AN 16-45-221

HANDBOOK
OPERATING INSTRUCTIONS

RADIO RECEIVER

MODEL SP-600-JX

(HAMMARLUND MFG.)

PUBLISHED UNDER AUTHORITY OF THE SECRETARY OF THE AIR FORCE

O-23 JUL 52 3,200

27 JUNE 1952

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SECTION I

GENERAL DESCRIPTION

1-1. GENERAL.

1-2. Radio Receiver, Model SP-600-JX rack mountings (See figure 1-1.), is manufactured by the Hammarlund Manufacturing Co. Inc., New York, N. Y. The receiver is a 20-tube radio communications receiver designed for direct mounting in a standard 19-inch relay rack. It comprises a chassis with a light grey front panel, a top cover, and a bottom plate.

1-3. The receiver has a self-contained power supply designed to operate from a single phase, 90 to 270 volt, 50- to 60-cps, a-c source. The power transformer primary and secondary are each separately fused, the primary by a three ampere fuse contained in a fuse holder located on the rear apron and the high voltage secondary by a three-eighths ampere pigtail type fuse soldered between the transformer terminal 11 and chassis ground. The bottom plate of the receiver must be removed to get at the pigtail type fuse.

CAUTION

Maintain the fuse complement to prevent damage.

1-4. To provide for reception, auxiliary components are associated with the radio receiver. These usually comprise a headset and/or a loud speaker, but frequency shift receiver converter equipment and/or teleprinter or tape recording equipment may also be used with the receiver. All operational activities require the use of an antenna which is connected to the antenna input connector (See 11, figure 1-3.), at the top rear of the receiver chassis. Apart from the "PHONES" jack (See 1, figure 1-2.), contained in the front panel, all the receiver auxiliary component connecting means are located on the rear apron (See figure 1-3.). The rear apron also contains an "AC" outlet (See 1, figure 1-3.), for an electric lamp or clock and a "PHONO" inlet (See 2, figure 1-3.), for a record player attachment, all of which must be suited to operate from the available a-c source.

1-5. The receiver provides for the reception of amplitude-modulated, keyed, and frequency-shift carrier intelligence signals. In the instance of voice-frequency or low-speed telegraph signals, a headset may be plugged in the "PHONES" jack (See 1, figure 1-2.), contained in the front panel and/or a loud speaker connected to the "AUDIO OUTPUT" terminals (See 3, figure 1-3.), on the rear apron. In the instance of teleprinter or high-speed telegraph signals, a teleprinter or a tape recorder must be used. When the received signal is an amplitude-modulated or keyed carrier signal, the recording equipment is transmission line connected to the "AUDIO OUTPUT" terminals, with the speaker removed. When the received signal is a frequency-shift carrier signal the "IF OUTPUT" cable connector (See 4, figure 1-3.), on the rear apron is connected by coaxial cable to frequency-shift receiver converter equipment. In diversity receiving systems involving two or more receivers, each receiver is cable connected to the system through means of its "IF OUTPUT" connector.

1-6. DESCRIPTION.

1-7. The radio receiver provides for the superheterodyne reception of any radio frequency carrier within its 0.54 to 54.0 mc tuning range. All carrier frequencies are converted to a 455 kc intermediate frequency, but those above 7.4 mc are initially converted to 3,955 kc through a system of double superheterodyne conversion. The receiver provides for continuously variable tuning, or, operations may be carried out at any pre-determined, fixed, crystal controlled frequency.

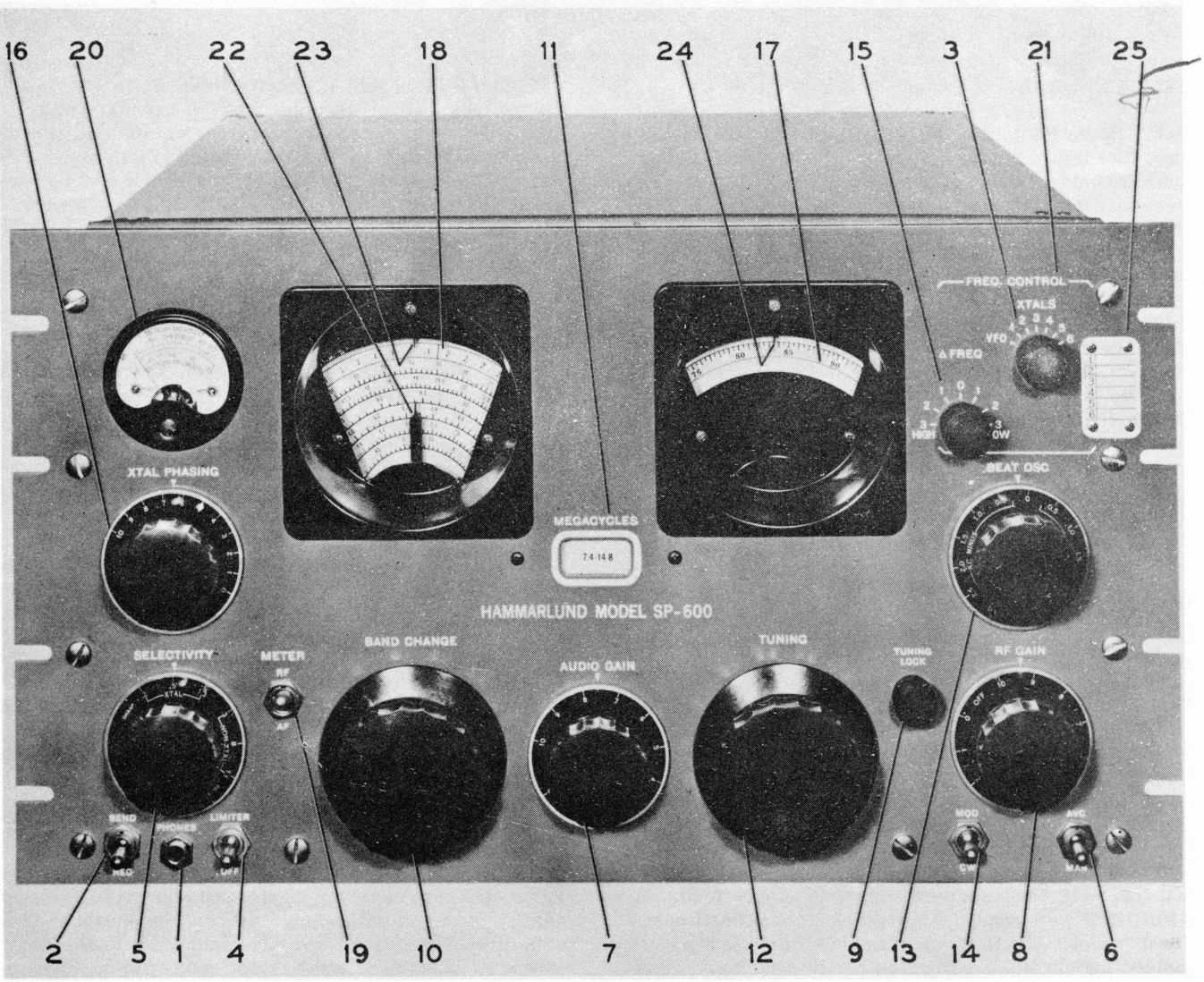
1-8. The receiver may be desensitized for protection in the presence of a strong local carrier. To provide against the wide variations encountered in the strength of any carrier picked up or tuned in, the r-f gain is adjusted manually and maintained within narrow limits through use of a system of automatic volume control incorporated in the receiver. In the presence of acoustical noise, the audio gain is manually adjusted to provide for comfortable, intelligible reception.

