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**HANDBOOK  
OPERATING INSTRUCTIONS**

**RADIO RECEIVER  
MODEL SP-600-JX-17**

(HAMMARLUND)

**PUBLISHED UNDER AUTHORITY OF THE SECRETARY OF THE AIR FORCE  
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**TABLE OF CONTENTS**

<i>Section</i>	<i>Page</i>
I GENERAL DESCRIPTION	1
1-1 General	1
1-10 Description	4
1-26 Operational Theory	6
1-31 Capabilities and Limitations	7
1-38 Equipment Required for a Frequency-Shift Space Diversity Receiving System	9
II OPERATING PROCEDURES	9
2-2 Description of Controls	9
2-22 Sequence of Operation	12
2-24 Prior to Use	12
2-25 M-C-W Reception – Phone or Single-Tone Telegraph	12
2-32 C-W Reception – Telegraph	13
2-39 Frequency-Shift Reception – Teletype	15
2-46 Suppressed Carrier Multichannel Reception – Phone, Telegraph, and Teletype	16
2-53 Space Diversity Reception – MCW	18
2-55 Space Diversity Reception – CW	18
2-57 Space Diversity Reception – Frequency-Shift	18
2-59 During Use	18
2-61 Following Use	21
2-64 Presentations and Readings	21
2-69 Precautions To Be Observed	21
III OPERATING CHECKS AND ADJUSTMENTS	22
IV EMERGENCY OPERATION AND REPAIR	23
4-1 Other than Normal Operation	23
4-5 Replacement or Repairs	24

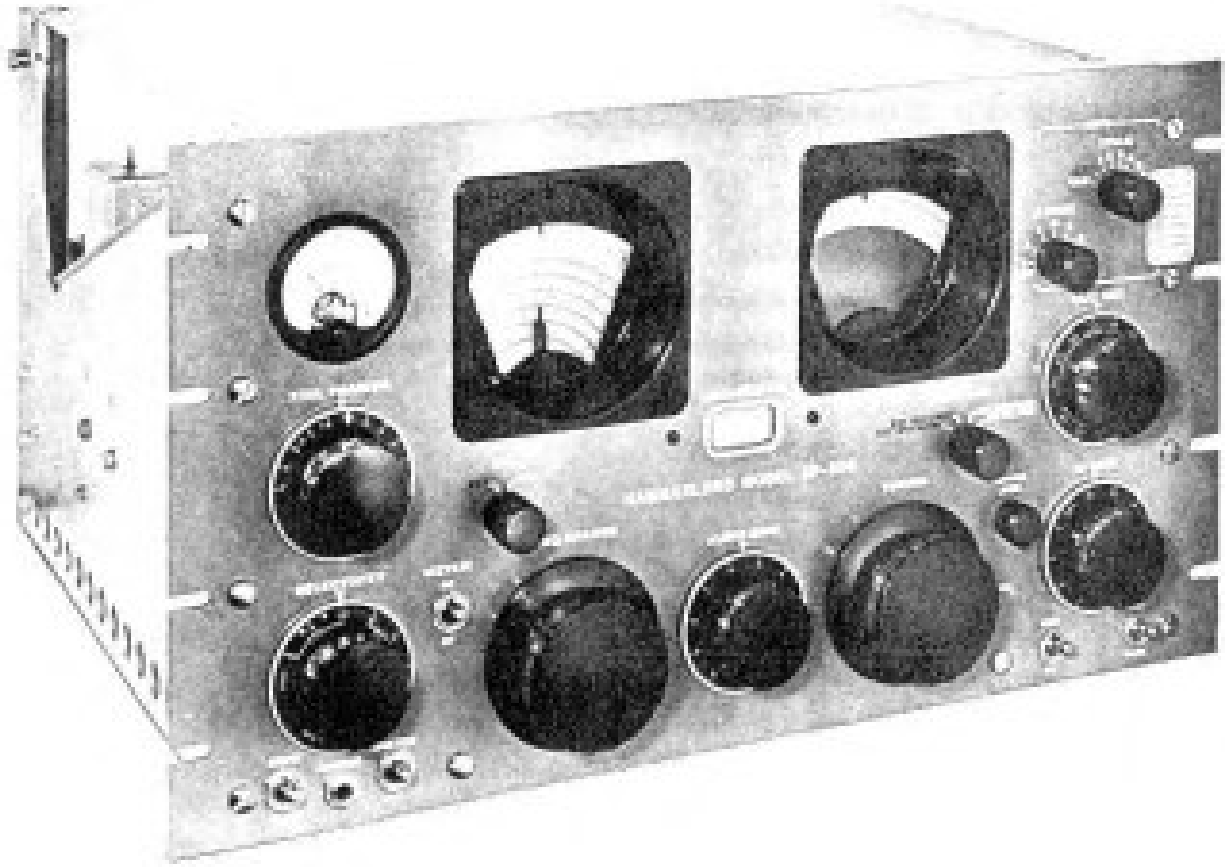


Figure 1-1. Radio Receiver, Diversity Model SP-600-JX-17 Rack Mountings

## SECTION I

### GENERAL DESCRIPTION

#### 1-1. GENERAL.

1-2. Radio Receiver, Diversity Model SP-600-JX-17 rack mountings (figure 1-1), is manufactured by the Hammarlund Manufacturing Co. Inc., New York 1, N.Y. It is a 20-tube radio communication receiver designed for direct mounting in a standard 19-inch relay rack. It comprises a chassis and light grey front panel assembly to which are mounted a top cover and a bottom plate.

1-3. The radio receiver has a self-contained power supply designed to operate from a 50- to 60-cps, single-phase a-c source, within the voltage range of 90 to 270 volts. The power transformer primary and secondary are each separately fused, the primary by a 1.6 ampere slow-blow fuse and the high voltage secondary by a three-eighths ampere fuse, each of which is contained in a cartridge type fuse holder located on the rear apron of the receiver. The receiver spare fuse complement is located under the cover (1, figure 1-3) designated "SPARE FUSES".

#### CAUTION

Maintain the fuse complement to prevent damage.

1-4. The radio receiver is designed for enclosed station, fixed or mobile use, such as are encountered aboard ship, in the field, or when airborne. It is adaptable to a two-way operational activity and finds especial use in multi-receiver space diversity receiving systems wherein advantage is taken of the fact that a more usable (stronger) signal is provided from at least one of several receivers, whose antenna systems are spaced several wavelengths apart. The radio receiver provides for the reception of keyed, amplitude-modulated, and frequency-shift carrier signals. The carrier signal intelligence may be slow-speed (manual) or high-speed (automatic) telegraph, phone, teletype, facsimile, etc. For Morse code and teletypewriter operation, use is made of c-w (keyed-carrier) and single-tone carrier signals. Further, for teletypewriter operation, especial use is made of two-tone and frequency-shift carrier signals.

1-5. To render the signal intelligence audible and/or recordable, auxiliary components are associated with the radio receiver. These are common to the radio receivers

(usually two for frequency-shift and three for c-w reception) when used in a space diversity receiving system. When the receiver is to provide for the reception of phone or slow-speed telegraph, use is made of a headset and/or a loud speaker; otherwise, these are used to monitor the signal. To receive high-speed telegraph, use is made of a recorder driving unit and/or a tape ink recorder. To receive frequency-shift teletype, use is made of suitable frequency-shift receiver converter equipment associated with a teletypewriter.

1-6. The signal output of the single- or multi-receiver circuit or system, for received signals other than phone, may be developed in the form of d-c output to denote a dot (mark) and no d-c output to denote a dash (space), the signal intelligence being contained in the succession of dots and dashes that obtain. Alternately, it may be developed in the form of a-c output wherein, for the interval of each dot (mark), or each dot (mark) and each dash (space), keyed-tone signals obtain. The signal in the form of d-c output is suitable to operate applicable recording equipment such as a tape ink recorder, a line relay, or a tone generator. The signal in the form of a-c output provides the audible output of the circuit or system; or as applicable, it is used to operate a recorder driving unit associated with the tape ink recorder; or, it is used to provide input to a suitable frequency-shift receiver converter associated with a teletypewriter.

1-7. The tone generator keyed output may be used to provide the signal to the headset and/or loud speaker monitor. It may also be fed to a transmission line to provide the signal at the remote end of the line. The keyed-tone used is in the voice frequency range, each signal sent requiring only a small frequency band (170 cycles) so that the line may be used for several such tone (carrier) signals, as well as for phone.

1-8. The radio receiver provides for continuously variable reception within the frequency range of 0.54 to 54.0 mc and for fixed-frequency crystal-controlled reception within the frequency range of two to 30.0 mc. Its design is such that even the weakest signals provide for its rated power output. This is due to the high signal-plus-noise to noise voltage ratio developed at the receiver input grid. As such the receiver is well suited to the reception of the short wave signals within its frequency range, which are inherently subject to non



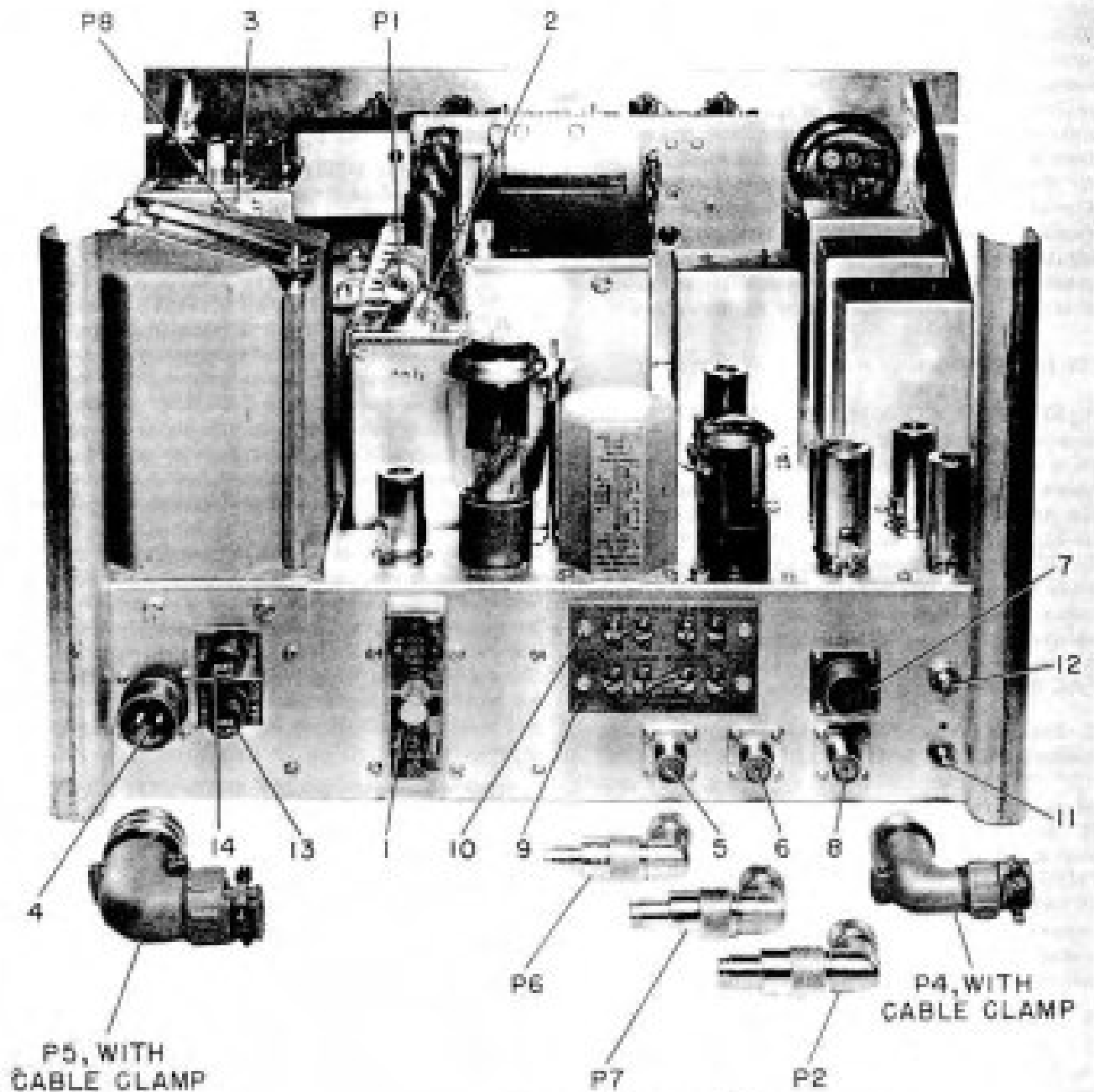


Figure 1-3. Radio Receiver, Rear Apron Identification

the signal. Doing this is an advantage when keyed carrier signals are received, since during intervals of signal intelligence, or of no signal intelligence but with the carrier on the air, the local amplitude-modulation used assures that a steady audible (monitoring) tone is always heard. When use is made of space diversity reception, the external bfo used may be that from one of the receivers so that it becomes the bfo for itself and the bfo of the other receiver of the system. Likewise, the radio receiver, crystal-controlled first heterodyne oscillator (used for fixed-frequency crystal reception), and its double conversion heterodyne oscillator, may both be components external to the receiver, possibly the identical elements from the other receiver of the system.

