

SECTION 4

RADIO SET AN/GRC-9

22. **General.**—a. Radio Set AN/GRC-9 is a combined radio transmitter and radio receiver which provides voice, continuous wave, and modulated continuous wave communication as a portable, teampack, field set. Auxiliary equipment is provided so that it may be installed and operated from a vehicle.

b. The equipment consists of Receiver-Transmitter RT-77/GRC which can be either crystal or master-oscillator controlled. The receiver-transmitter has a frequency range of 2 to 12 megacycles and is amplitude-modulated.

c. The operating voltages of the transmitter may be furnished by either a vibrator power unit for vehicular mounting or a hand generator for field operation. The operating voltages for the receiver may be furnished by the vibrator power unit, hand generator, or an external dry battery.

d. The equipment, set up for normal operation, is illustrated in Figure 24.

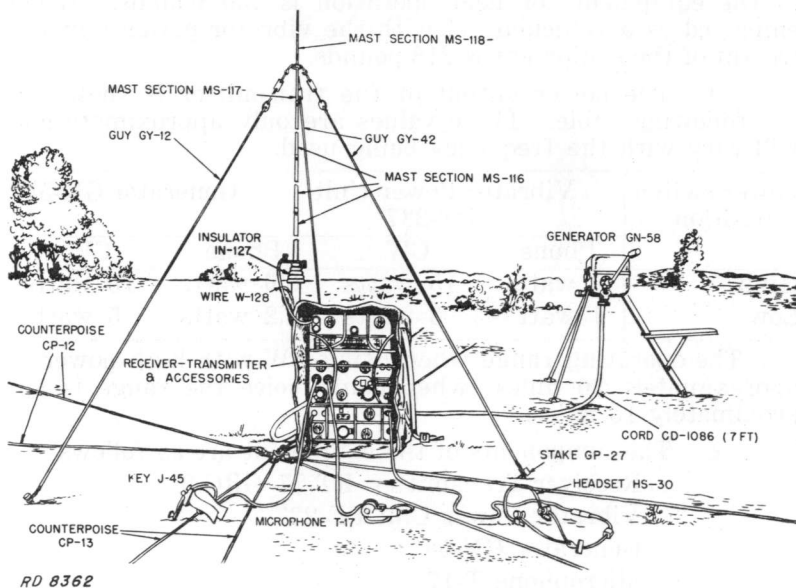


Figure 24.—Radio Set AN/GRC-9.

23. **Technical Characteristics.**—a. The frequency range of the equipment is covered in three bands as follows:

- Band 1 6.6 mc to 12 mc.
- Band 2 3.6 mc to 6.6 mc.
- Band 3 2.0 mc to 3.6 mc.

The transmitter is of the crystal or master-oscillator type. Two crystal channels for each band are provided.

b. Two types of antennas are supplied with each equipment. A 15-foot whip type antenna, consisting of five mast sections is used for vehicular or semipermanent operation. A long-wire antenna, 244.5 feet long, may also be used to increase the operating range of the equipment. When using the long-wire antenna care must be taken to ensure that the antenna is calibrated for the particular frequency being used. In semipermanent installations a half-wave doublet antenna may be used with the equipment. Although this type of antenna increases the transmission range, its use is not recommended if frequent moves must be made. A counterpoise is used to provide a more efficient ground when using the whip antenna.

c. When used as a field set the equipment is carried in canvas carrying bags by a team of four men. The total weight of the equipment for field operation is 130 pounds. When employed as a vehicular set with the vibrator power unit the weight of the equipment is 218 pounds.

d. The power output of the transmitter is shown in the following table. These values are only approximate and will vary with the frequency being used.