1-9. The receiver provides a choice of six degrees of acceptance band width or selectivity to the carrier tuned in, the band width chosen being that which provides optimum receiver performance for the existing quality of the signal. Also, interfering unwanted signals may be phased out to highly attenuate their strength. A noise limiter effectively eliminates ignition noise, and similar pulse noise, from the audio output.

1-10. The receiver may be accurately tuned to the desired carrier and the strength of the carrier measured in relation to a carrier intensity of one microvolt. The audio output may be measured in relation to the standard reference output of six milliwatts.

1-11. OPERATIONAL THEORY.

1-12. The six frequency bands of the receiver provide for the continuous coverage of the 0.54 to 54.0 mc frequency range. The four r-f coil assemblies for each band are contained in a rotary turret which is used to change bands. The manner in which the coil assemblies for each band are placed adjacent to their respective sections of the precise four-gang tuning condenser assures receiver sensitivities at high signal to noise ratios. An anti-backlash gear-train, used for tuning provides for calibration accur-



1. "PHONES" jack
2. "SEND" "REC" toggle switch
3. "XTALS" control
4. "LIMITER" "OFF" toggle switch
5. "SELECTIVITY" switch
6. "AVC" "MAN" toggle switch
7. "AUDIO GAIN" control
8. "RF GAIN" control
9. "TUNING LOCK" control
10. "BAND CHANGE" control
11. "MEGACYCLES" window
12. "TUNING" control
13. "BEAT OSC" control
14. "MOD" "CW" toggle switch
15. " Δ FREQ" control
16. "XTAL PHASING" control
17. Vernier dial
18. Main tuning dial
19. "METER" "RF" "AF" toggle switch
20. Meter
21. "FREQ CONTROL"
22. Movable pointer
23. Fixed pointer
24. Vernier pointer
25. Plastic chart

Figure 1-2. Radio Receiver, Front Panel Identification

acy and completely accurate resetability, further enabling maximum benefit to be derived from the crystal filter circuit incorporated in the i-f amplifier of the receiver.

1-13. The crystal frequency control unit incorporated in the receiver results in the ultimate in frequency stability, being superior to the practical precision attainable for variable frequency tuning. Its use preestablishes the communication channel, even when receiving conditions are poor, without necessitating a time consuming search by the operator.

1-14. The receiver makes full use of superheterodyne reception for any signal within its frequency range, the overall receiver selectivity being essentially that developed in the 455 kc i-f amplifier. The use of 3,955 kc, for double conversion, maintains high "image" rejection ratios above 7.4 mc.

1-15. The r-f signal section of the receiver provides for any signal tuned in to become available at a high intensity level in relation to the noise originating in this part of the receiver. The signal is then single or double converted, always providing 455 kc i-f input to the i-f section of the receiver. The i-f section of the receiver develops the i-f signal to the desired selectivity at the proper amplification. It provides for amplitude-modulated or keyed carrier signals to become available as audio output and for frequency-shift carrier signals to become available as i-f output. The a-f section provides the a-f signal as the controllable audio output of the receiver. The self-contained power supply develops all the d-c and a-c supply voltages used by the receiver, some of the d-c voltages being regulated to maintain sensitivity and frequency stability.

1-16. CAPABILITIES AND LIMITATIONS.

1-17. The radio receiver provides optimum receiver performance when properly installed and operated. It may be used in fixed and/or mobile operations subject to wide ranges in temperature and humidity. Subsequent to a 15-minute warm up period its frequency stability closely approaches that of a crystal. It incorporates advanced design and shielding to reduce its radiation characteristics to a possible minimum. This enables the receiver to maintain performance in multi-receiver installations and to comply with shipboard regulations. The receiver embodies the necessary chassis rigidity to withstand severe vibration and shock. It is also adequately treated with fungicidal varnish to condition it for tropical use.

1-18. The receiver is adaptable to a two-way operational activity. The manual "SEND" "REC" toggle switch (See 2, figure 1-2.), provides normal reception when in the "REC" position and instantly desensitizes the receiver when in the "SEND" position, the receiver power remaining "on" for both positions of the switch. A relay may be connected to the "RELAY" receptacle (See 5, figure 1-3.), to enable a hand microphone to perform the switch function.

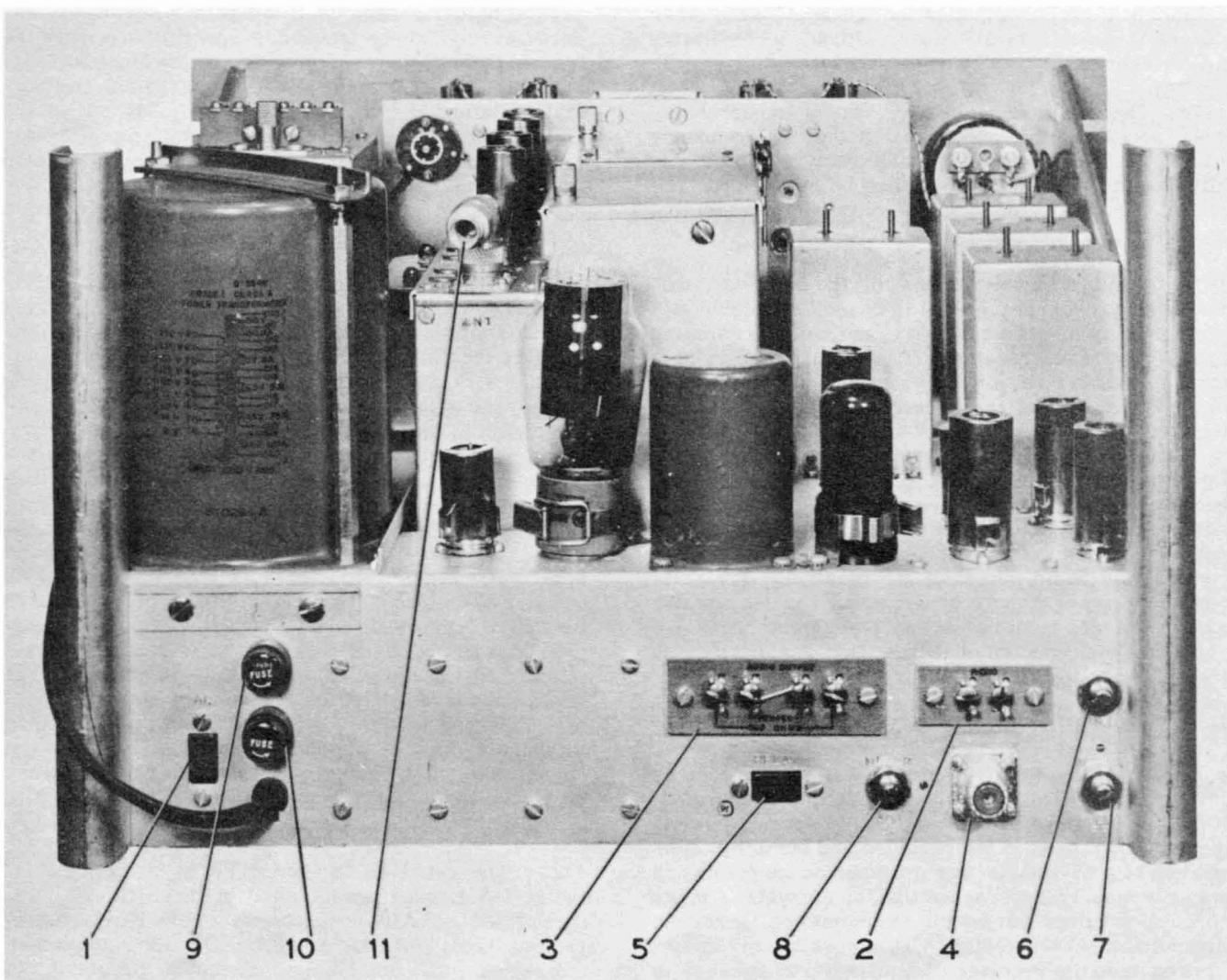
1-19. The crystal frequency control unit incorporated in the receiver provides for pre-determined, fixed frequency, crystal controlled channel operation at any frequency within the tuning range of the receiver. The receiver is switched from a condition providing for continuous variable tuning to fixed frequency operation by turning the "XTALS" control (See 3, figure 1-2.), from its "VFO" position to one of its other positions designated "1", "2", "3", "4", "5", or "6", each of which is associated with a numbered crystal holder located at the top front of the receiver. The crystal holder chosen is fitted with a separately ordered crystal whose frequency specification suits the frequency of the pre-determined operational activity. In ordering, the signal frequency, for which the crystal is intended, must be specified. Any one of the ordered crystals may be used in any one of the six crystal holders provided. When the receiver is used for the same signal frequency on fixed frequency operation as on variable frequency operation a slight retuning of the receiver is desirable.