### 1-10. DESCRIPTION.

1-11. RECEIVER CONNECTOR USES. All operational activities, preferably, use a Beverage-type antenna which is coaxial cable connected to the "ANT" input connector (2, figure 1-3), at the top rear of the receiver chassis. Apart from the headset "PHONES" jack (1, figure 1-2), contained in the front panel, and the "HFO OUTPUT" coaxial cable connector (3, figure 1-3), contained in the frequency control unit housing the fixed-frequency crystal-controlled heterodyne oscillator, all the receiver associated component connecting means are located on the rear apron. The rear apron also contains the "AC POWER" plug connector (4) of the receiver.

1-12. The "HFO OUTPUT" connector (3, figure 1-3) is associated with the "HFO" "VAR" "EXT" "XTALS" "1" "2" "3" "4" "5" "6" switch (2, figure 1-2) contained in the front panel. When the switch is in its "EXT" position, the first heterodyne oscillator for the receiver is derived from the component connected to the "HFO OUTPUT" connector. When the switch is in its "XTALS" "1", "2", "3", "4", "5", or "6" position, the receiver provides its own fixed-frequency crystal-controlled first heterodyne oscillator, as well as output from it to the "HFO OUTPUT" connector.

1-13. The "IFO" coaxial cable connector (5, figure 1-3) is associated with the "IFO" "EXT" "INT" switch (3, figure 1-2) contained in the front panel of the receiver. When the switch is in its "EXT" position, the double conversion heterodyne oscillator for the receiver is derived from the component connected to the "IFO" connector. When the switch is in its "INT" position, the receiver provides its own double conversion oscillator.

1-14. The "BFO" coaxial cable connector (6, figure 1-3) is associated with the "BFO-AVC" "EXT BFO" "SLOW" "FAST" "INT BFO" "SLOW" "FAST" switch (4, figure 1-2) contained in the front panel of the receiver. When the switch is in one of its two "EXT BFO" positions, the bfo for the receiver is derived from the component connected to the "BFO" connector. When the switch is in one of its two "INT BFO" positions, the receiver provides its own bfo.

1-15. The "REMOTE" connector (7, figure 1-3) provides for remotely switching "on" or "off" the internal bfo of the receiver, as may be done at the receiver by switching the receiver "MOD" "CW" switch (5, figure 1-2) from "MOD" to "CW". The connector also provides for applying external tone modulation to a received keyed-carrier signal.

1-16. The "IF OUTPUT" coaxial cable connector (8, figure 1-3) provides the received signal (usually frequency-shift) as the receiver i-f output for frequency-shift receiver converter use, usually part of a space diversity receiving system.

1-17. The receiver "AUDIO OUTPUT" terminals (9, figure 1-3) are suited for a 600-ohm loud speaker or transmission line. The receiver a-c signal output (phone, single-tone telegraph or teletype, or two-tone teletype) is available at the "AUDIO OUTPUT" terminals. To render high-speed telegraph and single- or two-tone signals intelligible, the tape ink recorder used for high-speed telegraph and the teletypewriter used for teletype are respectively associated with demodulator equipment, transmission line interconnected to the receiver. When a local teletypewriter is used to operate another teletypewriter, remotely or locally connected to the transmission line, the send teletypewriter relay is connected to the jumpered "AUDIO OUTPUT" terminals so that the line current on "mark" balances out between the balanced split output transformer winding of the receiver, for which the jumpered connections of (9) provide a mid-point tap. This use of the line may be simultaneous to its other uses.

1-18. The receiver "DIODE OUTPUT" "AVC" terminals (10, figure 1-3) are used to interconnect two receivers in a space diversity receiving system. The "AVC" terminal designated "G" is grounded for each receiver to a common ground while that designated "-" is interconnected between receivers. This is done to provide common avc between receivers for the space diversity reception of an amplitude-modulated or frequency-shift signal. The common automatic volume control (avc) used provides for the avc due to the stronger signal received on one receiver to further decrease the weaker signal and noise due to the other. To provide for the space diversity reception of phone the audio output is that from only one receiver. To do this the jumpered "DIODE OUTPUT" terminals are opened on one receiver and the "-" terminal connected to the other receiver which provides the output. To provide for the space diversity reception of cw to a tone keyer (generator) or tape ink recorder, the receiver interconnections are as outlined for phone, but no avc and no bfo are used. This is the case when the d-c output from the three interconnected "DIODE OUTPUT" terminals is used. When the a-c output is used, the diversity demodulator, associated with the tape ink recorder, is provided with the a-c output from the "AUDIO OUTPUT" terminals (9) of each receiver. To provide for the space diversity reception of frequency-shift carrier signals, the i-f output or the audio output from each receiver may

be used to provide input to respectively suitable frequency-shift receiver converter equipment.

1-19. RECEIVER OPERATION. All operational activities require that the receiver switches and controls be set properly for the mode of operation contemplated. These are all contained on the front panel of the receiver, apart from the "METER ADJ RF" and the "METER ADJ AF" adjustment controls (11 and 12, figure 1-3), used to calibrate the dual-scale meter on the front panel. These are contained on the rear apron of the receiver and are not to be moved from their adjustment positions, set at the factory.

1-20. The radio receiver is adaptable to a two-way operational activity through use of the "SEND" "REC" switch (6, figure 1-2). With the receiver "RF GAIN" control (7) turned clockwise from its switch "OFF" position, when the a-c line source is plug-connected to the "AC POWER" connector (4), the receiver a-c power is "on" for either position of the "SEND" "REC" switch (6). When the switch is in its "SEND" position, the receiver is "desensitized" for protection in the presence of a strong local carrier such as that due to the local transmitter, forming part of a two-way activity. When the switch is in its "REC" position, the receiver provides for instant reception.

1-21. When the radio receiver "HFO" "VAR" "EXT" "XTALS" "1" "2" "3" "4" "5" "6" switch (2, figure 1-2) is in its "VAR" position, the receiver "TUNING" control (8) provides for the continuously variable tuning of the receiver, so that any desired carrier signal may be tuned in within the frequency band indicated by the "BAND CHANGE" switch (9). When the switch is in its "XTALS" "1", "2", "3", "4", "5", or "6" position, the receiver provides for the fixed-frequency crystal-controlled reception of any signal within its two to 30 mc frequency range, the frequency of the signal received being dependent on the signal frequency for which the crystal associated with the switch position chosen, is intended. Here, the "BAND CHANGE" switch (9) is intended as before, but due to the inherent frequency tolerance of the crystal, exact tuning is provided through use of the "HFO" " $\Delta$  FREQ" control (10). The "TUNING" control (8) is positioned to the main tuning dial (11) frequency indication of the signal to be received and then adjusted so that the tuning meter (12) tuning indication is maximized further. The receiver "TUNING LOCK" (13) when turned clockwise, provides optional locking means for the vernier dial (14), so that the "TUNING" control (8) position for the main and associated vernier dial remains as chosen, and is not changed due to accidental shift or severe vibration. The "TUNING" control (8) remains free to turn even when the "TUNING LOCK" (13) is locked.

1-22. The receiver "SELECTIVITY" switch (15, figure 1-2) provides a choice of six degrees of acceptance bandwidth or selectivity to the signal tuned in. The switch position chosen is that which provides optimum receiver performance for the existing quality of the re-

ceived signal. When the switch is in any one of its three "XTAL" knob dial positions, the "XTAL PHASING" control (16) is used to highly attenuate the strength of an interfering unwanted signal, if any, even when closely adjacent to the desired signal. The receiver "LIMITER" "OFF" switch (17), in its "LIMITER" position, provides for effectively eliminating ignition noise, and other similar pulse-type noise, from the receiver audible output.

1-23. The receiver "MOD" "CW" switch (5, figure 1-2) in its "CW" position renders the receiver bfo operative. When the "BFO-AVC" "EXT BFO" "SLOW" "FAST" "INT BFO" "SLOW" "FAST" switch (4) is in its "INT BFO" "SLOW" or "FAST" position, the bfo output is available for receiver use and also becomes available at the "BFO" output connector (6, figure 1-3), for external use. When the switch is in its "EXT BFO" "SLOW" or "FAST" position, the bfo, while operative, has its output suppressed (grounded). With the "MOD" "CW" switch (5, figure 1-2) in its "CW" position, the receiver "BEAT OSC" control (18) provides for the receiver a-c signal output to be keyed-tone signals, the "BEAT OSC" control (18) setting chosen providing for the tone of the keyed-tone signals to be anywhere within the range of  $\pm 3$ -kc. The "BEAT OSC" control (18) may be turned in either direction on scale to provide the 3-kc tone range for the received c-w signal. When the "MOD" "CW" switch (5) is in its "MOD" position the receiver provides for the reception of an amplitude-modulated signal. When the receiver is to provide for the reception of a frequency-shift signal, the "MOD" "CW" switch (5) position is dependent on whether the receiver i-f or a-f output is to be associated with the suitable frequency-shift receiver converter equipment. When the receiver i-f output is used, the use of the bfo provides optional receiver output for monitoring purposes. When the receiver a-f output is used, b-f-o output is required, but it need not be that due to the internal bfo of the receiver. When the receiver is to provide for suppressed carrier (single or double side band) m-c-w reception, b-f-o output is used to reinsert the carrier at the receiver, the position chosen for the "BEAT OSC" control (18) being that of its "0" dial knob setting.

1-24. The receiver "RF GAIN" control (7, figure 1-2) is set, through manual adjustment, to provide against the wide variations encountered in the level of any carrier picked up or tuned in. To maintain the receiver a-c output constant within narrow limits for the "RF GAIN" control (7) position chosen, the receiver incorporates automatic volume control (avc). The receiver "AVC" "MAN" switch (19), when in its "AVC" position, provides this a-v-c action. The "RF GAIN" control (7) function is effective in either position of the "AVC" "MAN" switch (19). The a-v-c action is provided with a slow or fast time constant dependent on the setting of the "BFO-AVC" "EXT BFO" "SLOW" "FAST" "INT BFO" "SLOW" "FAST" switch (4). When the switch is in either "AVC" "SLOW" position,

the a-v-c time constant is slow; when it is in either "AVC" "FAST" position, the a-v-c time constant is fast. It should be noted that the "SLOW" or "FAST" a-v-c time constants provided are only effective in overcoming the signal fading when the rate of fading is slow compared to the speed of signaling. For c-w reception in the presence of deep rapid nonselective fading, this is not the case for a high-speed signal and even less so for a low-speed signal, so that neither the "SLOW" nor "FAST" a-v-c time constant is effective. However, a "SLOW" switch position is used, since it is effective for high-speed signals in the presence of slow fading. To overcome the deep rapid nonselective fading, space diversity reception (usually with three receivers) is used. For frequency-shift reception, since the carrier is present both for "mark" and "space", and the frequency is of most importance, a faster a-v-c time constant may be used, so that a "FAST" switch position is used to partially overcome deep rapid nonselective fading. To further overcome the deep rapid nonselective fading, space diversity reception (usually with two receivers) is used. When the fading is selective the resultant distortion is such that signal "mark" and "space" intervals are somewhat concurrent. For c-w reception the distortion results in serious "space" bias. For frequency-shift reception the effect is that a beat note at the carrier shift results. Since it is outside the highest-used frequency component of the signal, it may be attenuated through use of the selectivity provided in the receiver, provided the frequency-shift signal has the necessary frequency stability. Again, both for c-w and frequency-shift reception, use is made of space diversity reception in the presence of selective fading.

1-25. The receiver tuning meter (12, figure 1-2) provides a meter tuning indication for the desired signal tuned in, when the "AVC" "MAN" switch (19) is in its "AVC" position. The meter top scale indication is the ratio of the signal level to a signal of one microvolt, expressed in db. When the "METER" "RF" "AF" switch (20) is held in its depressed "AF" position, the meter bottom scale indication is the ratio of the receiver audio output to the standard reference output of six milliwatts, expressed in db.

**CAUTION**

Never depress the "METER" "RF" "AF" switch (20) from its normal "RF" position to its held depressed "AF" position without first making sure that the receiver "AUDIO OUTPUT" terminals (9, figure 1-3) are provided with a suitable 600-ohm load, and then only with the "AUDIO GAIN" control (21, figure 1-2) at or near its minimum control position, so that advancing it keeps the meter indication on scale; otherwise the meter may be damaged.

**1-26. OPERATIONAL THEORY.**

1-27. GENERAL. An analysis of the operation of the

radio receiver is best evolved by considering the signal path through the receiver r-f, i-f, and a-f sections, into which the receiver may be considered theoretically subdivided. The self-contained power supply of the receiver is considered separately.