Power switch position	Vibrator Power Unit PE-237		Generator GN-58	
	Phone	CW	Phone	CW
High	7 watts	15 watts	3.6 watts	10 watts
Low	1 watt	5 watts	1.2 watts	5 watts

The operating range when using CW with high power is approximately 30 miles; when using voice the range is approximately 15 miles.

e. The components of the equipment are as follows:

- Receiver-Transmitter RT-77/GRC-9
- Vibrator Power Unit PE-237
- Generator GN-58
- Microphone T-17
- Microphone T-45
- Headset HS-30
- Roll BG-174 (antenna equipment)

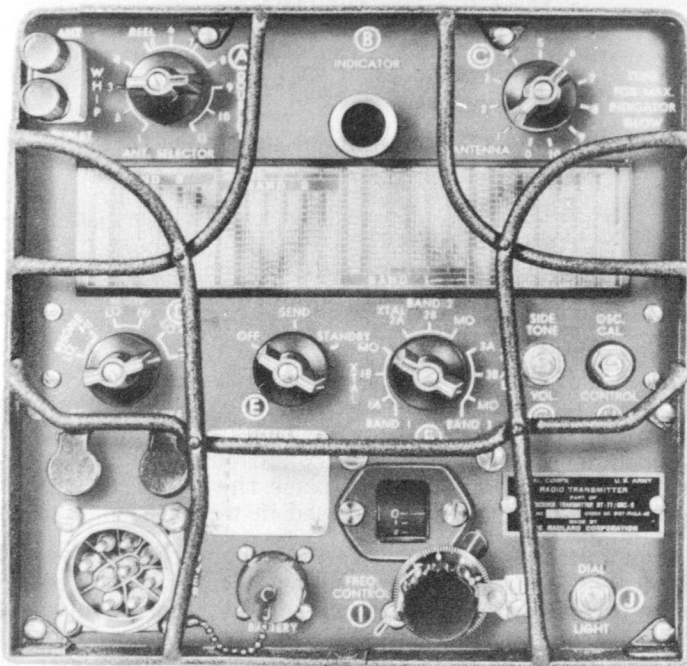
- 3 Mast Sections MS-116A
- 1 Mast Section MS-117A
- 1 Mast Section MS-118A
- Insulator IN-127
- Generator accessories
- Power cables
- Bag BG-172 (equipment accessories)
- Loudspeaker LS-7
- Key J-45
- Antenna AT-101/GRC-9
- Antenna AT-102/GRC-9
- Counterpoise CP-12 and CP-13
- Spare tubes
- Antenna bracket

f. All jacks, controls, and switches of the equipment are waterproofed for complete protection of the radio set when operating under extremely humid conditions. When the cover of the receiver-transmitter is in place the entire assembly is waterproof and will float if immersed in water.

24. Transmitter Section of Receiver-Transmitter RT-77/GRC-9.—a. On the front panel are located all the controls necessary for operation of the transmitter; these controls are protected by an open grillwork. The antenna and doublet lead-ins are attached to the binding posts in the upper left-hand corner. In the lower left-hand corner are two jacks for the insertion of the microphone and the handkey. Small covers are held against the jacks by means of springs in order to keep out dirt and moisture. The DC power input receptacle for both the transmitter and receiver are in the extreme lower left-hand corner of the transmitter. The receptacle contacts are arranged so that the power cord from either the generator or the vibrator power unit will fit in only one position. This is an assurance that correct voltages will be fed to the proper components. Although the battery supplies power only to the receiver, it is connected by cable to a receptacle on the transmitter panel. This receptacle is located to the right of the power receptacle. There is a small metal key in the battery receptacle which allows the battery cable plug to fit in only one position, as is the case with the power receptacle.

b. The large chart on the transmitter gives the numbers to which the tuning dials must be turned, in order to transmit the corresponding frequencies on the chart. There is a smaller white chart, marked CRYSTALS, on which should be marked in pencil, the frequency ranges of transmission obtained with the different crystals.

c. The controls of the transmitter are illustrated in Figure 25 and their function is described in the following chart.



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Figure 25.—Transmitter Section, RT-77/GRC-9.

Panel letter	Control	Function
A	ANT. SELECTOR dial switch	A multicontact switch which arranges the components in the output circuits of the final power amplifier so that any of the three available antennas connected will be properly tuned to resonance. Positions 1, 2, 3, and 4, match the power amplifier coil to a vertical mast or whip antenna to cover the frequency range of the transmitter. Positions 5, 6, 7, and 8 match the coil to an end-fed long-wire antenna, and positions 9, 10, and 11 match the coil to a center-fed or doublet antenna.