1-20. The input to the receiver provides for coupling to a balanced doublet antenna, the 100-ohm matching transmission line used providing flexibility as to the relative locations of the receiver and the doublet antenna. A doublet antenna is preferred since it provides good signal to noise ratios in the presence of atmospheric and ignition noise. A straight wire antenna when used is connected to one terminal of the antenna input connector whose other terminal is then grounded.

1-21. The receiver shielding minimizes ignition and other pulse type noise. The noise "LIMITER" "OFF" toggle switch (See 4, figure 1-2.), may be switched to its "LIMITER" position to by-pass such noise from the audio output of the receiver. The receiver maintains a 10 to one signal-plus-noise to noise ratio at its output for sensitivities of two microvolts, or better. This provides for optimum receiver performance in the presence of a weak signal tuned in since the background "hiss" noise originating in the first vacuum tube and prior circuitry does not interfere with reception.

1-22. The receiver "SELECTIVITY" switch (See 5, figure 1-2.), provides a choice of three "XTAL" and three "NON-XTAL" positions of receiver selectivity, ranging from "SHARP" to "BROAD", as indicated on the switch dial. Since noise, no matter its origin, is of the pulse type, whereby it comprises all frequencies, the noise tuned in with the signal is passed, to the extent of the overall acceptance bandwidth of the receiver. The selectivity switch "XTAL" positions restrict the pass band to 0.2, 0.5 or 1.3 kc while the "NON-XTAL" positions restrict the pass band to 3.0, 8.0, or 13.0 kc.

1-23. The receiver avc system is rendered operative by the "AVC" "MAN" toggle switch (See 6, figure 1-2.). In the "AVC" position the receiver output remains constant within a 1:4 voltage ratio when the input is increased from two to 200,000 microvolts. The use of avc precludes an audible blast when tuning through a carrier relatively strong compared to the setting of the "AUDIO GAIN" control (See 7, figure 1-2.), apart from compensating for the possible fading characteristics of the signal over long or short



1. "AC" outlet
2. "PHONO" inlet
3. "AUDIO OUTPUT" terminals
4. "IF OUTPUT" connector
5. "RELAY" receptacle
6. "BFO INJ" control
7. "METER ADJ RF"
8. "METER ADJ AF"
9. "SPARE FUSE" holder
10. "FUSE" holder
11. Antenna Input Connector

Figure 1-3. Radio Receiver, Rear Apron Identification

intervals of time.

1-24. The receiver maximum undistorted power output is approximately two watts with the "AUDIO GAIN" control (See 7, figure 1-2.), full on. No class of service requires this amount of output so that the "AUDIO GAIN" control is always backed-up somewhat.

1-25. Since the radio receiver is a superheterodyne type of receiver a carrier frequency, twice the applicable i-f frequency higher in frequency than the desired carrier frequency tuned in, is also converted to the 455 kc or 3,955 kc i-f frequency applicable respectively to signal frequencies below and above 7.4 mc. This "image" frequency is rejected by the receiver to the extent that when the desired signal strength at 7.4 mc is one microvolt, the strength of the "image" frequency would have to be 4,000 microvolts to produce an equal effect on the receiver. At other signal frequencies the strength of the "image" frequency would have to be even more. Also, when the receiver is tuned to 600 kc, a 455 kc carrier input to the antenna would have to be 2700 microvolts to produce the same effect as a one microvolt signal at 600 kc. For frequencies other than 600 kc, this i-f rejection ratio is even better.

SECTION II

OPERATING PROCEDURES

CAUTION

In an emergency turn the equipment off by pulling the receiver power cord plug from the a-c power source.

2-1. SEQUENCE OF OPERATION.

2-2. PRIOR TO USE. The radio receiver has its operating controls and switches adjusted to suit the operational activity contemplated. The procedures outlined to operate the receiver identify each operating control and switch by its front panel designation (See figure 1-2.).

2-3. MCW RECEPTION--VOICE, MUSIC, or TELEGRAPH.

2-4. PRELIMINARY REQUIREMENTS.

a. Plug in the headset in the "PHONES" jack (See 1, figure 1-2.), or listen to the loud speaker, when used.
b. Switch the "SEND" "REC" toggle switch (2) to "REC".
c. Unclamp the "TUNING LOCK" (9) by turning it counter-clockwise.
d. Turn the "RF GAIN" control (8) from its dial knob "OFF" position in a clockwise direction. A "click" will indicate that the receiver is in its "on" position. Do this at least 15 minutes prior to using the receiver. Note that the pilot lamps light up.
e. Switch the "SELECTIVITY" switch (5) to its "NON-XTAL" "3" kc knob dial position.
f. Switch the "MOD" "CW" toggle switch (14) to "MOD".
g. Switch the "AVC" "MAN" toggle switch (6) to "AVC".
h. Set the "XTAL PHASING" control (16) to its "◊" knob dial position.
i. Switch the frequency control "XTALS" switch (3), to its "VFO" position.
j. Determine the signal frequency to be received.
k. Indent the "BAND CHANGE" control (10) to the "MEGACYCLES" window (11) tuning range dial indication for the frequency band in which the desired signal frequency is located.
l. Turn the "RF GAIN" control (8) to its maximum clockwise position.
m. Turn the "AUDIO GAIN" control (7) to a position providing for comfortable reception.
n. Turn the "TUNING" control (12) so that the main tuning dial (18) frequency indication corresponds to the desired signal frequency to be tuned in.

2-5. TUNING PROCEDURE. To tune in the mcw signal follow the preliminary requirements outlined in paragraph 2-4 and continue as follows:

a. Turn the "TUNING" control (See 12, figure 1-2.), in either direction to resonate the signal, as is the case when the meter (20) indication is a maximum. At resonance the main dial (18) frequency reading should be within one quarter of one percent of the desired signal frequency tuned in.
b. Clamp the "TUNING LOCK" (9) by turning it clockwise, if desired.
c. Readjust the "AUDIO GAIN" control (7) to a position for comfortable reception.