1-28. R-F SECTION. The r-f section of the receiver provides signal selective circuitry for any signal tuned in within the receiver frequency range of 0.54 to 54.0 mc. It does this through the use of six sets of r-f tuner sub-assemblies housed in a rotary turret assembly. Each set is used for one frequency band of the receiver and comprises an antenna r-f tuner, two identical interstage r-f tuners, and an oscillator r-f tuner. The "BAND CHANGE" switch (9, figure 1-2) provides for indenting the rotary turret assembly so that the r-f tuner sub-assemblies for a particular frequency band become part of the r-f section of the receiver. The antenna and two-stage r-f gain provided the signal assures that the signal-plus-noise to noise ratio developed in the r-f section is high enough so that even the weakest of signals provides for useful receiver output. The r-f section preselection, in turn, assures that the gain available to the signal is greatly in excess to that provided any other signal not tuned in. Since the receiver utilizes the principles of superheterodyne reception, a signal at a frequency twice the 455-kc intermediate frequency higher than the desired signal, also provides an i-f signal acceptable to the i-f section of the receiver. This "image" frequency, like any other signal not tuned in, is greatly attenuated. However, for signals tuned in on the three higher frequency bands of the receiver the "image" frequency at 455 kc would be too closely adjacent to the desired signal. To maintain high "image" rejection ratios, the receiver provides for double superheterodyne reception on these bands. On the three lower frequency bands (below 7.4 mc), the signal tuned in is first heterodyne detected to a 455-kc i-f signal, while on the three higher frequency bands, it is first heterodyne detected to a 3,955-kc i-f signal, which is then second heterodyne detected to a 455-kc i-f signal. With the receiver "HFO" "VAR" "EXT" "XTALS" "1" "2" "3" "4" "5" "6" switch (2) in its "VAR" position, the receiver provides for continuously variable tuning. When the switch is in one of its "XTALS" "1", "2", "3", "4", "5", or "6" positions, the receiver first heterodyne variable oscillator is replaced by a fixed-frequency crystal-controlled heterodyne oscillator. Doing this results in the ultimate in receiver frequency stability, being superior to the practical precision attainable for variable frequency tuning. Its use pre-establishes the communication channel, even when receiving conditions are poor, without necessitating a time consuming search by the operator. The "HFO OUTPUT" connector (3, figure 1-3) is associated with the fixed-frequency crystal-controlled heterodyne oscillator.

1-29. I-F SECTION. The i-f section of the receiver incorporates the 455-kc i-f amplifier wherein practically all of the overall gain and selectivity of the receiver is developed. Also, it incorporates the single-double conversion switch, which assumes its single or double con-

version position, dependent on whether the rotary turret is indented respectively for one of its three lower or three higher frequency bands. For signals tuned in on one of the three lower frequency bands, the signal has access to the 455-kc i-f amplifier through a 455-kc i-f gate. For this condition the switch renders the double conversion i-f channel inoperative. For signals tuned in on one of the three higher frequency bands, the signal has access to the 455-kc i-f amplifier through the 3,955-kc i-f double conversion channel. For this condition the switch renders the 455-kc i-f gate inoperative. The six choices of receiver selectivity provided by the "SELECTIVITY" switch (15, figure 1-2) are developed in the 455-kc i-f channel of the receiver. At the input to the 455-kc i-f amplifier is the 455-kc i-f crystal filter circuit incorporated in the receiver. The use of the crystal filter enables the receiver to attain the three degrees of "SHARP" "XTAL" selectivity. The precise, clocklike, anti-backlash gear-train tuning mechanism provides for the completely accurate resetability and calibration accuracy of the receiver such that maximum benefit can be derived from the sharp, crystal pass bands of the 455-kc i-f crystal filter. The "XTAL PHASING" control (16) is part of the crystal filter. The 455-kc  $\pm$  3-kc bfo and associated "BEAT OSC" control (18), "BFO" connector (6, figure 1-3), and "BFO-AVC" "EXT BFO" "SLOW" "FAST" "INT BFO" "SLOW" "FAST" switch (4, figure 1-2), the "REMOTE" connector (7, figure 1-3), and the "IF OUTPUT" connector (8) are all associated with the 455-kc i-f channel of the receiver. The "IFO" "EXT" "INT" switch (3, figure 1-2) and the "IFO" connector (5, figure 1-3) are both associated with the second heterodyne oscillator of the i-f section.

**1-30. A-F SECTION, POWER SUPPLY, ETC.** The a-f section of the receiver incorporates an a-f amplifier to develop the a-f power output of the receiver. The "AUDIO GAIN" control (21, figure 1-2) is used to control the receiver output to the "AUDIO OUTPUT" terminals (9, figure 1-3) and that to the "PHONES" jack (1, figure 1-2). The self-contained power supply develops all the a-c and the d-c supply voltages used by the receiver. The critical d-c supply voltages are regulated to maintain constant the receiver sensitivity and frequency stability. The "RF GAIN" control (7) is part of the self-contained power supply bias rectifier. Its chosen setting, in conjunction with the a-v-c system of the receiver, when used, determines the gain developed in the r-f and i-f sections of the receiver.

### **1-31. CAPABILITIES AND LIMITATIONS.**

**1-32. GENERAL.** The radio receiver provides optimum receiver performance when properly installed and operated. Its antenna input connector provides for coaxial cable coupling to a Beverage-type antenna system. The 70-ohm coaxial cable used provides flexibility as to the relative locations of the receiver and the antenna system. In use, the receiver may be subjected to ambient temperatures within the range of 32 to 140°F, at relative humidities as high as 95 percent. After a

15-minute warm-up period its frequency stability, as a percentage of the signal frequency tuned in, ranges from 0.001 to 0.01 percent, the higher frequency stability being attained at the lower signal frequencies. 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 adequately treated with fungicidal varnish to condition it for tropical use.

**1-33. PRESELECTION.** The "image" frequency of any signal tuned in on the receiver is attenuated to the extent that when the desired signal strength is one microvolt, the strength of the "image" frequency would have to be at least 4,000 microvolts (at 7.4 mc) to develop the same receiver output. 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 signal input to the receiver would have to be 2,700 microvolts to produce the same effect as a one microvolt signal at 600 kc. For frequencies other than 600 kc, this 455-kc i-f rejection ratio of the receiver is even better. Likewise, the 3,955-kc i-f rejection ratio of the receiver is at least 50,000 for any signal frequency on bands 4, 5, or 6, the frequency bands for which the 3,955-kc i-f channel of the receiver is operative.

**1-34. SENSITIVITY.** The undistorted power output of the receiver is two watts, or better. It provides this a-f output at a signal-plus-noise to noise power ratio of 10 to one. This provides for optimum receiver performance in the presence of a weak signal tuned in since the background "hiss" noise, due to the first electron tube and the antenna r-f tuner, does not interfere with reception. The receiver sensitivity (minimum signal input to develop its rated a-f output) is two microvolts for an a-m signal and 0.75 microvolts for a c-w signal, or better. The receiver sensitivity may be reduced in the presence of a strong signal by turning its r-f gain control counter-clockwise from its maximum clockwise position. This is done to prevent overloading of the r-f and i-f sections of the receiver. The receiver a-f output may be decreased by turning its audio gain control counter-clockwise. This is done to prevent overloading of the a-f section of the receiver; also, to provide for comfortable reception at the desired a-f output level. When the receiver a-v-c system is rendered operative, the receiver output remains constant within a 1:4 voltage ratio when the input is increased from two to 200,000 microvolts. This is the case no matter the setting of the r-f gain control. The use of avc precludes an audible blast when tuning through a carrier signal relatively strong compared to the setting of the audio gain control, apart from compensating for the possible fading characteristics of the signal over long or short intervals of time.

**1-35. SELECTIVITY.** The overall acceptance band-

width or selectivity of the radio receiver is chosen so that the reception is the best possible for the nature of the signal and the quality of the communication link. 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 selectivity of the receiver. The selectivity switch of the receiver provides for a choice of six degrees of overall receiver bandwidths, defined as those at the edges of which the receiver gain is half that of the mid-band value. The sharp, crystal derived bandwidths are 0.2, 0.5, and 1.3 kc. The broad non-crystal bandwidths are 3.0, 8.0, and 13 kc. In the presence of noise, consequently, it is advantageous to restrict the overall receiver bandwidth to the narrowest possible, for which the signal remains intelligible. However, the bandwidth requirements of the various types of signals which may be received differ considerably. Thus for phone the receiver 455-kc i-f channel pass-band requirements are  $455 \text{ kc} \pm 2,500 \text{ cps}$ . This is also the i-f channel requirement in the instance of single-tone modulated telegraph. For keyed c-w operation such as slow-speed telegraph, teletypewriter operation (60 words per minute), and high-speed telegraph (400 words per minute), the requirements are respectively  $455 \text{ kc}, \pm 50 \text{ cps}, \pm 75 \text{ cps},$  and  $\pm 600 \text{ cps}$ . When two frequencies, one for "mark" and another for "space", and two channels are used, the bandwidth required is double that indicated. Also, the frequency stability of the received signal and that of the receiver itself affect the width of the pass band which must be available to the signal. This is true especially with regard to c-w and frequency-shift signals, since for single and two-tone signals the frequency of the receiver audio output signals, delivered to the teletypewriter connecting circuits, do not vary appreciably. It is evident then that a c-w (keyed-carrier) signal which is tone amplitude-modulated at the receiver can make use of a narrower audio filter than is the case otherwise, thereby eliminating more of the noise from the desired signal. To provide for the reception of phone, in the presence of noise, the use of a narrower pass band means that the higher frequency components and the noise are attenuated to the extent possible, but not so as to impair the intelligibility of the signal. To provide for the reception of telegraph or teletypewriter signals, full use should be made of the signal pass-band requirements. It should be understood that lower words-per-minute speeds require less bandwidths, and that those indicated are such that the third harmonic of the fundamental "mark" "space" dot-cycle is included to provide an approximation to the ideal square-wave pulse shape of the signal. It should be noted that a reduction of the i-f channel signal band-width requirements would only result in a reduction of the signal-to-noise ratio, since the effective percentage modulation would be less approximate than developed at the transmitter. This is explained in the fact that to overcome a specific noise, a high percentage of modulation is desired.

1-36. FIDELITY. The audio output versus frequency, or overall fidelity characteristic of the receiver is more uniform the wider the overall acceptance bandwidth or selectivity of the receiver. For phone, the use of a "sharp" knob dial position of the selectivity switch depends on a compromise between the acceptable noise and the fidelity. For c-w telegraph or teletypewriter signals, which involve single-tone reception and also two-tone reception in the instance of teletype, preferably near 1000 cps for the former and near 2500 cps for the latter, the use of a sharp selectivity switch position is not restricted, other than as outlined in paragraph 1-35. 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. When ignition or similar pulse-type noise interferes with reception, the noise-limiter switch should be set to its limiter position. Doing this will decrease the percent modulation handling capabilities of the receiver so that in the absence of noise the switch should be kept in its "off" position. The noise-limiter action is such that the audible variations of the noise, as well as the desired audible signal, are bypassed from the a-f output of the receiver for the interval of each noise spike. Utilization of a pass band narrower than outlined in paragraph 1-35 would result in the receiver tone output for "mark" and no tone output for "space" to be less sharply defined.

1-37. FREQUENCY CONTROL UNIT. The frequency control unit is the crystal-controlled first heterodyne oscillator of the receiver. It has associated with it six crystal sockets each of which can be fitted with a type CR-18/U crystal, provided to specification for reception at any predetermined signal frequency within the frequency range of two to 30.0 mc. The six crystal sockets are numbered in accordance, and associated, with the frequency control unit, crystal selector switch positions, which provide for their choice. The small plastic chart (22, figure 1-2), likewise numbered, has provision to pencil in or ink-record, subject to erasure, the signal frequency of the crystal, associated with each switch position. When ordering a crystal the signal frequency for which it is intended must be specified. Since the receiver provides for the single or double conversion reception of a 7.4-mc signal, dependent on whether it is to be received respectively on band 3 or band 4, care must be taken when specifying the frequency of the CR-18/U crystal. For bands 2 and 3, the frequency of the crystal must be 455 kc higher than the signal frequency of the operational activity. For bands 4, 5, and 6 this frequency difference must be 3,955 kc, but from 12.0450 mc, since the third harmonic mode of operation of the crystal is used, the calculated crystal frequency is divided by three. The allowable frequency tolerance of each crystal cannot be greater than 0.005 percent. A crystal holder is associated with the six crystal sockets, it acting as a retainer for the one or more crystals used. The signal frequency for which each crystal is intended is stamped on the top and one side of each.

### 1-38. EQUIPMENT REQUIRED FOR A FREQUENCY-SHIFT SPACE DIVERSITY RECEIVING SYSTEM.

1-39. The tabulation of the complete equipment required for the space diversity reception of a frequency-shift teletype signal is subdivided into the two tables which follow (refer to paragraphs 1-40 and 1-41).

1-40. COMPONENTS OF THE EQUIPMENT PROPER. The components of the frequency-shift space diversity receiving system supplied and covered by this publication are listed in table 1-1.

