S10	Normal-Standby	"	86654
Valves			
V1	R-f amplifier	R.V.C.	6K7
V2	Converter	"	6A8
V3	I-f amplifier	"	6F7
V4	Detector	"	6R7

Symbol	Description	Maker	Type No.
V5	Output	R.V.C.	6K6G
V6	Modulator	"	6L6
V7	Modulator	"	6L6
V8	Crystal oscillator	"	6L6
V9	Power amplifier	"	6L6

Miscellaneous

Symbol	Description	Maker	Type No.
E1	Relay, d-p d-t, 6000-ohm coil	Marconi	94633
J1	Key jack	Yaxley	701
J2	Phones jack	"	A-1
P1	Pilot lamp 12-16 volts for 12-v sets, 24 volts for 32-v sets	Mazda #52	Min. screw base
P2	Same as P1		
	Pilot lamp mounting (2 required)	Yaxley	330
F1	Fuse, 30 amp	Littelfuse	1099
	Fuse mounting	"	1212-A
CC1	Cable connector	Amphenol	92-C1
CC2	Cable connector	"	PC-4M
Speaker	Permag	Oxford	3YMP
Dynamotor	For 12-volt sets:	Marconi	95247
	" 32-volt " ~~6125-21-416-0044~~	"	95248 → actually ROBBINS & MEYERS #84-Q46819 (See CIIC)
	Key assembly	"	86660
	Monophone assembly	"	86662
	Battery cable	"	90572
	Antenna insulator	Johnson	51

Symbol	Description	Maker	Type No.
	Base insulators	Johnson	55
	Base insulators	"	42

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MAINTENANCE INSTRUCTIONS FOR PIONEER DYNAMOTORS

I. BRUSHES

A. Two Sets of Brushes:

1. The larger brushes carry the input current to the low-voltage commutator which usually has the fewer number of bars - output brushes are the smaller ones on the opposite end.

B. Type of Brushholder: (Different for various series of dynamotors.)

1. Check the nameplate of your unit to determine type of your dynamotor.

C. When to Replace Brushes:

1. Types "E" and "RA". If it is found that the brushes have worn down to a length of 3/16" they should be replaced.

2. Types "FS", "OS", "PS", "CS", "US", and "TS". These brushholders are so designed that the spring will not touch the commutator when brush is worn. When brush is worn out there will be no contact, resulting in no output, or operation will be electrically noisy due to poor contact. It is advisable to examine the brushes after every 500 running hours. The life of the brushes may vary considerably. Examine all four brushes.

D. Replacing Old Brushes:

1. When ordering replacement brushes, BE SURE to specify the type of dynamotor employed, as brush material and spring tension are especially developed for each type of dynamotor to insure best performance and maximum life.

2. If the brushes are not worn excessively, replace them in the original position in the same holder from which they were removed to insure good electrical contact between the commutator and brushes.

3. Brush-dust may collect in and around the brushholder. This should be blown off with compressed and filtered air free of any oil.

E. Seating New Brushes:

1. The commutator end of the brush must be concave. As near 100% as possible of the brush surface should come in contact with the commutator.

2. For final seating of new brushes use #8-0 Garnet paper. Before using the garnet paper, operate the dynamotor (connected to the battery) to determine the direction of rotation of the armature. Then (disconnect battery from dynamotor) place the sanded side of the garnet paper against the brush with both ends of the garnet paper led out opposite of the brush to be seated. Then pull the end of the garnet paper that will rotate the armature in its proper direction of rotation.

3. Run in the brushes for several hours until noise and ripple is at a minimum. By turning on the receiver you can check for noise and ripple.

II. COMMUTATOR

A. Dark Polished Appearance of Commutator.

After the dynamotor has run for a time, the commutator takes on a dark polished appearance which SHOULD BE PRESERVED as this film helps prolong brush and commutator life. BE SURE there is no oil, grease, or dirt on commutator. Oil or grease on the commutator acts as an abrasive and will cause excessive wear of brushes and commutator.

1. Periodic inspections are recommended.

2. To clean the commutator in case of excessive coating, touch it very lightly with fine sandpaper (#000) while the dynamotor is running. Then STOP the dynamotor and use a penknife or similar instrument (being careful not to scratch the surface) to remove the oil or dirt between the bars on the commutator. Clean with a dry cloth free of lint.