2-6. ADJUSTMENTS UNDER NOISY CONDITIONS. To provide for the best possible mcw reception under noisy atmospheric or man-made static conditions, follow the preliminary requirements outlined in paragraph 2-4 and the tuning procedure outlined in paragraph 2-5, and continue as follows:

a. Switch the "SELECTIVITY" switch (See 5, figure 1-2.) to the switch position which provides the most intelligible reception for the operational activity in which engaged.
b. If the "SELECTIVITY" switch (5) is used in one of its "XTAL" positions, turn the "XTAL PHASING" control (16) to a position which phases out an interfering signal, if any.
c. Switch the "LIMITER" "OFF" toggle switch (4) to the "LIMITER" position to eliminate ignition noise, and others, if any.
d. During "stand-by" periods in the transmission

when the desired signal frequency is "off the air" turn the "RF GAIN" control (8) down somewhat from its maximum clockwise position to cut down on the receiver noise output in such instances.

e. While in the process of initially setting the "TUNING" control (12) to the desired signal frequency, turn the "RF GAIN" control (8) down somewhat to avoid receiver noise output while the "TUNING" control (12) is traversing positions at which there are no signal transmissions.

f. When the signal level fluctuates (fades) so that at intervals the signal level is low, the receiver signal output may be favored in relation to the receiver noise output by turning the "RF GAIN" control (8) down to some point most suited to the receiving conditions of the operational activity.

2-7. ADJUSTMENTS SUITABLE TO A WEAK SIGNAL. When the preliminary requirements (Refer to paragraph 2-4.) and the tuning procedure (Refer to paragraph 2-5.) do not provide for tuning in the desired signal frequency due to it being too weak to be readily distinguishable from other signals or interference of any kind, identify the desired frequency by using the following procedure:

a. Switch the "MOD" "CW" toggle switch (See 14, figure 1-2.) to "CW".

b. Determine some strong low frequency signal to be used to accurately set the "BEAT OSC" control (13) to 455 kc, which setting may not correspond exactly to its "O" knob dial setting.

c. Indent the "BAND CHANGE" control (10) to the "MEGACYCLES" window (11) tuning range dial indication for the frequency band in which the low signal frequency is located.

d. Tune in the low signal frequency by turning the "TUNING" control (12) in either direction to resonate the signal accurately with the indication on the meter (20) at a maximum.

e. Adjust the "BEAT OSC" control (13) for zero beat audio output, and maintain this setting for it.

f. Indent the "BAND CHANGE" control (10) to the "MEGACYCLES" window (11) tuning range dial indication for the frequency band in which the desired signal frequency is located.

g. Turn the "TUNING" control (12), in either direction, to resonate the desired signal for zero beat audio output.

h. Switch the "MOD" "CW" toggle switch (14) back to "MOD".

i. Clamp the "TUNING LOCK" (9) by turning it clockwise, if desired.

j. Readjust the "AUDIO GAIN" control (7) to a position for comfortable reception.

2-8. CRYSTAL FREQUENCY CONTROL UNIT OPERATION. When the operational activity is to provide for the fixed frequency crystal controlled mcw reception of the signal frequency, follow the preliminary requirements outlined in paragraph 2-4, and continue as follows:

a. Switch the frequency control "XTALS" switch (See 3, figure 1-2.) to its "1", "2", "3", "4", "5", or "6" crystal frequency position whose numeral designation corresponds to that of the crystal holder which carries the crystal suited to the signal frequency. The "XTALS" switch (3) position is readily determined by noting the numeral on the plastic chart (25) alongside of which the signal frequency is recorded.

b. Turn the "Δ FREQ" control (15) in either direction on scale to resonate the signal, as is the case when the indication on the meter (20) is a maximum.

c. Turn the "TUNING" control (12) in either direction to further resonate the signal, as is the case when the indication on the meter (20) is a maximum.

d. Clamp the "TUNING LOCK" (9) by turning it clockwise, if desired.

e. Readjust the "AUDIO GAIN" control (7) to a position for comfortable reception.

2-9. SUPPRESSED CARRIER RECEPTION. When the mode of operation contemplated is to provide for the reception of mcw single or double side band transmissions, the desired signal carrier, suppressed at the transmitter, must be reinserted at the receiver. This is done by providing for the cw reception of the single or double side bands and reinserting the suppressed carrier in the form of the 455 kc i-f output from the buffer stage associated with the bfo. Thus for the reception of suppressed carrier transmissions, follow the preliminary operating requirements as outlined in paragraph 2-11, as applicable to cw reception, and continue as follows:

a. When the desired signal is a double side band suppressed carrier transmission, continue as outlined in paragraphs 2-5, also listening to the signal so that the tuning procedure outlined in paragraph 2-5a provides for the most intelligible signal.

b. When the desired signal is a single side band suppressed carrier transmission, continue as outlined in paragraph 2-5, but with regard to the tuning procedure outlined in paragraph 2-5a, remember that the carrier is reinserted at one edge of the single side band being received. Thus when tuning in the signal, approach the resonant or proper tuning position in turn from each side, choosing the resonant or proper tuning position for which the signal is intelligible.

2-10. CW RECEPTION--TELEGRAPH.

2-11. PRELIMINARY REQUIREMENTS.

a. Plug in the headset in the "PHONES" jack (See 1, figure 1-2.), or listen to the loud speaker, when used.

b. Switch the "SEND" "REC" toggle switch (2) to "REC".

c. Unclamp the "TUNING LOCK" (9) by turning it counter-clockwise.

d. Turn the "RF GAIN" control (8) from its dial knob "OFF" position in a clockwise direction. A "click" will indicate that the receiver is in its "on" position. Do this at least 15 minutes prior to using the receiver. Note that the pilot lamps light up.

e. Switch the "SELECTIVITY" switch (5) to its "NON-XTAL" "3" kc knob dial position.

f. Switch the "MOD" "CW" toggle switch (14) to "CW".

g. Switch the "AVC" "MAN" toggle switch (6) to "MAN" for low-speed telegraph signal reception and to "AVC" for high-speed telegraph signal reception. Remember that the meter (20) only provides an r-f signal indication in the "AVC" position of the switch (6).

h. Set the "BEAT OSC" control (13) to its "O" knob dial position.
i. Set the "XTAL PHASING" control (16) to its "◊" knob dial position.
j. Switch the frequency control "XTALS" switch (3), to its "VFO" position.
k. Determine the signal frequency to be received.
l. Indent the "BAND CHANGE" control (10) to the "MEGACYCLES" window (11) tuning range dial indication for the frequency band in which the desired signal frequency is located.
m. Turn the "RF GAIN" control (8) clockwise to a position below that at which the receiver noise output is blocked off, if on "MAN", and full on, if on "AVC".
n. Turn the "AUDIO GAIN" control (7) to a position providing for comfortable reception.
o. Turn the "TUNING" control (12) so that the main tuning dial (18) frequency indication corresponds to the desired signal frequency to be tuned in.

2-12. TUNING PROCEDURE. To tune in the cw signal follow the preliminary requirements outlined in paragraph 2-11 and continue as follows:
a. Turn the "TUNING" control (See 12, figure 1-2.), in either direction, for zero beat audio output or maximum indication on the meter (20), either tuning procedure providing for resonating the signal, (Refer to paragraph 2-11g.). At resonance, the main dial (18) frequency reading should be within one quarter of one percent of the desired signal frequency tuned in.
b. Clamp the "TUNING LOCK" (9) by turning it clockwise, if desired.
c. Turn the "BEAT OSC" control (13) in either direction to get tone output, preferably around 1000 cps. Reception may be better with the control turned in one direction as compared to the other. In any case choose position in either direction, no matter the tone, which provides for the most intelligible reception.
d. Readjust the "RF GAIN" control (8) for cleanest signal and the "AUDIO GAIN" control (7) to a position for comfortable reception.