**Table 1-1. COMPONENTS OF THE EQUIPMENT PROPER**

QUANTITY	NAME	GOVERNMENT TYPE DESIGNATION
2	Radio Receiver, Diversity Model SP-600-JX-17 Rack Mountings.	

1-41. COMPONENTS AND AUXILIARY EQUIPMENT NOT SUPPLIED. The components and auxiliary equipment of the frequency-shift space diversity receiving system not supplied are listed in table 1-2.

**Table 1-2. COMPONENTS AND AUXILIARY EQUIPMENT NOT SUPPLIED**

QUANTITY	NAME	GOVERNMENT OR COMMERCIAL TYPE DESIGNATION
2	Crystals; as per Military Specification MIL-C-3098. <i>Note:</i> Two crystals are required, one for each receiver, for each signal frequency at which the operational activity is contemplated.	CR-18/U. Holder as per HC-6/U or CR-7, (Sig C).

**Table 1-2. COMPONENTS AND AUXILIARY EQUIPMENT NOT SUPPLIED (CONT)**

QUANTITY	NAME	GOVERNMENT OR COMMERCIAL TYPE DESIGNATION
2	Headset.	No. 49507, (Navy).
2	Cord, headset.	No. 3W.49534, (Navy).
2 x 150 ft	Cable, coaxial; lead-in wire.	WE-724 (Western Electric)
2	Antenna system; Beverage (wave antenna) resistor terminated type with transformer match for 70-ohm coaxial cable lead-in wire.	Standard fish-bone type (RCA), or equivalent.
1	Equipment, frequency-shift converter.	FRE (Navy), or equivalent.
1	Teletypewriter Set.	EE-97-A (Sig C).
2 x 2	Crows foot counterpoise with 8-25 ft toes.	
2 x 6 ft	Cable, coaxial; i-f output cable.	WE-724 (Western Electric)
3 x 5 ft	Cable, coaxial; for h-f-o, i-f-o, and b-f-o receiver slave interconnections.	WE-724 (Western Electric)
1	Source, a-c, single phase, 90 to 270 v, 50 to 60 cps, one kw.	

## SECTION II

### OPERATING PROCEDURES

2-1. GENERAL. The radio receiver must be properly installed and operated to provide for optimum receiver performance. The procedure used to operate the radio receiver is dependent on the operational activity contemplated. It becomes more or less complex dependent on the type of signal to be received, on whether space diversity reception is to be used, and on the existent quality of the communication link. The receiver is operated through adjustment of its operating controls and through setting of its switches to suit it for the operational activity contemplated.

#### 2-2. DESCRIPTION OF CONTROLS.

2-3. The controls used to operate the receiver are all located on the front panel (figure 1-2). All are referred to by their panel designations.

2-4. The a-c power switch of the receiver is at the extreme counter-clockwise position of the "RF GAIN" control (7, 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. Also, the four pilot lamps will 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 holder type fuse to blow due to the excessive initial filter capacitor charging current through it under such conditions of operation.

2-5. "SEND" "REC". The "SEND" "REC" switch (6, figure 1-2) is set to "SEND" to desensitize the receiver during transmission intervals in a two-way operational activity carried on at the same signal frequency. Otherwise, the strong local transmission could damage the receiver. When set back to "REC" the receiver provides for instant reception.

2-6. "IFO" "EXT" "INT". The "IFO" "EXT" "INT" switch (3, figure 1-2) is set to "INT" when use is to be made of the internal double conversion 3.5-mc crystal oscillator of the receiver. When the switch is set to "EXT", the double conversion oscillator of the receiver is that externally plug connected to the "IFO" connector (5, figure 1-3), which may be that from another receiver.

2-7. "MOD" "CW". The "MOD" "CW" switch (5, figure 1-2) is set to "MOD" to render the internal bfo of the receiver inoperative when the mode of operation contemplated is mcw. When the switch is set to "CW" the receiver bfo is rendered operative to provide for c-w reception.

2-8. "BFO-AVC" "EXT BFO" "SLOW" "FAST" "INT BFO" "SLOW" "FAST". The "BFO-AVC" "EXT BFO" "SLOW" "FAST" "INT BFO" "SLOW" "FAST" switch (4, figure 1-2) is set to "INT BFO" "SLOW" or "FAST" when use is to be made of the internal bfo of the receiver. When the switch is set to "EXT BFO" "SLOW" or "FAST", the bfo of the receiver is that externally plug connected to the "BFO" connector (6, figure 1-3), which may be that from another receiver. When the switch is in either of its two "SLOW" positions, the a-v-c time constant of the receiver is slower (longer duration) than when the switch is in either of its two "FAST" positions. This is done through the use of a capacitor which the switch (4) switches in to the a-v-c circuit to provide the increased time constant. When the signal fading is slow, the use of either "FAST" or either "SLOW" position of the switch (4) provides for effective a-v-c action to overcome it, provided the rate of fading does not approximate the signaling speed. When the signal fading is fast, the use of either "FAST" position of the switch (4) provides for effective a-v-c action to overcome it, again provided the rate of fading does not approximate the signaling speed. However, so that the a-v-c bias developed does not vary at the signal intelligence rate and thereby smooth out the carrier signal intelligence, the a-v-c time constant provided by the "SLOW" switch positions must be used for the a-v-c action to be effective for c-w reception. Otherwise, the "FAST" switch positions are used, but when the rapid

fading is close to the signaling speed, it is not effective, but more so for mcw and frequency-shift, than for cw.

2-9. "HFO" "VAR" "EXT" "XTALS" "1" "2" "3" "4" "5" "6". The "HFO" "VAR" "EXT" "XTALS" "1" "2" "3" "4" "5" "6" switch (2, figure 1-2) is set to "VAR" when use is to be made of the internal first heterodyne variable conversion oscillator of the receiver. The switch is set to "XTALS" "1", "2", "3", "4", "5", or "6" when use is made of the internal fixed-frequency crystal-controlled first heterodyne conversion oscillator of the receiver. The "XTALS" "1", "2", "3", "4", "5", or "6" switch position chosen is that corresponding to the numeral of the plastic chart (22) alongside of which is recorded the signal frequency of the operational activity contemplated. The switch is set to "EXT" when use is to be made of an external fixed-frequency crystal-controlled first heterodyne conversion oscillator connected to the "HFO OUTPUT" connector (3, figure 1-3).

2-10. "HFO" " $\Delta$  FREQ". The "HFO" " $\Delta$  FREQ" control (10, figure 1-2) is set on scale to the position for which the crystal, fitted in the crystal holder chosen by the "XTALS" "1", "2", "3", "4", "5", or "6" switch (2), oscillates at the exact frequency which provides for precisely tuning in the desired signal frequency of the operational activity contemplated. The "HIGH" "3" "2" "1" "0" "1" "2" "3" "LOW" panel markings are arbitrary, but advancing the control from "LOW" to "HIGH" means that the crystal frequency of oscillation is being increased. The range of the control adjustment provides for adjusting the frequency of the crystal to its nominal value, since it is supplied to a frequency tolerance of 0.005 percent.

2-11. "BAND CHANGE". The "BAND CHANGE" switch (9, figure 1-2) is turned 360 degrees per band in either direction to associate the frequency band, which includes the desired signal carrier, with the r-f section of the receiver. The frequency band indented is identified at the "MEGACYCLES" window (23) which shows the frequency band chosen as indicated on the band dial visible through it. Also, the top of the main dial movable pointer (24), for the band indented, locates itself at the chosen frequency range, band indication of the main dial, visible through the large window at the left side of the front panel.

2-12. "TUNING". The "TUNING" control (8, figure 1-2), for variable frequency operation, is turned in either direction, to tune in the signal. At resonance, the r-f section of the receiver provides the r-f acceptance band width for the signal and at the same time provides for the output of the variable frequency first heterodyne oscillator to be at the correct frequency for the passage of the converted signal through the i-f section of the receiver. For fixed-frequency crystal-controlled operation, the control is turned in either direction just to provide the r-f acceptance bandwidth for the signal, since the crystal associated with the fixed-frequency crystal-controlled first heterodyne oscillator determines the frequency of oscillation; also refer to paragraph

2-10. The control friction drives the vernier dial (14) visible through the large window at the right side of the front panel. This, in turn, gear-train drives the main tuning dial (11).

2-13. "TUNING LOCK". The "TUNING LOCK" (13, figure 1-2) is turned in a clockwise direction to lock the vernier dial at the chosen resonance setting. The tuning lock clamps the tuning mechanism at the desired setting, even though the "TUNING" control (8) remains free to turn. The "TUNING LOCK" prevents accidental shifting or severe vibration from detuning the receiver.

2-14. "SELECTIVITY". The "SELECTIVITY" switch (15, figure 1-2) has six positions to provide for 0.2, 0.5, 1.3, 3, 8, or 13-kc receiver bandwidths or degrees of selectivity at the edges of which the signal gain developed is attenuated to half the mid-band value. The three "XTAL" knob dial bandwidth positions are realized through use of the crystal filter incorporated in the i-f section of the receiver. The three "NON-XTAL" knob dial bandwidth positions are realized with the filter crystal shorted out. The switch knob dial is further designated "SHARP" adjacent to the 0.2-kc switch position, and "BROAD" adjacent to the 13-kc switch position. The use of a crystal filter bandwidth switch position provides definite operational advantages when the quality or fidelity of the receiver output is secondary to continuity of service, such as for the reception of phone and single or two-tone telegraph or teletype.

2-15. "XTAL PHASING". The "XTAL PHASING" control (16, figure 1-2) is set to a position which highly attenuates an interfering carrier closely adjacent to the desired signal tuned in. It is part of the crystal filter referred to in paragraph 2-14 and only provides its function when the "SELECTIVITY" switch (15) is in one of its three "XTAL" knob dial positions.

2-16. "BEAT OSC". The "BEAT OSC" control (18, figure 1-2) is used to adjust the nominal 455-kc frequency of the receiver bfo within the range of  $\pm 3$  kc, so that when detuned from its "0" control knob dial setting it provides tone output for c-w reception. The on-scale setting chosen for the control 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 knob dial setting or zero beat. The control when set to exactly 455 kc is useful for locating and tuning in weak signals of any kind and for carrier reinsertion at the receiver for suppressed carrier reception of single or double side band signals. For the reception of a frequency-shift signal, the proper choice of control setting provides for the receiver "mark" and "space" tone output to center up in the audio filter circuitry of the associated equipment. The bfo is rendered operative when the "MOD" "CW" switch (5) is at "CW".

2-17. "RF GAIN". The "RF GAIN" control (7, 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 2-4). It functions in either position of the "AVC" "MAN" switch (19) as outlined in paragraph 2-18.

2-18. "AVC" "MAN". The "AVC" "MAN" switch (19, figure 1-2) is set to "AVC" for the automatic volume control of the r-f and i-f gain of the receiver. It provides reasonable constancy of receiver output at the level determined by the setting of the "RF GAIN" control (7), for a fixed setting of the "AUDIO GAIN" control (21), so long as the tuned-in, receiver signal input develops an avc bias equal to, or greater than, the delay bias incorporated in the avc. The a-v-c action is provided with a slow or fast time constant as outlined (refer to paragraph 2-8). "AVC" is effective for the reception of phone, high-speed c-w telegraph, and teletype. The switch is set to "MAN" for the reception of low-speed c-w telegraph. When the strength of the carrier tuned in is less than two microvolts, the avc is not functioning, even with the "RF GAIN" control (7) at maximum, which is its minimum bias setting, since then it cannot develop sufficient bias to overcome the a-v-c delay bias, as outlined herein above.

2-19. "METER" "RF" "AF". The "METER" "RF" "AF" spring return switch (20, figure 1-2) is associated with the meter (12). With the switch (20) in its normal, non-depressed "RF" position, and the "AVC" "MAN" switch (19) set to "AVC", the meter top scale provides an indication of the r-f signal input to the receiver. With the switch (20) held in its depressed "AF" position, the meter bottom scale provides an indication of the a-f output of the receiver, for both positions of the "AVC" "MAN" switch (19). The meter "RF" indication provides a measure of the relative strength of the tuned-in signal in db from one microvolt when the "RF GAIN" control is set at maximum. The meter "AF" indication provides a measure of the relative audio output level in db from six milliwatts, the standard reference level output. Further the meter "RF" indication provides for accurate tuning when on avc. The meter "AF" indication provides for indication of receiver output to a connected load, even when remote, since otherwise the "AF" indication is excessive.

#### CAUTION

To provide against damaging the meter (12), never depress the "METER" "RF" "AF" switch (20) to its "AF" position without first backing up the "AUDIO GAIN" control (21) to its minimum control setting. Then, advancing the control slowly will determine whether the "AUDIO OUTPUT" terminals (9, figure 1-3) are suitably loaded with a 600-ohm load or loud speaker. With suitable loading the meter (12, figure 1-2) indication will be much less for a small advance of the control (21) than when the load is an open circuit.

2-20. "AUDIO GAIN". The "AUDIO GAIN" control (21, figure 1-2) is set for the desired audio output

level by advancing it in a clockwise direction to provide comfortable headset and/or loud speaker reception; or, the control is set to provide the audio output at a level suitable for operating other equipment associated with the receiver.