3. DO NOT touch the commutator unless it is established that the trouble is in the commutator. Dirt or oil accumulation on the commutator will affect the output. NEVER use emery cloth - USE ONLY #000 fine sandpaper.

B. Grooved or Rough Commutator:

1. If the commutator is rough or grooved, the armature should be taken out of the frame and the commutator "turned" or "ground". Only very light cuts should be taken. BE SURE that the shaft centres are clean and true. Armature must run concentric with bearing surface within .0005" by indicator reading.

2. BE CAREFUL that there are no tool marks left on the surface of the commutator.

3. The mica between the bars on the commutator should be undercut to a depth of .025" if commutator is turned. BE SURE there are no mica fins left on sides of bars.

4. After undercutting the commutator BE SURE to smooth the surface with #8-0 Garnet paper to remove any burrs. Then clean with a dry cloth free from lint.

5. When cleaning the commutator BE CAREFUL not to get any foreign matter in the ball bearings.

6. The ends of the commutator are covered with a red film of insulating compound to insure against current leakage due to moisture or oil creepage - DO NOT remove this film.

7. If it is necessary to undercut the commutator, the ball bearings should be removed. BEFORE replacing the ball bearings it is advisable to clean them by washing in gasoline. BE SURE to dry well - then repack with grease.

III. BALL BEARINGS

A. The ball bearings are packed in grease. After 500 running hours, remove the screw plug in the hub of the end bracket, and if additional lubrication is required, fill opening with any of the following:

Master Lubricants Co. Lubrico M6.
New York & New Jersey Lubricant Co. F927.
Standard Oil Co. G5990.

or equivalent approved grade lubricant. Replace the screw plug.

IV. ARMATURE AND FIELD COILS

A. If the source of trouble is believed to be in the armature or field coils, the unit should be returned to the factory unless complete testing facilities are available. Shorted, grounded, or open, armatures and field coils should be replaced.

1. Grounded Armature.

(a) Test the low-voltage commutator - a 220-volt circuit should be used to test for a "grounded" armature. A lamp is connected in this circuit - one terminal of the circuit is connected to the armature shaft and the other to the low-voltage commutator. The lamp will light if the armature is "grounded".

(b) Test the high-voltage commutator - a 550-volt circuit should be used. Connect the two terminals in the same manner and if the lamp lights the commutator is "grounded".

(c) Connect terminals from 550-volt circuit to both the high- and low-voltage commutators.

2. Shorted Armature.

If two adjacent bars on the commutator are joined by brush dust, solder, pieces of copper, or similar foreign matter, the bars are joined electrically and the result is a "shorted" armature. A shorted armature should be replaced. Should the insulation be weak, as shown by "burnt colour" windings, it is recommended that the armature be replaced. The standard testing instrument for detecting a "short" in the armature is known as a "growler".

3. Open Armature.

If at least two adjoining commutator bars are black, there is an "open" in the armature (caused by arcing across the commutator).

4. Grounded Field Circuit.

Use a 220-volt lamp circuit. Connect one terminal of the lamp circuit to one of the terminals of the field, leaving the other terminal of the field free. Momentarily touch the shell of the dynamotor with the other terminal of the 220-volt lamp circuit - if the field is "grounded" the lamp will light.

5. Open Field.

Remove field leads from brushholders. Check continuity by touching both leads from field with same voltage as input rating of dynamotor. Read current drain on an ammeter. If no indication is observed, field is open.

V. <u>IF OUTPUT OF THE DYNAMOTOR IS NOT SATISFACTORY</u>

A. In checking output voltage of dynamotors, meters having at least 500- to 1000-ohms-per-volt resistance should be used.