2-13. ADJUSTMENTS UNDER NOISY CONDITIONS. To provide for the best possible cw reception under noisy atmospheric or man-made static conditions, follow the preliminary requirements outlined in paragraph 2-11 and the tuning procedure outlined in paragraph 2-12, and continue as follows:
a. Switch the "SELECTIVITY" switch (See 5, figure 1-2.) to the "XTAL" position which provides the best reception.
b. Turn the "XTAL PHASING" control (16) to a position which phases out an interfering signal, if any.
c. Switch the "LIMITER" "OFF" toggle switch (4) to the "LIMITER" position to eliminate ignition noise, and others, if any.
d. Monitor the "RF GAIN" control (8) by adjusting it manually to that position providing the cleanest signal, and readjust the "AUDIO GAIN" control (7) to a position for comfortable reception.

2-14. ADJUSTMENTS SUITABLE TO A WEAK SIGNAL. When the preliminary requirements (Refer to paragraph 2-11.) and the tuning procedure (Refer to paragraph 2-12.) do not provide for tuning in the desired signal frequency due to it being too weak to be readily distinguishable from other signals or interference of any kind, identify the desired signal frequency by using the following procedure:
a. Determine some strong low frequency signal to be used to accurately set the "BEAT OSC" control (See 13, figure 1-2.) to 455 kc, which setting may not correspond exactly to its "O" knob dial setting.
b. Indent the "BAND CHANGE" control (10) to the "MEGACYCLES" window (11) tuning range dial indication for the frequency band in which the low signal frequency is located.
c. Switch the "AVC" "MAN" toggle switch (6) to "AVC".
d. Tune in the low signal frequency by turning the "TUNING" control (12) in either direction to resonate the signal accurately with the indication on the meter (20) at a maximum.
e. Adjust the "BEAT OSC" control (13) for zero beat audio output, and maintain this setting for it.
f. Indent the "BAND CHANGE" control (10) to the "MEGACYCLES" window (11) tuning range dial indication for the frequency band in which the desired signal frequency is located.
g. Leave the "AVC" "MAN" toggle switch (6) on "AVC" for the reception of high-speed telegraph signals and switch to "MAN" for the reception of low-speed telegraph signals.
h. Turn the "TUNING" control (12), in either direction, to resonate the desired signal for zero beat audio output.
i. Clamp the "TUNING LOCK" (9) by turning it clockwise.
j. Readjust the "RF GAIN" control (8) for cleanest signal and the "AUDIO GAIN" control (7) to a position for comfortable reception.

2-15. CRYSTAL FREQUENCY CONTROL UNIT OPERATION. When the operational activity is to provide for the fixed frequency crystal controlled cw reception of the signal frequency, follow the preliminary requirements outlined in paragraph 2-11, and continue as follows:
a. Switch the frequency control "XTALS" switch (See 3, figure 1-2.) to its "1", "2", "3", "4", "5", or "6" crystal frequency position whose numeral designation corresponds to that of the crystal holder which carries the crystal suited to the signal frequency. The "XTALS" switch (3) position is readily determined by noting the numeral on the plastic chart (25) alongside of which the signal frequency is recorded.
b. Turn the "Δ FREQ" control (15) in either direction on scale to resonate the signal, as is the case for zero beat audio output or when the indication on the meter (20) is a maximum, the meter providing an indication when the "AVC" "MAN" toggle switch (6) is in its "AVC" position, (Refer to paragraph 2-11g.).
c. Turn the "TUNING" control (12) in either direction to further resonate the signal, as is the case for zero beat audio output or when the indication on the meter (20) is a maximum, the meter providing an indication when the "AVC" "MAN" toggle switch (6) is in its "AVC" position, (Refer to paragraph 2-11g.).
d. Clamp the "TUNING LOCK" (9) by turning it clockwise, if desired.
e. Readjust the "RF GAIN" control (8) to that position providing cleanest signal and "AUDIO GAIN" control (7) to a position for comfortable reception.

2-16. DURING USE. The radio receiver provides optimum performance for long periods of time, limited only by the quality and strength of the signal being received. To maintain the communication link in a condition providing for optimum reception, repeat, when needed, the operating procedures outlined above (Refer to paragraph 2-6, a, b, c, and f.), in the instance of mcw reception and (Refer to paragraph 2-13, a, b, c, and d.), in the instance of cw reception.

2-17. FOLLOWING USE.

a. Turn the "RF GAIN" control (See 8, figure 1-2.), counter-clockwise to its "OFF" knob dial indication to turn the receiver "off".

b. Fill out an Operation Data form (See figure 2-1.), to provide data useful to the maintenance activities.

2-18. Figure 2-1 is self explanatory in terms of the various headings shown. The column headed Operating Conditions, Atmos., is to be filled in with such terms as Clear, Dust, Smoke, etc., as applicable.

2-19. DESCRIPTION OF CONTROLS.

2-20. The controls used to operate the receiver are all located on the front panel, (See figure 1-2.). All are referred to by their chassis designations.

2-21. The a-c power switch of the receiver is at the extreme counter-clockwise position of the "RF GAIN" control (See 8, figure 1-2.). When the "RF GAIN" control is turned from its "OFF" control knob dial position in a clockwise direction, a "click" indicates the power "on" position. The four pilot lamps will also be seen to light up the main tuning and vernier dials.

CAUTION

Do not wantonly switch the receiver power off and on again once it is turned on. Doing this may cause the 3/8-amp pigtail type fuse to blow due to the excessive initial filter condenser charging current through it under such conditions of operation.

2-22. "SEND" "REC". Switch the "SEND" "REC" toggle switch (See 2, figure 1-2.), to "SEND" for transmission from an associated transmitter, and to "REC" for reception.

2-23. "MOD" "CW". Switch the "MOD" "CW" toggle switch (See 14, figure 1-2.), to "MOD" for mcw reception, and to "CW" for cw reception. "CW" reception results in audio output as telegraph. "MOD" reception results in audio output as voice or music; or as a teleprinter signal, or similar signal, which is transmission line fed to auxiliary equipment. In "CW" position a capacitor is added to the avc circuit, the increased time constant provided enabling avc to be used for cw reception of high-speed telegraph signals.

2-24. The tuning mechanism of the receiver provides the operator with accurate dial indications as to the frequency of the carrier tuned in.

2-25. "BAND CHANGE". Turn the "BAND CHANGE" control (See 10, figure 1-2.), 360 degrees per band in either direction to indent the frequency band which includes the desired carrier signal. The frequency band indented is identified by the "MEGACYCLES" window (11) which shows the frequency range chosen. Doing this also locates the top of the main dial pointer at the chosen frequency range visible through the large window at the left side of the front panel.

2-26. "TUNING". Turn the "TUNING" control (See 12, figure 1-2.), in either direction to the desired carrier frequency. This tuning control friction drives the vernier dial (17) visible through the front panel right hand window. This in turn gear-train drives the main tuning dial (18).

2-27. "TUNING LOCK". Turn the "TUNING LOCK"

OPERATING DATA

RADIO RECEIVER, MODEL SP-600-JX, RACK MOUNTINGS, SERIAL NO. _____

DATE	HOURS			OPERATING CONDITIONS			
	ON	OFF	TOTAL	TEMP°F	REL. H. %	ATMOS.	MINOR REPAIRS

TROUBLE:

Figure 2-1. Operating Data Form

(See 9, figure 1-2.), in a clockwise direction to lock the vernier dial at the chosen frequency setting. This tuning lock clamps the tuning mechanism at the desired frequency setting by locking the vernier dial, even though the "TUNING" control (12) remains free to turn. The "TUNING LOCK" prevents accidental shifting or severe vibration from detuning receiver.