2-21. "LIMITER" "OFF". The "LIMITER" "OFF" switch (17, figure 1-2) is set to its "LIMITER" position when ignition or similar pulse-type noise is interfering with reception, so that the noise (and desired audio output) is bypassed from the receiver audio output for the interval of each noise spike.

#### 2-22. SEQUENCE OF OPERATION.

2-23. The operating procedures of the receiver involve a sequence of operations prior to, during, and following its use in an operational activity. These procedures are outlined below for each possible mode of operation of the receiver. In each instance each control and switch is identified by its front panel designation (figure 1-2). Likewise, any receiver connector referred to is identified by its chassis designation (figure 1-3).

#### CAUTION

In an emergency remove the a-c power source input to the radio receiver by pulling the power cord plug from the receiver a-c power connector socket.

#### 2-24. PRIOR TO USE.

#### 2-25. M-C-W RECEPTION - PHONE OR SINGLE-TONE TELEGRAPH.

2-26. The sequence of operations performed to ready the receiver for the m-c-w reception of phone or single-tone telegraph is outlined in paragraphs 2-27, 2-28, 2-29, 2-30, and 2-31.

#### 2-27. PRELIMINARY REQUIREMENTS.

- a. Plug in the headset in the "PHONES" jack (1, figure 1-2), or listen to the loud speaker when used.
- b. Set the "SEND" "REC" switch (6) to "REC".
- c. Set the "BFO" "EXT" "INT" switch (3) to "INT".
- d. Set the "BFO" "VAR" "EXT" "XTALS" "1" "2" "3" "4" "5" "6" switch (2) to "VAR".
- e. Set the "LIMITER" "OFF" switch (17) to "OFF".
- f. Set the "SELECTIVITY" switch (15) to its "NON-CUTAL" "3" kc knob dial position.
- g. Set the "AVC" "MAN" switch (19) to "AVC".
- h. Set the "XTAL PHASING" control (16) to the position indicated by a diamond, between numbers "4" and "6".
- i. Unclamp the "TUNING LOCK" (13) by turning it counter-clockwise.
- j. Turn the "RF GAIN" control (7) from its dial knob "OFF" switch position in a clockwise direction. A click will indicate that the receiver is in its a-c power on position. Do this at least 15 minutes prior to using the receiver. Note that the pilot lamps light up.
- k. Set the "MOD" "CW" switch (5) to "MOD".

Since the bfo is inoperative, the "BFO-AVC" "EXT BFO" "SLOW" "FAST" "INT BFO" "SLOW" "FAST" switch (4) may assume either "FAST" "AVC" position, suitable for m-c-w reception.

l. Indent the "BAND CHANGE" switch (9) to the "MEGACYCLES" window (23) band dial indication in which the desired signal frequency is located.

m. Turn the "RF GAIN" control (7) to its maximum clockwise position.

n. Turn the "AUDIO GAIN" control (21) to a position providing for the receiver noise output not to be objectionable.

o. Turn the "TUNING" control (8) so that the main tuning dial (11) frequency indication corresponds to the desired signal frequency to be tuned in.

#### Note

Turn the "RF GAIN" control (7) down somewhat to avoid receiver noise output while the "TUNING" control (8) is traversing positions at which there are no signal transmissions.

2-28. M-C-W TUNING FOR VARIABLE FREQUENCY RECEPTION. To tune in a m-c-w signal, follow the preliminary requirements outlined in paragraph 2-27 and continue as follows:

a. Turn the "TUNING" control (8, figure 1-2) in either direction to resonate the signal, as is the case when the meter (12) indication is a maximum. At resonance the main tuning dial (11) frequency reading should be within one-quarter of one percent of the desired signal frequency tuned in.

b. Clamp the "TUNING LOCK" (13) by turning it clockwise, if desired.

c. Readjust the "AUDIO GAIN" control (21) to a position for comfortable reception.

2-29. M-C-W TUNING FOR VARIABLE FREQUENCY RECEPTION OF A WEAK SIGNAL. When the preliminary requirements outlined in paragraph 2-27 and the tuning procedure outlined in paragraph 2-28 do not provide for tuning in the desired signal, due to its being too weak to be readily distinguishable from other signals or interference of any kind, identify the desired signal by use of the following procedure:

a. Set the "MOD" "CW" switch (5, figure 1-2) to "CW".

b. Determine some strong (m-c-w or c-w) signal on one of the lower frequency bands of the receiver, for use to accurately set the "BEAT OSC" control (18) to 455 kc, which setting may not correspond exactly to its "O" knob dial setting.

c. Set the "BFO-AVC" "EXT BFO" "SLOW" "FAST" "INT BFO" "SLOW" "FAST" switch (4) to "INT BFO" "SLOW" for a l-f c-w signal and to "INT BFO" "FAST" for a l-f m-c-w signal.

d. Indent the "BAND CHANGE" switch (9) to the "MEGACYCLES" window (23) band dial indication in which the strong low-frequency signal is located.

e. Tune in the low-frequency signal by turning the "TUNING" control (8) in either direction to resonate the signal accurately with the indication on the meter (12) at a maximum.

f. Adjust the "BEAT OSC" control (18) for zero beat audio output, and maintain this setting for it.

g. Indent the "BAND CHANGE" switch (9) to the "MEGACYCLES" window (23) band dial indication in which the desired signal frequency is located.

h. Turn the "TUNING" control (8) in either direction to resonate the desired signal for zero beat audio output.

i. Set the "MOD" "CW" switch (5) back to "MOD".

j. Clamp the "TUNING LOCK" (13) by turning it clockwise, if desired.

k. Readjust the "AUDIO GAIN" control (21) to a position for comfortable reception.

**2-30. M-C-W CRYSTAL-CONTROLLED RECEPTION.** When the operational activity is to provide for the fixed-frequency crystal-controlled reception of phone or single-tone telegraph, follow the preliminary requirements outlined in paragraph 2-27, and continue with the step sequence that follows:

a. Set the "HFO" "VAR" "EXT" "XTALS" "1" "2" "3" "4" "5" "6" switch (2, figure 1-2) to the "1", "2", "3", "4", "5", or "6" crystal position whose numeral designation corresponds to that of the crystal holder which carries the crystal suited to the signal frequency of the operational activity. The switch position is readily determined by noting the numeral on the plastic chart (22) alongside of which the signal frequency is recorded.

b. Turn the "HFO" "Δ FREQ" control (10) in either direction on scale to resonate the signal, as is the case when the indication on the meter (12) is a maximum.

c. Turn the "TUNING" control (8) in either direction to resonate the r-f section of the receiver to the signal, as is the case when the indication on the meter (12) is a maximum.

d. Clamp the "TUNING LOCK" (13) by turning it clockwise, if desired.

e. Readjust the "AUDIO GAIN" control (21) to a position for comfortable reception.

**2-31. NOISE SUPPRESSION, M-C-W RECEPTION** To provide for the best possible m-c-w reception under noisy atmospheric and/or man-made static conditions, follow the preliminary requirements outlined in paragraph 2-27 and the tuning procedure outlined in paragraph 2-28, 2-29, or 2-30, as applicable, and continue as follows:

a. Set the "SELECTIVITY" switch (15, 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 (15) is used in one of its "XTAL" positions, turn the "XTAL PHASING" control (16) to a position which highly attenuates an interfering signal, if any.

c. Set the "LIMITER" "OFF" switch (17) to the "LIMITER" position to eliminate ignition noise, and others, if any, from the audio output.

d. During "stand-by" periods in the transmission when the desired signal is "off the air" turn the "RF GAIN" control (7) down somewhat from its maximum clockwise position to cut down on the receiver noise output in such instances.

e. 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 (7) down to some point most suited to the receiving conditions.

### **2-32. C-W RECEPTION — TELEGRAPH.**

2-33. The sequence of operations performed to ready the receiver for the c-w reception of telegraph are outlined in paragraphs 2-34, 2-35, 2-36, 2-37, and 2-38.

### **2-34. PRELIMINARY REQUIREMENTS.**

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

b. Set the "SEND" "REC" switch (6) to "REC".

c. Set the "IFO" "EXT" "INT" switch (3) to "INT".

d. Set the "HFO" "VAR" "EXT" "XTALS" "1" "2" "3" "4" "5" "6" switch (2) to "VAR".

e. Set the "LIMITER" "OFF" switch (17) to "OFF".

f. Set the "SELECTIVITY" switch (15) to its "NON-XTAL" "3" kc knob dial position.

g. Set the "AVC" "MAN" switch (19) to "MAN" for low-speed telegraph signal reception and to "AVC" for high-speed telegraph signal reception. Remember that the meter (12) only provides an r-f signal indication in the "AVC" position of the "AVC" "MAN" switch (19).

h. Set the "XTAL PHASING" control (16) to the position indicated by a diamond, between numbers "4" and "6".

i. Unclamp the "TUNING LOCK" (13) by turning it counter-clockwise.

j. Turn the "RF GAIN" control (7) from its dial knob "OFF" switch position in a clockwise direction. A "click" will indicate that the receiver is in its a-c power "on" position. Do this at least 15 minutes prior to using the receiver. Note that the pilot lamps light up.

k. Set the "MOD" "CW" switch (5) to "CW". Since the bfo is operative, the "BFO-AVC" "EXT BFO" "SLOW" "FAST" "INT BFO" "SLOW" "FAST" switch (4) is set to "INT BFO" "SLOW" for the reception of a high-speed telegraph signal. Since the "AVC" "MAN" switch (19) is set at "MAN" for the reception of a low-speed telegraph signal, it does not matter whether the switch (4) assumes its "SLOW" or "FAST" "INT BFO" position in this instance.

l. Set the "BEAT OSC" control (18) to its "O" knob dial position.

m. Indent the "BAND CHANGE" switch (9) to the "MEGACYCLES" window (23) band dial indication in which the desired signal frequency is located.

n. Turn the "RF GAIN" control (7) clockwise to a position below that at which the receiver noise output is blocked off, if on "MAN", and to fully on, if on "AVC".

o. Turn the "AUDIO GAIN" control (21) to a position providing for the receiver noise output not to be objectionable.

p. Turn the "TUNING" control (8) so that the main tuning dial (11) frequency indication corresponds to the desired signal frequency to be tuned in.

2-35. C-W TUNING FOR VARIABLE FREQUENCY RECEPTION. To tune in a c-w signal, follow the preliminary requirements outlined in paragraph 2-34 and continue as follows:

a. Turn the "TUNING" control (8, figure 1-2), in either direction, for zero beat audio output or maximum indication on the meter (12). Either tuning procedure provides for resonating the signal, but refer to step "g", paragraph 2-34. At resonance, the main dial (11) frequency reading should be within one-quarter of one percent of the desired signal frequency tuned in.

b. Clamp the "TUNING LOCK" (13) by turning it clockwise, if desired.

c. Turn the "BEAT OSC" control (18), 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 the position in either direction, no matter the zone, which provides for the most intelligible reception.

d. Readjust the "RF GAIN" control (7) for the cleanest signal and the "AUDIO GAIN" control (21) to a position for comfortable reception.

2-36. C-W TUNING FOR VARIABLE FREQUENCY RECEPTION OF A WEAK SIGNAL. When the preliminary requirements outlined in paragraph 2-34 and the tuning procedure outlined in paragraph 2-35 do not provide for tuning in the desired signal, due to its being too weak to be readily distinguishable from other signals or interference of any kind, identify the desired signal by use of the following procedure:

a. Determine some strong (m-c-w or c-w) signal on one of the lower frequency bands of the receiver, for use to accurately set the "BEAT OSC" control (18, figure 1-2) to 455 kc, which setting may not correspond exactly to its "O" knob dial setting.

b. Set the "BFO-AVC" "EXT BFO" "SLOW" "FAST" "INT BFO" "SLOW" "FAST" switch (4) to "INT BFO" "SLOW" for a l-f c-w signal and to "INT BFO" "FAST" for a l-f m-c-w signal.

c. Indent the "BAND CHANGE" switch (9) to the "MEGACYCLES" window (23) band dial indication in which the strong low-frequency signal is located.

d. Set the "AVC" "MAN" switch (19) to "AVC", if it is at "MAN".

e. Tune in the low-frequency signal by turning the "TUNING" control (8) in either direction to resonate the signal accurately with the indication on the meter (12) at a maximum.

f. Adjust the "BEAT OSC" control (18) for zero beat audio output, and maintain this setting for it.

g. Indent the "BAND CHANGE" control (9) to the "MEGACYCLES" window (23) band dial indication in which the desired signal frequency is located.

h. Leave the "AVC" "MAN" switch (19) on "AVC" for the reception of high-speed telegraph signals and switch to "MAN" for the reception of low-speed telegraph signals.

i. Set the "BFO-AVC" "EXT BFO" "SLOW" "FAST" "INT BFO" "SLOW" "FAST" switch (4) back to "INT BFO" "SLOW".

j. Turn the "TUNING" control (8), in either direction, to resonate the desired signal for zero beat audio output.

k. Clamp the "TUNING LOCK" (13) by turning it clockwise, if desired.

l. Turn the "BEAT OSC" control (18) in either direction, to get tone output, preferably around 1000 cps, as outlined in step "c" of paragraph 2-35.

m. Readjust the "RF GAIN" control (7) for cleanest signal and set the "AUDIO GAIN" control (21) to a position for comfortable reception.