B. Low Output.

1. Check output current in milliamperes to be sure there is no short or overload in the associated equipment.

2. Check input voltage at the dynamotor.

3. See that bearings are free.

4. Check for armature laminations rubbing on the field laminations.

5. See that brushes are free to move, giving proper pressure on commutator.

6. Check input current in amperes. High reading may indicate short or ground in the dynamotor.

C. Possible Causes for Low Output.

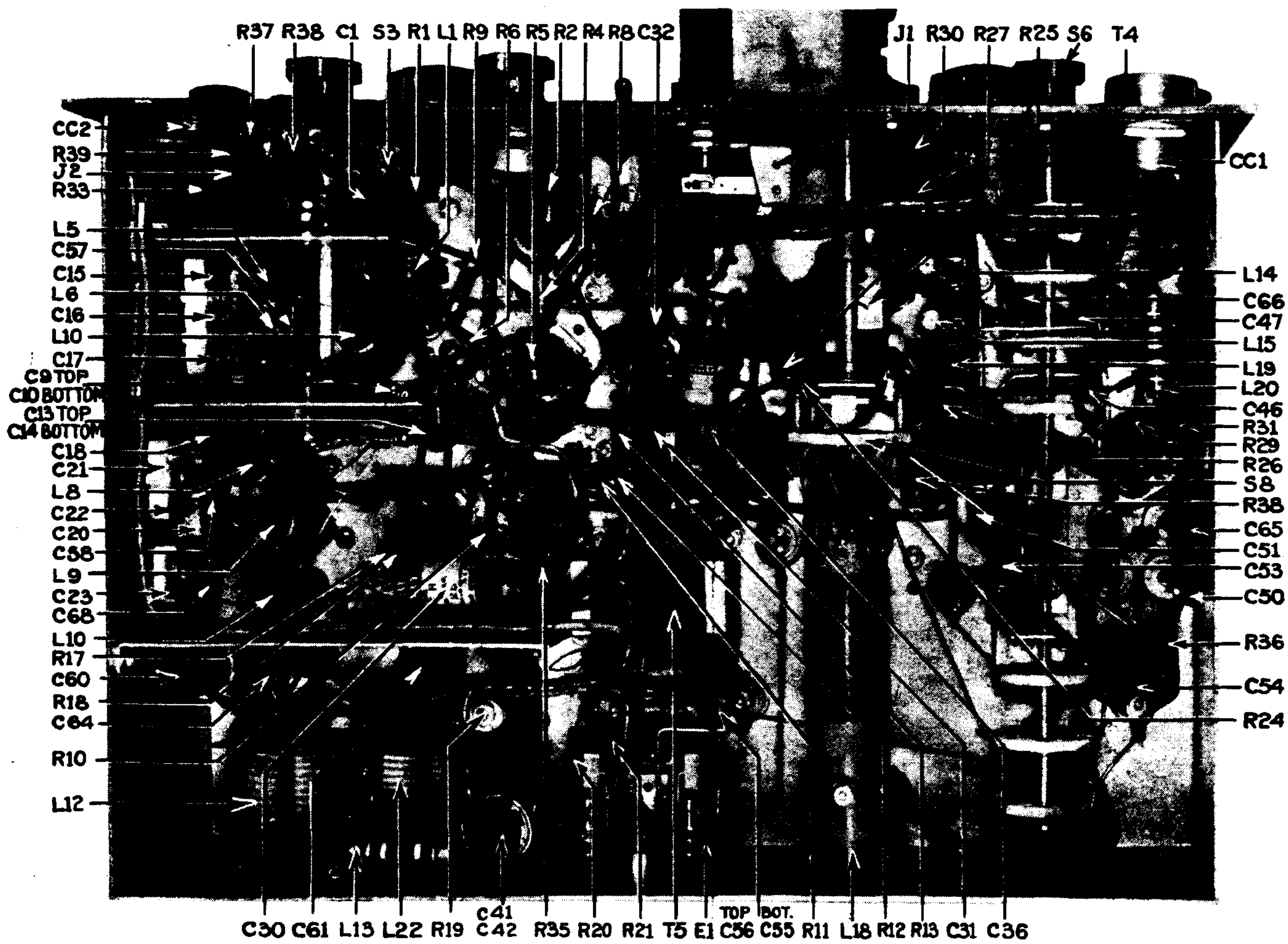
1. Battery terminals loose or corroded.
2. Discharged battery and low input voltage.
3. Loose connections.
4. Brushes - (see paragraph I)
   (a) Worn
   (b) Binding in holder
   (c) Excessive sideplay
   (d) Not seated properly.
5. Commutator - (see paragraph II)
   (a) Dirt or oil
   (b) Rough or grooved
   (c) Grounded, shorted, or open.
6. Field coils - grounded or open.
7. Shorted output winding.