2-28. "SELECTIVITY". The "SELECTIVITY" switch (See 5, figure 1-2.), provides for choice as to 0.2, 0.5, 1.3, 3.0, 8, or 13 kc bandwidth or selectivity at which the signal is attenuated to half the mid band value. The three "XTAL" knob dial positions are realized through means of the crystal filter incorporated in the i-f amplifier of the receiver. The crystal filter provides definite operational advantages when the quality or fidelity of the receiver output is secondary to continuity of service.

2-29. "XTAL PHASING". Set the "XTAL PHASING" control (See 16, figure 1-2.), to a position which highly attenuates an interfering carrier closely adjacent to the desired signal carrier. This control is associated with the crystal filter. It provides this function only in the "XTAL" knob dial position of the "SELECTIVITY" switch (5).

2-30. "BEAT OSC". Detune the "BEAT OSC" control (See 13, figure 1-2.), in either direction from "0" control knob dial setting to provide tone output for cw reception.

2-31. The "MOD" "CW" toggle switch (See 14, figure 1-2.), when in the "CW" position turns the beat oscillator "on". The setting chosen for the "BEAT OSC" control (13) determines the pitch of the tone output. The operator chooses the control setting which provides him with the most intelligible reception. This may be better in a negative or positive control sense from "0" control dial setting or zero beat. The "BEAT OSC" is useful in locating weak signals of any kind, and for carrier reinsertion at the receiver for suppressed carrier operations, i.e., single or double side band transmissions.

2-32. "RF GAIN". The "RF GAIN" control (See 8, figure 1-2.), increases the r-f and i-f gain of the receiver when turned in a clockwise direction from its receiver a-c power switch "on" position, (Refer to paragraph 2-21.). This control is adjustable in either position of the "AVC" "MAN" toggle switch (6).

2-33. "AVC" "MAN". Switch the "AVC" "MAN" toggle switch (See 6, figure 1-2.), to "AVC" for the automatic volume control of the "RF GAIN" control (8) dial setting chosen and switch to "MAN" for manual control of the "RF GAIN" control. "AVC" is effective for the reception of voice, music, or high-speed cw telegraph signals. "MAN" control is most effective for the reception of low-speed cw telegraph. When the strength of the carrier tuned in is less than two microvolts, the avc is not functioning since it only functions when the strength of the carrier tuned in is greater than the threshold level or delay incorporated in the avc.

2-34. When the "AVC" "MAN" toggle switch (See 6, figure 1-2.), is in the "MAN" position, the meter (20) does not provide an indication of the level of the r-f signal; it only provides for the indication in the "AVC" position of the switch.

2-35. "METER" "RF" "AF". Leave the "METER" "RF" "AF" spring return toggle switch (See 19, figure 1-2.), in its normal position for rf. Hold depressed for af. This switch is associated with the dual scale meter (20) at the upper left on the front panel. With the "METER" "RF" "AF" switch in its normal "RF" position, the meter indication is used for accurate tuning when on avc. The meter "RF" indication is the relative strength of the received carrier signal in db from one microvolt when the "RF GAIN" control (See 8, figure 1-2.) is at maximum. When the "METER" "RF" "AF" switch is in its "AF" or depressed position the meter indication is the relative audio output level in db from a six milliwatt standard reference level output.

CAUTION

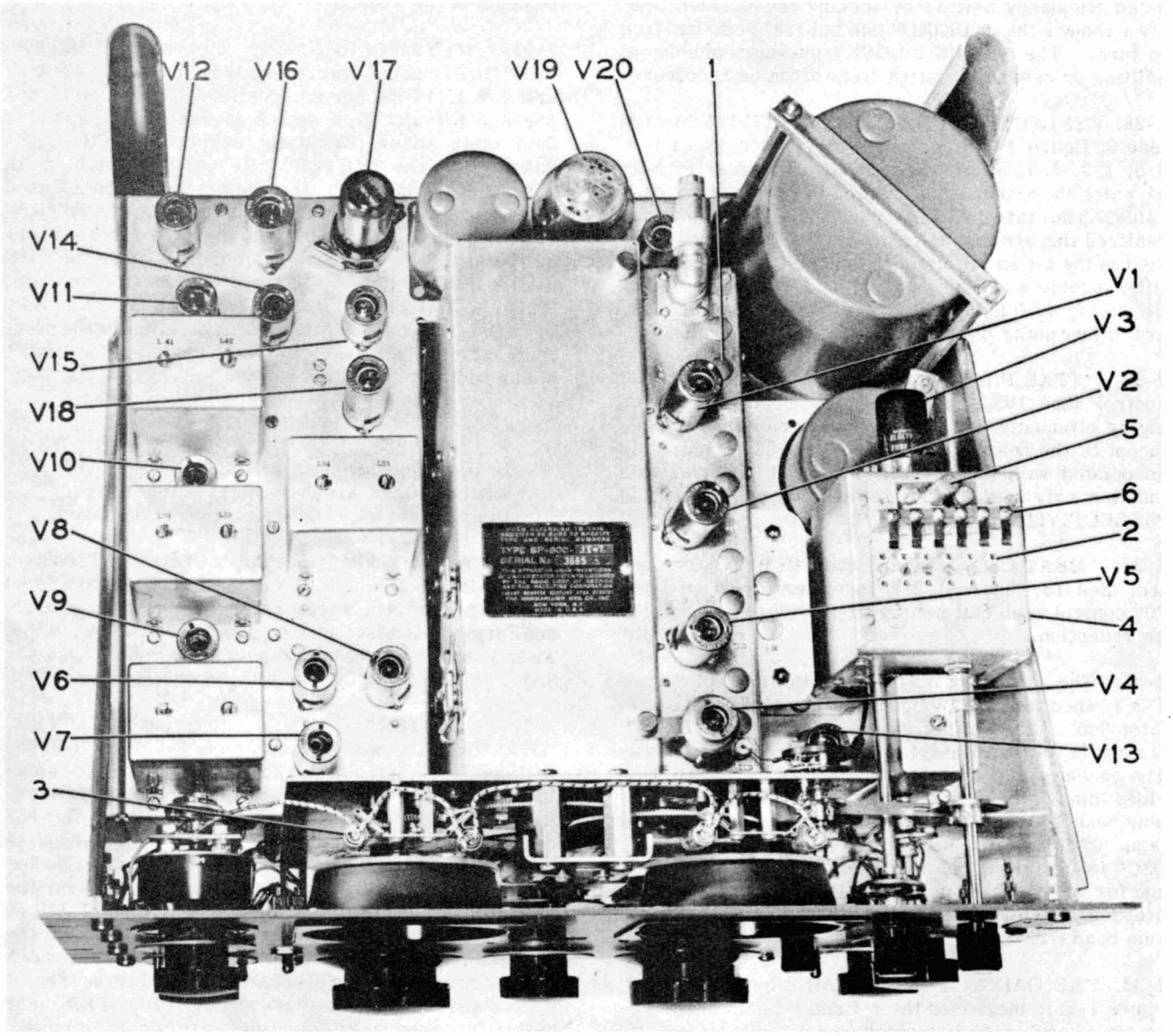
Never depress the "METER" "RF" "AF" switch unless speaker audio output is very low as otherwise the meter may be damaged.

2-36. "AUDIO GAIN". Set the "AUDIO GAIN" control (See 7, figure 1-2.), to the desired audio output level by advancing it in a clockwise direction to provide comfortable headset and/or loud speaker reception. This control is set at or near maximum when the "AVC" "MAN" toggle switch (6) is on "MAN".