2-37. C-W CRYSTAL-CONTROLLED RECEPTION. When the operational activity is to provide for the fixed-frequency crystal-controlled reception of telegraph, follow the preliminary requirements outlined in paragraph 2-34, and continue with the step sequence that follows:

a. Set the "HFO" "VAR" "EXT" "XTALS" "1" "2" "3" "4" "5" "6" switch (2, figure 1-2) to the "1", "2", "3", "4", "5", or "6" crystal position whose numeral designation corresponds to that of the crystal holder which carries the crystal suited to the signal frequency of the operational activity. The switch position is readily determined by noting the numeral on the plastic chart (22) alongside of which the signal frequency is recorded.

b. Turn the "HFO" "Δ FREQ" control (10) 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 (12) is a maximum, the meter providing an indication when the "AVC" "MAN" switch (19) is in its "AVC" position as outlined in step "g" of paragraph 2-34.

c. Turn the "TUNING" control (8), in either direction, to resonate the r-f section of the receiver to the signal, as is the case when the indication on the meter (12) is a maximum, with the zero beat audio output position of the "HFO" "Δ FREQ" control (10) maintained, the meter providing an indication when the "AVC" "MAN" switch (19) is in its "AVC" position. If the switch (19) is in its "MAN" position temporarily switch it to its "AVC" position.

d. Clamp the "TUNING LOCK" (13) by turning it clockwise, if desired.

e. Turn the "BEAT OSC" control (18), 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

the position in either direction, no matter the tone, which provides for the most intelligible reception.

f. Readjust the "RF GAIN" control (7) for cleanest signal and set the "AUDIO GAIN" control (21) to a position for comfortable reception.

**2-38. NOISE SUPPRESSION, C-W RECEPTION.** To provide for the best possible c-w reception under noisy atmospheric or man-made static conditions, follow the preliminary requirements outlined in paragraph 2-34 and the tuning procedure outlined in paragraphs 2-35, 2-36, or 2-37, as applicable, and continue as follows:

a. Set the "SELECTIVITY" switch (15, figure 1-2) to the "XTAL" switch position which provides the best reception.

b. Turn the "XTAL PHASING" control (16) to a position which highly attenuates an interfering signal, if any.

c. Set the "LIMITER" "OFF" switch (17) to the "LIMITER" position to eliminate ignition noise, and others, if any, from audio output.

d. Readjust the "RF GAIN" control (7) for cleanest signal, and set the "AUDIO GAIN" control (21) to a position for comfortable reception.

### **2-39. FREQUENCY-SHIFT RECEPTION — TELETYPE.**

**2-40.** The sequence of operations performed to ready the receiver for frequency-shift reception of teletypewriter signals are outlined in paragraphs 2-41, 2-42, 2-43, 2-44, and 2-45.

#### **2-41. PRELIMINARY REQUIREMENTS.**

a. Plug in the headset in the "PHONES" jack (1, figure 1-2).

b. Set the "SEND" "REC" switch (6) to "REC".

c. Set the "IFO" "EXT" "INT" switch (3) to "INT".

d. Set the "HFO" "VAR" "EXT" "XTALS" "1" "2" "3" "4" "5" "6" switch (2) to "VAR".

e. Set the "LIMITER" "OFF" switch (17) to "OFF".

f. Set the "SELECTIVITY" switch (15) to its "NON-XTAL" "5" kc knob dial position.

g. Set the "AVC" "MAN" switch (19) to "AVC".

h. Set the "XTAL PHASING" control (16) to the position indicated by a diamond, between numbers "4" and "6".

i. Unclamp the "TUNING LOCK" (13) by turning it counter-clockwise.

j. Turn the "RF GAIN" control (7) from its dial knob "OFF" switch position in a clockwise direction. A "click" will indicate that the receiver is in its a-c power "on" position. Do this at least 15 minutes prior to using the receiver. Note that the pilot lamps light up.

k. Set the "MOD" "CW" switch (5) to "CW".

l. Set the "BFO-AVC" "EXT BFO" "SLOW" "FAST" "INT BFO" "SLOW" "FAST" switch (4) to "INT BFO" "FAST" when the signal is in the h-f range (three to 30.0 mc); otherwise, set to "INT BFO" "SLOW".

m. Set the "BEAT OSC" control (18) to its "O" knob dial position.

n. Indent the "BAND CHANGE" switch (9) to the "MEGACYCLES" window (23) band dial indication in which the desired signal frequency is located.

o. Turn the "RF GAIN" control (7) clockwise to its maximum clockwise position.

p. Turn the "AUDIO GAIN" control (21) to a position providing for the receiver noise output not to be objectionable.

q. Turn the "TUNING" control (8) so that the main tuning dial (11) frequency indication corresponds to the desired signal frequency to be tuned in.

**2-42. FREQUENCY-SHIFT TUNING FOR VARIABLE FREQUENCY RECEPTION.** To tune in a frequency-shift signal, follow the preliminary requirements outlined in paragraph 2-41 and continue as follows:

a. Turn the "TUNING" control (8, figure 1-2), in either direction, such that the two-tone output slightly off resonance results in single-tone audio output or maximum indication on the meter (12). Either tuning procedure provides for resonating the signal. At resonance, the main dial (11) frequency reading should be within one-quarter of one percent of the desired signal frequency tuned in.

b. Clamp the "TUNING LOCK" (13) by turning it clockwise, if desired.

c. Turn the "BEAT OSC" control (18), in either direction, to get two-tone output, at 2500 cps  $\pm$  the carrier shift. Reception may be better with the control turned in one direction as compared to the other.

**2-43. FREQUENCY-SHIFT TUNING FOR VARIABLE FREQUENCY RECEPTION OF A WEAK SIGNAL.** When the preliminary requirements outlined in paragraph 2-41 and the tuning procedure outlined in paragraph 2-42 do not provide for tuning in the desired signal, due to its being too weak to be readily distinguishable from other signals or interference of any kind, identify the desired signal by use of the following procedure:

a. Determine some strong (m-c-w or c-w) signal on one of the lower frequency bands of the receiver, for use to accurately set the "BEAT OSC" control (18, figure 1-2) to 455 kc, which setting may not correspond exactly to its "O" knob dial setting.

b. Set the "BFO-AVC" "EXT BFO" "SLOW" "FAST" "INT BFO" "SLOW" "FAST" switch (4) to "INT BFO" "SLOW" for a l-f c-w signal and to "INT BFO" "FAST" for a l-f m-c-w signal.

c. Indent the "BAND CHANGE" switch (9) to the "MEGACYCLES" window (23) band dial indication in which the strong low-frequency signal is located.

d. Tune in the low-frequency signal by turning the "TUNING" control (8) in either direction to resonate the signal accurately with the indication on the meter (12) at a maximum.

e. Adjust the "BEAT OSC" control (18) for zero beat audio output, and maintain this setting for it.

f. Set the "BFO-AVC" "INT BFO" "SLOW" "FAST" "EXT BFO" "SLOW" "FAST" switch (4) back to the position chosen for it as outlined in step "1" of paragraph 2-41.

g. Indent the "BAND CHANGE" switch (9) to the "MEGACYCLES" window (23) band dial indication in which the desired signal frequency is located.

h. Turn the "TUNING" control (8), in either direction, such that the two-tone output, slightly off resonance, results in single-tone audio output or maximum indication on the meter (12). Either tuning procedure provides for resonating the signal. At resonance the main dial (11) frequency reading should be within one-quarter of one percent of the desired signal frequency tuned in.

i. Clamp the "TUNING LOCK" (13) by turning it clockwise, if desired.

j. Turn the "BEAT OSC" control (18) in either direction to get two-tone output, at 2500 cps  $\pm$  the carrier shift. Reception may be better with the control turned in one direction as compared to the other.

k. Readjust the "RF GAIN" control (7) for cleanest signal and set the "AUDIO GAIN" control (21) to a position for comfortable reception.

**2-44. FREQUENCY-SHIFT CRYSTAL-CONTROLLED RECEPTION.** When the operational activity is to provide for the fixed-frequency crystal-controlled reception of a frequency-shift signal, follow the preliminary requirements outlined in paragraph 2-41 and continue with the step sequence that follows:

a. Set the "HFO" "VAR" "EXT" "XTALS" "1" "2" "3" "4" "5" "6" switch (2, figure 1-2) to the "1", "2", "3", "4", "5", or "6" crystal position whose numeral designation corresponds to that of the crystal holder which carries the crystal suited to the signal frequency of the operational activity. The switch position is readily determined by noting the numeral on the plastic chart (22) alongside of which the signal frequency is recorded.

b. Turn the "HFO" " $\Delta$  FREQ" control (10) in either direction on scale to resonate the signal, as is the case for single-tone output compared to two-tone output slightly off resonance, or when the indication on the meter (12) is a maximum.

c. Turn the "TUNING" control (8), in either direction, to resonate the r-f section of the receiver to the signal, as is the case when the indication on the meter (12) is a maximum, with the single-tone output position of the "HFO" " $\Delta$  FREQ" control (10) maintained.

d. Clamp the "TUNING LOCK" (13) by turning it clockwise, if desired.

e. Turn the "BEAT OSC" control (18), in either direction, to get two-tone output, at 2500 cps  $\pm$  the carrier shift. Reception may be better with the control turned in one direction as compared to the other.

f. Readjust the "RF GAIN" control (7) for cleanest signal and set the "AUDIO GAIN" control (21) to a position for comfortable reception.

**2-45. NOISE SUPPRESSION, FREQUENCY-SHIFT RECEPTION.** To provide for the best possible frequency-shift reception under noisy atmospheric or man-made static conditions, follow the preliminary requirements outlined in paragraph 2-41 and the tuning procedure outlined in paragraph 2-42, 2-43, or 2-44, as applicable, and continue as follows:

a. Set the "SELECTIVITY" switch (15, figure 1-2) to the "XTAL" switch position which provides the best reception.

b. Turn the "XTAL PHASING" control (16) to a position which highly attenuates an interfering signal, if any.

c. Set the "LIMITER" "OFF" switch (17) to the "LIMITER" position to eliminate ignition noise, and others, if any from the audio output.

d. Readjust the "RF GAIN" control (7) for cleanest signal, and set the "AUDIO GAIN" control (21) to a position for comfortable reception.

**2-46. SUPPRESSED CARRIER MULTICHANNEL RECEPTION - PHONE, TELEGRAPH, AND TELETYPE.**

2-47. To provide for single or double side band reception, the desired signal carrier, suppressed at the transmitter, must be reinserted at the receiver. This is done by rendering the internal bfo of the receiver operative so that the suppressed carrier at 455 kc can be added to the single or double side bands received.

2-48. The sequence of operations performed to ready the receiver for the suppressed-carrier multichannel reception of phone, telegraph, and teletypewriter signals are outlined in paragraphs 2-49, 2-50, 2-51, and 2-52.

**2-49. PRELIMINARY REQUIREMENTS.**

a. Plug in the headset in the "PHONES" jack (1, figure 1-2).

b. Set the "SEND" "REC" switch (6) to "REC".

c. Set the "IFO" "EXT" "INT" switch (3) to "INT".

d. Set the "HFO" "VAR" "EXT" "XTALS" "1" "2" "3" "4" "5" "6" switch (2) to "VAR".

e. Set the "LIMITER" "OFF" switch (17) to "OFF".

f. Set the "SELECTIVITY" switch (15) to its "NON-XTAL" "3", "8", or "13" kc knob dial position dependent on the bandwidth required for the single or double side band reception contemplated. Remember that the multichannel channel separations are usually 170 cycles and that the "3" kc knob dial switch position suffices for single side band reception and that for double side band reception, either the "8" kc or the "13" kc switch position may be required or prove adequate. Remember too that for double side band transmissions, the signal intelligence for each side band is independent of the other.

- g. Set the "AVC" "MAN" switch (19) to "AVC".
- h. Set the "XTAL PHASING" control (16) to the position indicated by a diamond between numbers "4" and "6".
- i. Unclamp the "TUNING LOCK" (13) by turning it counter-clockwise.
- j. Turn the "RF GAIN" control (7) from its dial knob "OFF" switch position in a clockwise direction. A "click" will indicate that the receiver is in its a-c power "on" position. Do this at least 15 minutes prior to using the receiver. Note that the pilot lamps light up.
- k. Set the "MOD" "CW" switch (5) to "CW".
- l. Set the "BFO-AVC" "EXT BFO" "SLOW" "FAST" "INTO BFO" "SLOW" "FAST" switch (4) to "INT BFO" "FAST".
- m. Set the "BEAT OSC" control (18) to its "O" knob dial position.
- n. Indent the "BAND CHANGE" switch (9) to the "MEGACYCLES" window (23) band dial indication in which the suppressed carrier desired signal frequency is located.
- o. Turn the "RF GAIN" control (7) clockwise to its maximum clockwise position.
- p. Turn the "AUDIO GAIN" control (21) to a position providing for the receiver noise output not to be objectionable.
- q. Turn the "TUNING" control (8) so that the main dial tuning frequency indication corresponds to the suppressed carrier desired signal frequency of the single or double side bands to be tuned in.