D. Possible Causes of Mechanical Noise.

1. Bearings -
   (a) Loose
   (b) Defective
   (c) Need lubricant
2. Brushes chattering.
3. Armature rubbing.

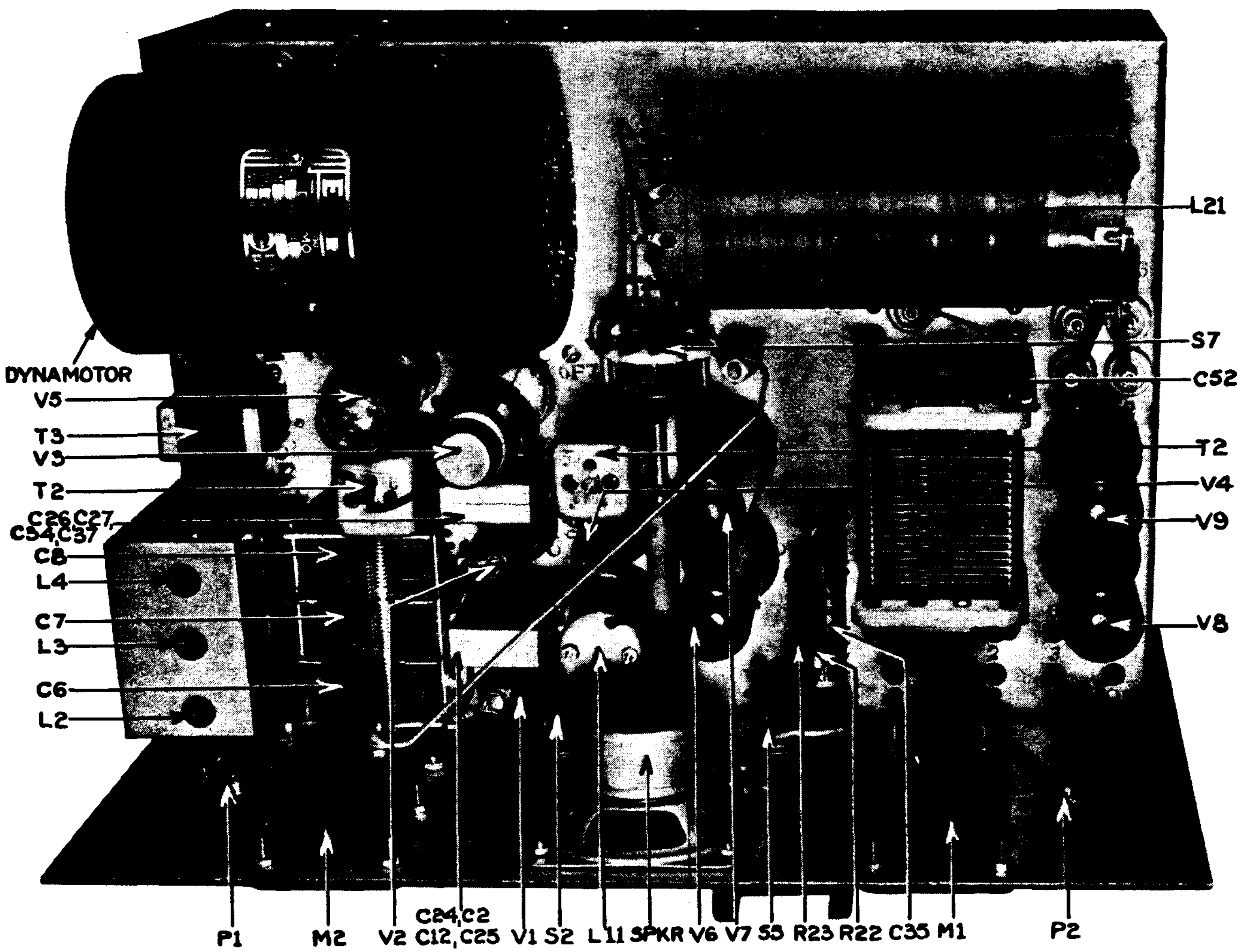
Canadian MARCONI Company,
Montreal, February 27, 1942.