2-37. "LIMITER" "OFF". Switch the "LIMITER" "OFF" toggle switch (See 4, figure 1-2.), to "LIMITER" position when ignition or similar pulse type noise is interfering with reception. The audio output versus frequency, or fidelity characteristic of the receiver is more uniform the wider the overall acceptance bandwidth or selectivity of the receiver. For voice and music, the use of the "LIMITER" and the "SHARP" knob dial position of the "SELECTIVITY" switch (5) depend on a compromise as between the acceptable noise and the fidelity. For telegraph, which involves single tone reception, preferably near 1000 cycles per second, the use of the "LIMITER" and "SHARP" selectivity positions are not restricted. This is so since the attenuation due to the use of a higher tone pitch may be compensated for by the clockwise increase in the setting of the "AUDIO GAIN" control (7).

2-38. The "FREQ CONTROL" panel marking (See 21, figure 1-2.), involves a "XTALS", "VFO", "1", "2", "3", "4", "5", "6" switch and a " Δ FREQ", "HI", "3", "2", "1", "0", "1", "2", "3", "LOW" crystal frequency adjustment control.

2-39. "XTALS", "VFO", "1", "2", "3", "4", "5", "6". Switch the "XTALS" (See 3, figure 1-2.), to "VFO" for continuous variable tuning. For fixed frequency crystal control operation switch to the position corresponding to the numeral of the "1", "2", "3", "4", "5", "6" switch positions corresponding to the same numeral assigned the signal frequency on the plastic chart alongside the crystal switch.



1.	Metal buttons	V 8.	3.5 mc osc
2.	Crystal holders	V 9.	First i-f amplifier
3.	Pilot lamps	V10.	Second i-f amplifier
4.	Freq control unit	V11.	Driver
5.	Knurled screw	V12.	Beat freq osc buffer
6.	Retainer spring assy	V13.	Beat freq osc
V1.	First r-f amplifier	V14.	Detector and avc
V2.	Second r-f amplifier	V15.	Limiter and meter
V3.	Freq control osc	V16.	Cathode follower and first audio
V4.	Variable freq osc	V17.	Audio output
V5.	First mixer	V18.	Voltage regulator
V6.	Second mixer	V19.	B-rectifier
V7.	Gate i-f amplifier	V20.	C-rectifier

Figure 2-2. Radio Receiver, Top View of Chassis

2-40. " Δ FREQ" "HI", "3", "2", "1", "0", "1", "2", "3", "LOW". Turn the " Δ FREQ" control (See 15, figure 1-2.), in either direction on scale to tune the receiver for fixed frequency crystal controlled operation. The scale markings on the front panel are arbitrary scale indications but advancing the control from "LOW" to "HI" means that the crystal frequency of operation is being increased.

NOTE

The tuning adjustment of this control must be made for each choice of signal frequency with the main tuning dial set to agree with the signal frequency used.

2-41. PRESENTATIONS AND READINGS.

2-42. TUNING PRESENTATION. The main tuning dial (See 18, figure 1-2.), is to the left and the vernier dial (17) is to the right when facing the front panel. The main tuning dial has six frequency band scales, calibrated in megacycles, and an arbitrary outer scale. The movable pointer (22) is used to read the frequency band scale chosen. The fixed pointer (23) is used to read the arbitrary outer scale. The vernier dial has an arbitrary, 0 to 100, scale. The vernier pointer (24) associated with this scale, is used to read it. The numeral under the fixed pointer of the main dial indicates the number of revolutions that have been made by the vernier dial at any setting. EXAMPLE: When the fixed pointer for the outer arbitrary scale of the main tuning dial indicates over the figure 4 and the vernier dial indicates 87.6, the reading to log for this setting is read 487.6. This precise mechanical vernier system divides the rotation of the main dial over each frequency band into approximately 600 vernier divisions, with one half division calibration points. Since it is easy to estimate one tenth division on the vernier dial, this divides each frequency band into approximately 6000 readable settings. This permits extreme accuracy in the logging of stations.

2-43. METER READINGS. When the receiver is used for headset or speaker reception, the operator can determine aurally as to whether or not reception is intelligible. When reception starts to become poor on a particular station frequency, he can notify the station, through means of his associated transmitter, so that the operator at the other end of the operational activity can switch to some other pre-determined frequency. With the "METER" "RF" "AF" spring return toggle switch (See 19, figure 1-2.), in its normal "RF" position, the operator can determine the strength of the carrier received. With the switch depressed to its "AF" position, the operator can determine the audio output level chosen with the "AUDIO GAIN" control (7) for the phones and/or speaker. Even when the headset and loud speaker are both connected to the receiver, the audio output available is sufficient to cope with any operational activity.

Table 2-1. Decibel Conversion Chart

db	RF Microvolts	db	AF Milliwatts
-6	0.5	-10	0.6
0	1	0	6
+6	2	+6	24
+20	10	+10	60
+40	100	+15	190
+60	1,000		
+80	10,000		
+100	100,000		

2-44. When the "AUDIO GAIN" control (See 7, figure 1-2.), is set to provide 500 milliwatts to a 600 ohm matching loud speaker, 15 milliwatts are provided to an 8000 ohm headset.

2-45. Table 2-1 may be used to determine the r-f microvolts or a-f milliwatts respectively equivalent to the db readings of the meter r-f and a-f scale calibrations.

2-46. PRECAUTIONS TO BE OBSERVED.

2-47. The receiver is precisely aligned and adjusted at the factory for optimum receiver performance. The metal buttons (See 1, figure 2-2.), cover the chassis openings used to get at the various inductance tuning cores and capacitor trimmers. These receiver alignment means as well as the "METER ADJ RF" (See 7, figure 1-3.), and the "METER ADJ AF" (See 8, figure 1-3.), screw driver meter adjustment means, are not operating controls, and cannot be manipulated without respectively impairing the receiver performance and the meter scale calibrations. Also, no occasion should arise to readjust the "BFO INJ" control (See 6, figure 1-3.) which is screw driver set at the factory for maximum bfo buffer output injection voltage.

SECTION III

OPERATING CHECKS AND ADJUSTMENTS

3-1. GENERAL. The radio receiver must show evidence of maintenance approval for use. Check to see that the receiver complement of operational spares is complete and that a spare three ampere fuse is contained in the "SPARE FUSE" holder (See 9, figure 1-3.), contained in the rear apron. To maintain the communication link, the operational instructions concerning the contemplated activity must be known and understood. The operational checks and adjustments made prior to, and during, each operational activity are outlined below.

3-2. In instances of fixed channel crystal controlled operations, the operational signal frequencies must be written on the plastic chart (See 25, figure 1-2.), on the front panel of the receiver. The crystal control unit, crystal holders (See 2, figure 2-2.), must contain the appropriate crystals in the correct holders.

3-3. PRIOR TO OPERATION.

a. Switch the receiver "on" and allow a warm up period of at least 15 minutes.

b. Check both for cw and mcw reception on each band and make sure each control and switch functions mechanically, while properly performing its electrical use. Refer to paragraphs 2-19 thru 2-40.

c. Adjust the operating controls for the operational activity contemplated. Refer to paragraphs 2-3 thru 2-15, as applicable.

d. Establish the communication link, using the associated transmitter to contact the remote station, as applicable, dependent on the activity.

3-4. DURING OPERATION. The receiver is monitored during use to maintain the communication link and to provide for optimum reception. Even though the receiver frequency stability approaches that of a crystal for variable tuning, and is crystal controlled for fixed frequency operation, the communication link is also dependent on the frequency stability of the receiver signal. Further, the receiver signal may vary in strength and in quality for the communication link established. The quality of the reception determines the need for monitoring the receiver. When the operational activity provides for mcw reception, under noisy conditions, monitor the receiver as outlined in paragraph 2-6. When the operational activity provides for cw reception, under noisy conditions, monitor the receiver as outlined in paragraph 2-13.