2-50. SUPPRESSED CARRIER TUNING FOR VARIABLE FREQUENCY RECEPTION. To tune in a suppressed carrier signal, follow the preliminary requirements outlined in paragraph 2-49 and continue as follows:

- a. Turn the "TUNING" control (8, figure 1-2) in either direction to resonate the single or double side band about the suppressed carrier frequency, as is the case when the meter (12) indication is a maximum. At resonance the main dial (11) frequency reading should be within one-quarter of one percent of the suppressed carrier of the single or double side bands tuned in. When it is desired to resonate the single or double side bands by listening to the receiver audio output, attenuate all but one channel of the transmission by setting the "SELECTIVITY" switch (15) to its "XTALS" "1.3" kc position. Then turn the "TUNING" control (8) in either direction to resonate the single or double side bands as is the case when the receiver audio output from the one circuit is clearly intelligible as phone, as two-tone teletypewriter signals (595 cps for "mark" and 425 cps for "space"), or as automatic Morse code keying of a 1000 cps tone, as applicable. Then reset the "SELECTIVITY" switch (15) to its required position as outlined in step "f" of paragraph 2-49.
- b. Clamp the "TUNING LOCK" (13) by turning it clockwise, if desired.
- c. Readjust the "AUDIO GAIN" control (21) to a position for comfortable reception.

2-51. SUPPRESSED CARRIER CRYSTAL-CONTROLLED MULTICHANNEL RECEPTION. When the operational activity is to provide for the fixed-frequency crystal-controlled multichannel reception of a single or double side band suppressed carrier signal, follow the preliminary requirements outlined in paragraph 2-49 and continue with the step sequence that follows:

- a. Set the "HFO" "VAR" "EXT" "XTALS" "1" "2" "3" "4" "5" "6" switch (2, figure 1-2) to the "1", "2", "3", "4", "5", or "6" crystal position whose numeral designation corresponds to the crystal holder which carries the crystal suited to the suppressed carrier signal frequency of the operational activity. The switch position is readily determined by noting the numeral on the plastic chart (22) alongside of which the suppressed carrier signal frequency is recorded.
- b. Turn the "HFO" " $\Delta$  FREQ" control (10) in either direction on scale to resonate the single or double side bands about the suppressed carrier frequency, as is the case when the meter (12) indication is a maximum. When it is desired to resonate the single or double side bands by listening to the receiver audio output, attenuate all but one channel of the transmission by setting the "SELECTIVITY" switch (15) to its "XTALS" "1.3" kc position. Then turn the "TUNING" control (8) in either direction to resonate the single or double side bands as is the case when the receiver audio output from the one circuit is clearly intelligible as phone, as two-tone teletypewriter signals (595 cps for "mark" and 425 cps for "space"), or as automatic Morse code keying of a 1000 cps tone, as applicable. Then reset the "SELECTIVITY" switch (15) to its required position as outlined in step "f" of paragraph 2-49.

- c. Turn the "TUNING" control (8) in either direction to resonate the r-f section of the receiver to the suppressed carrier single or double side band signal, as is the case when the indication on the meter (12) is further maximized, with the position of the "HFO" " $\Delta$  FREQ" control (10) maintained as set in step "b" of paragraph 2-51.

- d. Clamp the "TUNING LOCK" (13) by turning it clockwise, if desired.
- e. Readjust the "AUDIO GAIN" control (21) to a position for comfortable reception.

2-52. NOISE SUPPRESSION, SUPPRESSED CARRIER MULTICHANNEL RECEPTION. To provide for the best possible suppressed carrier single or double side band reception under noisy atmospheric or man-made static conditions, follow the preliminary requirements outlined in paragraph 2-49 and the tuning procedure outlined in paragraph 2-50 or 2-51, as applicable, and continue as follows:

- a. Set the "SELECTIVITY" switch (15, figure 1-2) to the "NON-XTAL" switch position which provides the best reception.
- b. Set the "LIMITER" "OFF" switch (17) to the "LIMITER" position to eliminate ignition noise, and others, if any, from the audio output.

## Section II

AN 16-45-433

## Paragraphs 2-53 to 2-60

c. Readjust the "RF GAIN" control (7) for cleanest signal, and set the "AUDIO GAIN" control (21) to a position for comfortable reception.

**2-53. SPACE DIVERSITY RECEPTION — MCW.**

2-54. The sequence of operations performed to ready two or more receivers for the space diversity reception of phone or single-tone telegraph are the following:

a. For each receiver, follow the preliminary requirements outlined in paragraph 2-27, but since only one receiver provides the composite audio output, turn the "AUDIO GAIN" control (21, figure 1-2) of each receiver which provides no a-f output to its minimum control position. Make sure to plug the headset in the "PHONES" jack (1) of the receiver which provides the a-f output.

b. For each receiver, follow the tuning procedure outlined in paragraph 2-28, 2-29, or 2-30, as applicable, readjusting the "AUDIO GAIN" control (21) of the receiver which provides the a-f output, to a position for comfortable reception.

c. By noting the meter (12) indication of signal strength for each receiver, readjust the "RF GAIN" control (7) of each receiver, apart from that receiving the weakest signal, so that initially each meter (12) of each receiver reads the same.

d. For each receiver, follow the noise suppression procedure outlined in steps "a" through "d" of paragraph 2-31.

**2-55. SPACE DIVERSITY RECEPTION — CW.**

2-56. The sequence of operations performed to ready two or more receivers for the space diversity reception of c-w telegraph is the following:

a. For each receiver, follow the preliminary requirements outlined in paragraph 2-34, but set the "AVC" "MAN" switch (19, figure 1-2) to "MAN", even for a high-speed signal. These are the procedures followed to derive the a-c output from each receiver. When the d-c output is required it is the composite d-c output from one of the receivers. In this instance, turn the "AUDIO GAIN" control (21) of each of the other receivers to its minimum control position. Make sure to plug the headset in the "PHONES" jack (1) of the receiver which provides the composite d-c output, since it will also provide a-c output to the headset monitor.

b. For each receiver, follow the tuning procedure outlined in paragraph 2-35, 2-36, or 2-37, as applicable, but with regard to the setting of the "AVC" "MAN" switch (19) outlined in step "h" of paragraph 2-36, set it to "MAN", even for a high-speed signal. Also, when the d-c output is to be used, just readjust the "AUDIO GAIN" control (21) of the receiver that provides the composite d-c output. However, readjust the "RF GAIN" control (7) of each of the receivers for the cleanest monitoring headset signal.

c. For each receiver, follow the noise suppression procedure outlined in paragraph 2-38, but when the d-c output is to be used, just readjust the "AUDIO GAIN"

control (21) of the receiver that provides the composite d-c output. Otherwise, follow the full procedure indicated both for composite d-c and a-c outputs.

**2-57. SPACE DIVERSITY RECEPTION — FREQUENCY SHIFT.**

2-58. The sequence of operations performed to ready two receivers for the space diversity reception of a frequency-shift signal is the following:

a. For one receiver, follow the preliminary requirements outlined in paragraph 2-41, whether or not the i-f or a-f receiver outputs are combined for space diversity system use. For the other receiver do likewise, but set the "IFO" "EXT" "INT" switch (3, figure 1-2) to "EXT" and set the "BFO-AVC" "EXT BFO" "SLOW" "FAST" "INT BFO" "SLOW" "FAST" switch (4) to "EXT BFO" "FAST" when the signal is in the h-f range (three to 30.0 mc); otherwise, set it to "EXT BFO" "SLOW".

b. For each receiver, follow the tuning procedure outlined in paragraph 2-42, 2-43, or 2-44, as applicable. However, with regard to the setting of the "BEAT OSC" control (18), only that providing b-f-o output for both receivers is adjusted. Also, with regard to readjustment of the "RF GAIN" control (7) of each receiver, note the meter (12) indication of signal strength for each receiver. Then readjust the "RF GAIN" control (7) of the receiver initially receiving the strongest signal, so that each meter (12) reads the same.

c. For each receiver, follow the noise suppression procedure outlined in paragraph 2-45.

**2-59. DURING USE.**

2-60. To maintain the communication link in a condition providing for optimum reception, repeat when needed the following operating procedures, as applicable.

a. Set the "SEND" "REC" switch (6, figure 1-2) to "SEND" when the operational activity is two-way, so that the transmitted signal level cannot adversely affect the receiver. Subsequent to transmission, set the switch to "REC" to provide for instant reception.

b. M-C-W RECEPTION. With the "TUNING LOCK" (13) unclamped, re-resonate the signal as outlined in step "a" of paragraph 2-28 and steps "b" and "c" of paragraph 2-30, as applicable. Do this periodically at 15-minute intervals, or at longer intervals dependent on the frequency drift noted. When noise is impairing the quality of the reception, repeat the procedures outlined in paragraph 2-31.

c. C-W RECEPTION. With the "TUNING LOCK" (13) unclamped, re-resonate the signal as outlined in step "a" of paragraph 2-35 and steps "b" and "c" of paragraph 2-37, as applicable. Do this periodically at 15-minute intervals or at longer intervals dependent on the frequency drift noted. When noise is impairing the quality of the reception, repeat the procedures outlined in paragraph 2-38. Also, reset the "BEAT OSC" control (18), if necessary, as outlined in step "c" of paragraph 2-35 or step "e" of paragraph 2-37.

d. **FREQUENCY-SHIFT RECEPTION.** With the "TUNING LOCK" (13) unclamped, re-resonate the signal as outlined in step "a" of paragraph 2-42 and steps "b" and "c" of paragraph 2-44, as applicable. Do this periodically at 15-minute intervals or at longer intervals dependent on the frequency drift noted. When noise is impairing the quality of the reception, repeat the procedures outlined in paragraph 2-45. Also, reset the "BEAT OSC" control (18), if necessary, as outlined in step "c" of paragraph 2-42 or step "e" of paragraph 2-44.

e. **SUPPRESSED CARRIER MULTICHANNEL RECEPTION.** With the "TUNING LOCK" (13) unclamped, re-resonate the signal as outlined in step "a" of paragraph 2-50 and steps "b" and "c" of paragraph 2-51, as applicable. Do this periodically at 10-minute intervals or at longer intervals dependent on the frequency drift noted. When noise is impairing the quality of the reception, repeat the procedures outlined in paragraph 2-52.

f. **M-C-W SPACE DIVERSITY RECEPTION.** With the "TUNING LOCK" (13) unclamped, re-resonate the signal received on each receiver as outlined in step "a" of paragraph 2-28 and steps "b" and "c" of paragraph 2-30, as applicable. Do this periodically at 15-minute intervals, or at longer intervals dependent on the frequency drift noted. Check to see that each receiver is contributing to the space diversity composite output by