"MARCONI" FR-12S & FR-12T TRANSMITTER RECEIVER



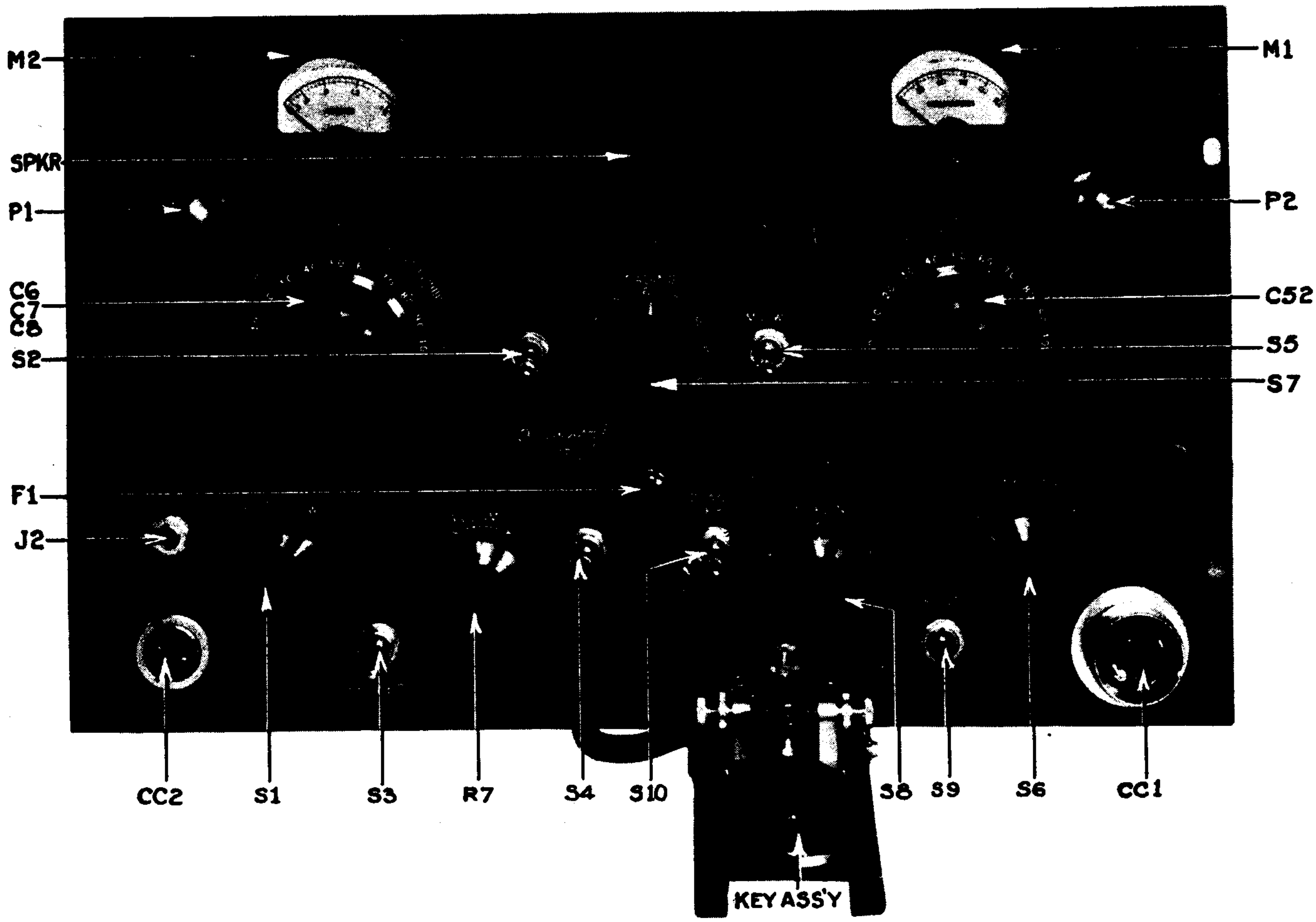
CHASSIS ASS'Y
BOTTOM VIEW

"MARCONI" FR-12S & FR-12T TRANSMITTER RECEIVER

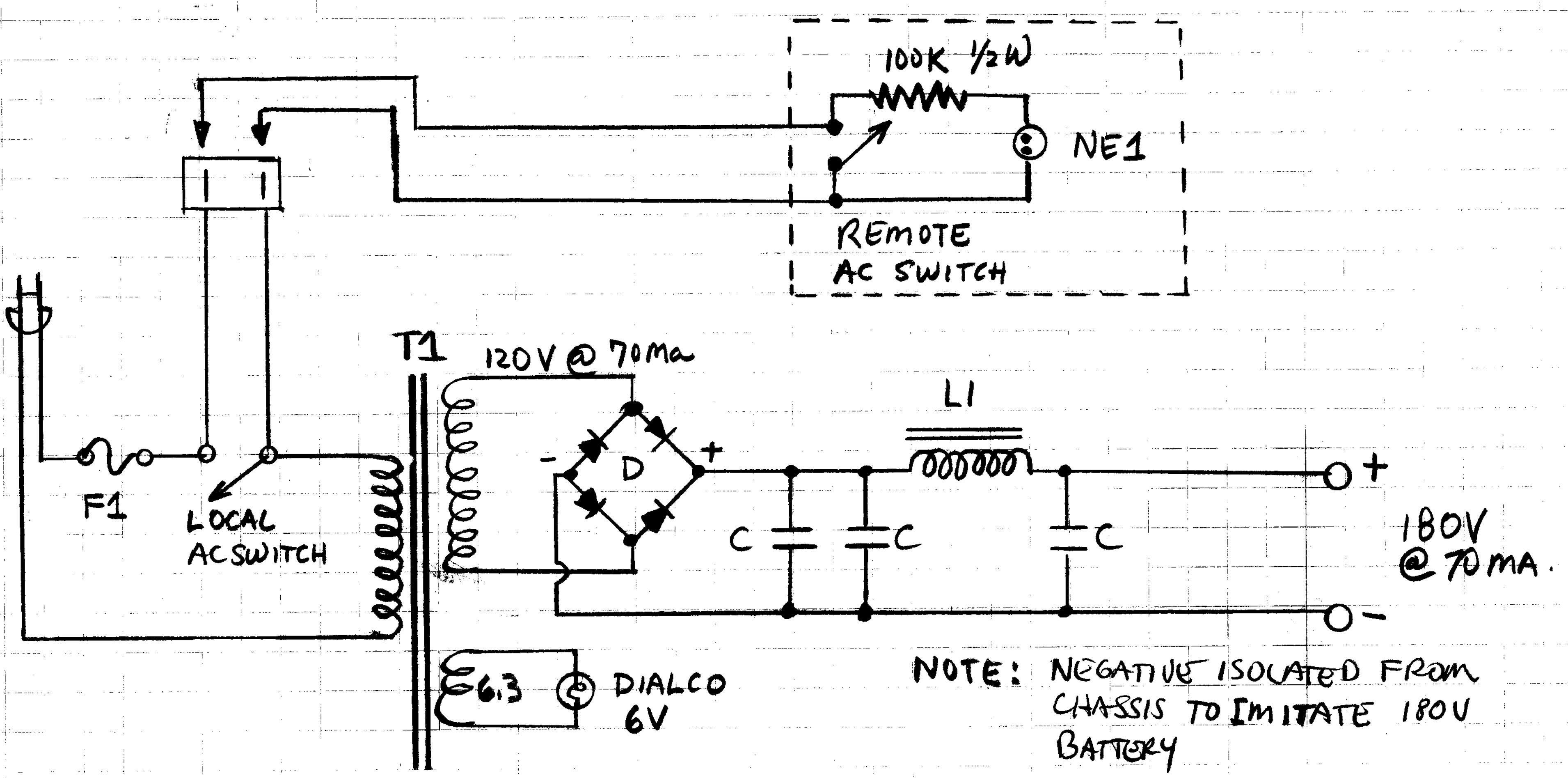


CHASSIS ASS'Y
TOP VIEW

"MARCONI" FR-12S & FR-12T TRANSMITTER RECEIVER



CHASSIS ASS'Y
FRONT VIEW



NOTE: NEGATIVE ISOLATED FROM CHASSIS TO IMITATE 180V BATTERY

T1
HAMMOND
262F6.

L1
HAMMOND
154M
2H @ 100ma

D
ALL DIODES
1N4007

C
ALL CAPS
10μf @ 450V

180V STANDBY POWER SUPPLY FOR FR12
S/N 921209