3-5. PRECAUTIONS TO BE OBSERVED.

a. Consult the time table, if any, with regard to the signal frequency to be used during a particular phase of the operational activity.

b. Notify the remote station when the switch-over to a new signal frequency is to be made, whether due to the schedule requirements, or for reason of the deteriorated quality of the signal being received.

c. Advise the remote station, prior to switch-over, to stand-by at intervals on an alternate specified channel frequency so that contact may be maintained in case of emergency.

SECTION IV

EMERGENCY OPERATION AND REPAIR

4-1. OTHER THAN NORMAL OPERATION.

4-2. ANTENNA SYSTEM. The radio receiver may be operated with a single insulated wire connected to one terminal of the antenna input connector. The other terminal of the antenna input connector is preferably grounded, but need not be, in an emergency.

4-3. ELECTRON TUBE COMPLEMENT. The electron tube type and the reference symbol designation of each electron tube comprising the electron tube complement of the receiver is metal stamped adjacent to each tube. Figure 2-2 may be used to rapidly indentify the location of each specific electron tube used in the receiver. In the instance of the unavailability of spare electron tubes, and specific receiver electron tube failure, table 4-1 may be used in an emergency to maintain continuity of service, when applicable.

WARNING

Turn the receiver "off" when changing tubes. Wear gloves, to prevent severe burns, when removing "hot" tubes.

4-4. REPLACEMENT OR REPAIR.

4-5. PILOT LAMPS. The pilot lamps (See 3, figure 2-2.), are of the bayonet type and are removed by lifting the pilot lamp socket off its support, twisting the pilot lamp counter-clockwise in relation to its socket, while exerting inward pressure, and then removing it. Before replacing a pilot light, when all four do not light, make sure a-c power plug is plug-

ged in the a-c source and that the receiver is turned "on". With the receiver "RF GAIN" control (See 8, figure 1-2.), in its "OFF" switch position to make the replacement, in turn, replace the three ampere fuse contained in the "FUSE" holder (See 10, figure 1-3.), the V20, and the V19 rectifier tubes, (See figure 2-2.).

4-6. ELECTRON TUBES. To remove the V3, V17, or V19 electron tubes (See figure 2-2.), each tube socket clamp must first be opened by spreading the clamp retainer out from the tube, so that the tube may be drawn out from its tube socket.

4-7. To remove the V1, V2, V5, V6, V7, V8, V9, V10, V11, V12, V13, V14, V15, V16, V18, or V20 electron tubes (See figure 2-2.), the respective tube shield is first removed by twisting counter-clockwise while exerting inward pressure. These tubes are all of the pin type and are preferably removed with the appropriate tube remover.

4-8. To remove the V4 electron tube (See figure 2-2.), loosen the knurled screw, holding the tube shield. Then turn the tube shield counter-clockwise, while exerting inward pressure, to remove it. The tube is of the pin type and is removed accordingly.

4-9. Any one of the electron tube complement of the receiver may require immediate replacement to maintain the operational activity. The defective tube identifies itself when its filament does not light up. Otherwise, keeping the receiver tuned, replace the tubes

Table 4-1. Chart for Other Than Normal Operation

JAN Tube Type	Reference Symbol	Remove	Replace For	Operation Limited to	Effect on Limited Operation
6AL5	V14, V15, V20	V15	V14 or V20	any	limiter and meter af, non-operative
		V14	V15 or V20	i-f output	no avc
		V14 and V15	V20	i-f output	limiter, meter af, avc, non-operative
6C4	V4, V8, V13	V4	V8 or V13	fixed freq osc	none
		V8	V4 or V13	any below 7.4 mc	none
		V13	V4 or V8	AM cw	none
		V8 and V13	V4	AM cw below 7.4 mc	none
6BA6	V1, V2, V7, V9, V10, V11, V12	V7	V1, V2, V9, V10, V11, or V12	any above 7.4 mc	none
		V12	V1, V2, V7, V9, V10, or V11	AM cw	none
6BE6	V5, V6	V6	V5	any below 7.4 mc	none
OA2	V18	V18	none	any	freq and sensitivity instability
5R4GY	V19	use spare*	V19	any	none
6AC7	V3	use spare*	V3	any	none
12AU7	V16	use spare*	V16	any	none
6V6GT	V17	use spare*	V17	any	none

*The "use spare" presumes the availability of said tubes.

in the following sequence. If the panel meter shows a reading, in the absence of audio output, replace V17, V16, and V14 electron tubes (See figure 2-2.), in turn, since they involve the a-f section of the receiver. If the meter does not show a reading, change the V15 electron tube to make sure the meter can indicate a reading. If the meter indicates a reading, in the absence of audio output, also replace the V13 and V12, electron tubes used for cw, but for no meter reading, replace in turn the V11, V10, and V9, electron tubes. Where the signal tuned in is below 7.4 mc replace the V7, electron tube, and when the signal tuned in is above 7.4 mc replace the V8 and the V6 electron tubes, in turn. When operating VFO, replace the V5 and the V4 electron tubes, in turn; when operating FFO, replace the V5 and V3 electron tubes, in turn. Next, try replacing the V2 and the V1 electron tubes, in turn. With regard to the V20 and the V19 rectifier tubes, (Refer to paragraph 4-5.). The V18 voltage regulator tube should be replaced if it does not show a faint violet glow.

4-10. CRYSTALS. To remove a crystal from the frequency control unit (See 4, figure 2-2.), loosen the knurled thumb screw (5) on top of the unit (4) and push the retainer spring assembly (6) to the rear. Remove the crystal from the crystal socket. To insert a crystal, the crystal is inserted in one of the crystal sockets, numbered "1", "2", "3", "4", "5", "6", on the frequency control unit (4). Bring the retainer spring assembly (6) forward so that the springs are over the top of the crystals in the sockets, and tighten the thumb screw (5).

4-11. Mark the signal frequency for which the crystal was selected, in megacycles on the plastic chart (See 25, figure 1-2.), provided for this purpose alongside the "XTALS" control (3). Pencil or ink may be used and can be erased to change these figures, if desired. The numerals on the chart should be used so that they agree with the numerals on the crystal socket positions, which are also indicated by the "XTALS" switch.

4-12. 3-AMP FUSE. To replace the 3-amp fuse, located in the FUSE holder (See 10, figure 1-3.), on the rear apron of the receiver, press in the top of the fuse holder while turning it approximately 45 degrees in a counter-clockwise direction. Removing the pressure in this position will release the fuse, spring clamped to the top of the fuse holder. The fuse and the top of the fuse holder can then be pulled apart. A spare 3-amp fuse is located in the "SPARE FUSE" fuse holder (9) which may be removed in a manner similar to that outlined above. To replace either of these two fuses the procedure is the reverse to that outlined. When a spare 3-amp fuse is available other than that provided in the "SPARE FUSE" fuse holder (9) it is preferably used so that in an emergency, a spare fuse is always available in the "SPARE FUSE" fuse holder (9).

CAUTION

Make sure that the fuse used is designated 3-amp.

4-13. 3/8-AMP FUSE. To replace the 3/8-amp pigtail type fuse, the receiver is turned bottom up and the bottom plate is removed by removing the seven No. 10-32 screws which hold the bottom cover in place. The fuse is removed by unsoldering its pigtail leads from terminal 11 of the power transformer and from chassis ground. The fuse is replaced by resoldering another fuse in the place of that removed. When the receiver audio output goes "dead", the 3/8-amp fuse should be checked first to see whether it has blown.

CAUTION

Make sure the designation on the fuse used is 3/8-amp.