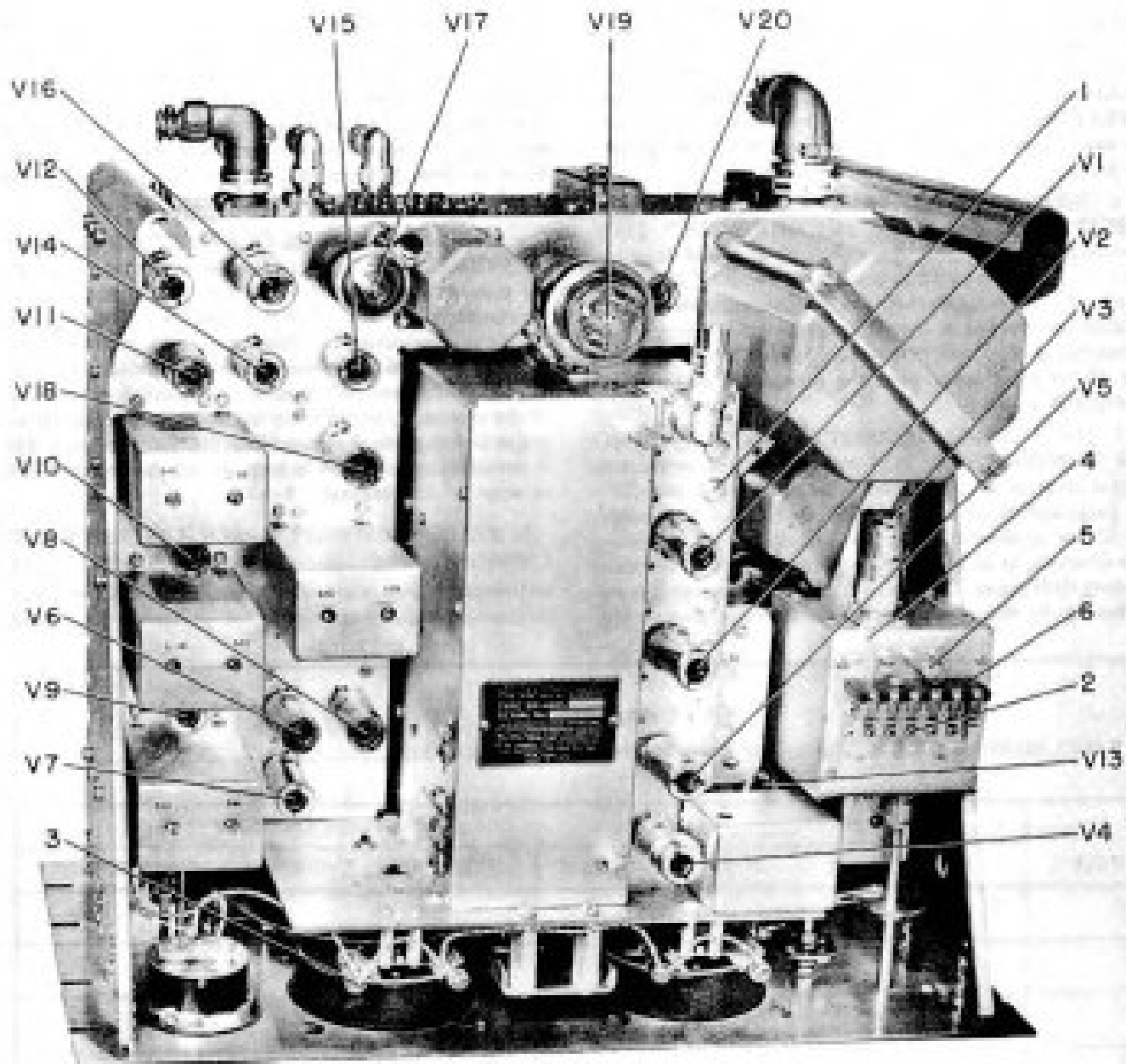
noting that the meter (12) of each receiver provides a signal indication, possibly fluctuating between wide limits. If one or more of the receiver meter indications are low or zero, back up on the "RF GAIN" control (7) of the receiver whose meter provides an indication, until all meters provide indications. To get all indications to be the same, it may be necessary to readjust the "RF GAIN" control (7) of one or more of the other receivers, as outlined in step "c" of paragraph 2-54. When noise is impairing the quality of the reception, repeat the procedures outlined in steps "a", "b", "c", and "d", of paragraph 2-31 for each receiver.

g. **C-W SPACE DIVERSITY RECEPTION.** With the "TUNING LOCK" (13) unclamped, re-resonate the signal received on each receiver as outlined in step "a" of paragraph 2-35 and steps "b" and "c" of paragraph 2-37, as applicable. Do this periodically at 15-minute intervals or at longer intervals dependent on the frequency drift noted. When noise is impairing the quality of the reception, repeat the procedures outlined in paragraph 2-38. Also, reset the "BEAT OSC" control (18), if necessary, as outlined in step "c" of paragraph 2-35 or step "e" of paragraph 2-37.

h. **FREQUENCY-SHIFT SPACE DIVERSITY RECEPTION.** With the "TUNING LOCK" (13) unclamped, re-resonate the signal received on each receiver as outlined in step "a" of paragraph 2-42 and

<b>OPERATING DATA</b>							
RADIO RECEIVER, MODEL SP-600-JX-17 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



1. Metal bottom
2. Crystal holders
3. Pilot lamps
4. Freq control unit
5. Knurled thumb screw
6. Retainer spring assy

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

steps "b" and "c" of paragraph 2-44, as applicable. Do this periodically at 15-minute intervals or at longer intervals dependent on the frequency shift noted. Check to see that each receiver is contributing to the space diversity composite output by noting that the meter (12) of each receiver provides a signal indication, possibly fluctuating between wide limits. If one receiver meter indication is low or zero, back up on the "RF GAIN" control (7) of the other receiver, until both receiver meters indicate the same. When noise is impairing the quality of the reception, repeat the procedures outlined in paragraph 2-45. Also, reset the "BEAT OSC" control (18) if necessary, as outlined in step "b" of paragraph 2-58.

#### 2-61. FOLLOWING USE.

2-62. Subsequent to the completion of the operational activity, and not unless advised to do so, do the following:

a. Turn the "RF GAIN" control (7, figure 1-2) counter-clockwise to its dial knob "OFF" position to turn the receiver "off".

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

2-63. 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.

#### 2-64. PRESENTATIONS AND READINGS.

2-65. TUNING PRESENTATION. The main tuning dial (11, figure 1-2), is to the left and the vernier dial (14) 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 (24) is used to read the frequency band scale chosen. The fixed pointer (25) is used to read the arbitrary outer scale. The vernier dial has an arbitrary 0-to-100 scale. The vernier pointer (26) 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.

2-66. METER READINGS. When the receiver is used for headset or speaker reception, the operator can determine aurally as to whether or not reception is intel-

ligible. When the receiver is used for teletypewriter or telegraph recorded copy, the operator can determine visually as to whether or not reception is intelligible. In either instance, 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 predetermined operational frequency. With the "METER" "RF" "AF" spring return switch (20, figure 1-2) in its normal "RF" position, the operator can determine the strength of the carrier received. With the switch held depressed to its "AF" position, the operator can determine the receiver audio output level to the associated phones, speaker, etc., as determined by the chosen setting of the "AUDIO GAIN" control (21). The receiver audio output available is sufficient to cope with any operational activity.

2-67. With the "AUDIO GAIN" control (21, figure 1-2) set to provide 500 milliwatts to a 600-ohm matching load connected to the "AUDIO OUTPUT" terminals (9, figure 1-3), 15 milliwatts are provided to an 8000-ohm headset connected to the "PHONES" jack (1, figure 1-2). Also, a minimum of 0.6 milliwatt of 455-kc i-f output is provided to a 70-ohm load connected to the "IF OUTPUT" connector (8, figure 1-3).

2-68. 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.

TABLE 2-1. METER DECIBEL CONVERSION CHART

DB	R-F MICROVOLTS	DB	A-F 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		

#### 2-69. PRECAUTIONS TO BE OBSERVED.

2-70. The receiver is precisely aligned and adjusted at the factory for optimum receiver performance. The metal buttons (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" and the "METER ADJ AF" screwdriver meter adjustment means (11 and 12, figure 1-3), are not operating controls, and cannot be manipulated without respectively impairing the receiver performance and the meter scale calibrations.

## 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 complement of operational spares for each receiver is complete and that each receiver is equipped with a spare 1.6 ampere and a spare three-eighths ampere fuse under the "SPARE FUSES" cover (1, figure 1-3) on 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 (22, figure 1-2) on the front panel of the receiver. The crystal frequency control unit, crystal holders (2, figure 2-2) must contain the appropriate crystals in the correct holders.

3-3. PRIOR TO OPERATION.

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

b. Check each receiver both for c-w and m-c-w reception on each band and make sure each control and switch functions mechanically, while properly performing its electrical use. Make the checks for variable frequency reception, and for fixed-frequency crystal-controlled reception at the signal frequencies for which the available crystals in the receiver are intended, provided said signals are on the air. In this connection, refer to paragraphs 2-2 thru 2-21.

c. Adjust the operating controls for each receiver used in the operational activity for the operational activity contemplated, as outlined in paragraphs 2-22 thru 2-60, 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. Each receiver in the operational activity is monitored during use to maintain the communication link and to provide for optimum reception. Even though the frequency stability of each receiver for variable frequency tuning approaches that of a crystal and the receiver is crystal-controlled for fixed-frequency reception, the communication link is also dependent on the frequency stability of the received signal. Further, the received signal may vary in strength and be subjected to atmospheric or man-made noise to impair its quality for the communication link established. The quality of the reception determines the need for monitoring each receiver. Monitor each receiver during use in accordance with the procedure outlined in paragraph 2-60, as applicable.

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. GENERAL. In an emergency, each receiver in a fixed-frequency crystal-controlled operational activity may be switched for variable frequency reception, if doing so provides for maintaining the communication link. Also, in a space diversity receiving system, one receiver may be turned "off", if defective, and the other receiver used to maintain operations. The receiving system may be such that it is set up initially so that one receiver is slave-interconnected to the other receiver designated the master receiver. When the master receiver is defective, the operational activity may possibly be maintained by reversing the receiver functions. When this is done in the instance of fixed-frequency crystal controlled reception, the frequency control unit crystal used must be associated with the master receiver. Again when an external oscillator provides the receiver heterodyne functions, but becomes defective, the use of the self-contained oscillators of each receiver provide the means to maintain continuity of service. Here each

receiver must be switched for variable frequency reception unless two frequency control unit crystals suited to the operational frequency are available. The master-slave system cannot be used unless the receivers are properly interconnected. If so, one crystal will suffice.

4-3. ANTENNA SYSTEM. The radio receiver provides for reception even when its antenna system simply comprises a short piece of insulated wire stripped at one end for connection to the "ANT" input connector (2, figure 1-3).

4-4. 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 identify 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.

**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
6C4	V4, V8, V13	V4	V8 or V13	fixed freq reception	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

## 4-5. REPLACEMENT OR REPAIRS.

**WARNING**

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

4-6. PILOT LAMPS. The four pilot lamps (3, figure 2-2) are of the bayonet type and are removed by lifting each 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 lamp, when all four do not light, make sure a-c source is plug connected to "AC POWER" plug connector (4, figure 1-3) and that the receiver is turned "on". With the receiver "RF GAIN" control (7, figure 1-2) in its "OFF" switch position to make the replacement, replace the 1.6 ampere fuse F1 contained in the "1.6A SLO FUSE" holder (13, figure 1-3), since, if F1 is defective the pilot lamps cannot light up.

4-7. ELECTRON TUBES. To remove the V17 or V19 electron tubes (figure 2-2), each tube top-hat type of clamp must first be removed. Do this by pressing inward on the top-hat spring while lifting the top-hat clamp off the tube. Then the tube may be drawn out from its tube socket. The top-hat type of clamp is replaced by seating it on the top of the tube so that the vertical bolt adjacent to it can be threaded through the hole in the top-hat spring, with pressure providing for a ratchet motion until the top hat is firmly seated in place.

4-8. To remove the V1, V2, V3, V5, V6, V7, V8, V9, V10, V11, V12, V13, V14, V15, V18, or V20 (figure 2-2) electron tube, the respective tube shield is removed first 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.

4-9. To remove the V4 electron tube (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.

4-10. Any one of the electron tube complement of the receiver may require immediate replacement to maintain the operational activity. A glass enclosed tube, when defective, may identify itself when its filament does not light up or when it does not warm up. V18, the voltage regulator tube, when defective, does not show a faint violet glow. Otherwise, replace the tubes in the following sequence. When the receiver is "dead" and the panel tuning meter (12, figure 1-2) provides no r-f indication, replace the V20 and the V19 rectifier tubes (figure 2-2), in turn. If the panel meter shows a reading, in the absence of audio output, replace the V17, V16, and V14 electron tubes 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 associated with the meter circuit, 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 the V12 electron tubes used for c-w reception; but for no meter reading, replace in turn the V11, V10, and V9 electron tubes. When 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 the operational activity provides for variable frequency reception, replace the V5 and the V4 electron tubes, in turn. For fixed-frequency crystal-controlled reception, replace the V5 and the V3 electron tubes, in turn. Next, try replacing the V2 and the V1 electron tubes, in turn.

4-11. CRYSTALS. To remove a crystal from the frequency control unit (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 from 1 thru 6 on the frequency control unit. Bring the retainer spring assembly (6) forward so that the springs are over the top of the crystals in the sockets, and tighten the knurled thumb screw (5).

4-12. Mark in megacycles on the plastic chart (22, figure 1-2), provided for this purpose, the signal frequency for which the crystal, fitted in the crystal socket, is intended. Pencil or ink may be used and can be erased to change these figures, if desired. Each numeral on the chart should be used so that it identifies the crystal fitted in the crystal socket bearing a like numeral, which also identifies the "XTALS" "1", "2", "3", "4", "5", or "6" switch (2) position providing a choice of a particular crystal, suited for a particular signal frequency.

4-13. 1.6-AMP and THREE-EIGHTHS AMPERE FUSES. To replace either the 1.6-amp or the three-eighths ampere fuses respectively located in the "1.6 A SLO" and " $\frac{3}{8}$  A" "FUSE" holders (13 and 14, 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 be pulled apart. A spare 3-amp fuse and a spare three-eighths ampere fuse are located in two of the four clips under the polystyrene "SPARE FUSES" cover (1). To replace either receiver fuse the procedure is the reverse to that outlined. When spare fuses are available other than those provided under the "SPARE FUSES" cover (1), use them, so that in an emergency those under the cover are always available.

**CAUTION**

Make sure that the fuses used are respectively designated 3-amp and three-eighths ampere and that they are properly disposed in the receiver.