Panel letter	Control	Function
B	INDICATOR	<p>This control is a neon indicator bulb which is connected in the antenna matching circuit; it glows at its brightest level when the antenna is tuned to resonance with the transmitter signal. The bulb is located behind two circular Polaroid lenses; the inner one is stationary whereas the outer one can be rotated around an axis perpendicular to its center. When the two red dots are 90 degrees apart, the light emerging from the indicator bulb will not be allowed to penetrate the lenses. This system is a safety measure for blackout conditions.</p>
C	ANTENNA TUNING	<p>Adjusts the position of powdered iron cores which slide in and out of the antenna matching transformers. When the proper position of these cores is found, the antenna will be tuned for the frequency of transmission desired and the INDICATOR will glow with maximum brilliancy. Thus, the ANTENNA TUNING is rotated until the neon indicator shows the brightest glow.</p>
D	PHONE-MCW-CW control	<p>Used to select any of the three types of transmission available.</p> <p>PHONE: This position permits the transmission of voice signals, using a microphone which is inserted in the MIKE jacks.</p> <p>MCW: In this position, the radio set transmits a signal of constant frequency depending on the tuning dial position. This signal is modulated by a constant audio frequency which is generated by an audio oscillator located in the transmitter. The transmitter is keyed in the usual manner as for CW signals. This system is also called tone modulation. With this system, the radio set receiving the signal need not have a beat-frequency-oscillator to make them</p>

Panel letter	Control	Function
		audible, since they are already modulated and can be detected in the usual manner.
		CW: The signal is keyed by means of a key which is inserted in the KEY jack. CW reception requires that the station receiving the signal have a beat-frequency-oscillator. Otherwise the signal would be inaudible.
		Each of the three positions described has a HI and LO position also. In the HI position, maximum power is available for transmission, while in the LO position, the transmitter output is greatly reduced so that relatively secure operation over short distances is possible.
E	OFF-SEND- STANDBY control	Controls power input to receiver and transmitter.
		OFF: In this position, both the receiver and transmitter are not in operation. All power is completely shut off.
		SEND: This position is used when it is desired to transmit or receive signals. When the key is not depressed or the microphone push-to-talk button is not pushed, only the receiver is supplied with voltage and receives signals. As soon as the key is depressed, relays in the transmitter switch the voltage from the receiver to the transmitter. The transmitter is automatically placed in operation and sends out the desired signal.
		STANDBY: This position is used when the dry battery or the vibrator power unit is used to supply power. When the switch is turned to STANDBY, only the receiver is in operation. In this position, less power is needed to operate the set, so that during long periods of listening there will be less current drain on the battery.

Panel letter	Control	Function
F	XTAL-MO-BAND switch	This switch allows the operator to select either crystal control or master oscillator control of the transmitter on any of the three bands. The crystal portions of this control operate in conjunction with six crystal units inserted in sockets on the transmitter chassis. Each crystal operates at a particular frequency in the selected band.
G	SIDE TONE VOL.	Controls the volume of the sidetone signal heard in the headset. Must be turned with a screwdriver.
H	OSC. CAL. control	Control used in conjunction with the receiver 200-kc crystal calibrating circuit. Must be turned with a screwdriver.
I	FREQ. control	The frequency control is the tuning adjustment for selecting the transmitting frequency. Transmitting frequencies with respect to dial calibration of the drum dial and tuning knob are shown on the calibration chart fastened to the front panel of the transmitter.
J	DIAL LIGHT	This is a push-button switch which, when pressed, lights a small dial light in back of the transmitter dial.

25. Receiver Section of Receiver-Transmitter RT-77/GRC-9.—a. The front panel of the receiver contains the controls necessary for its operation and is protected by an open grillwork. There are two phone jacks allowing two Headsets HS-30 to be used simultaneously. The jacks have covers which are held tightly over the jack openings by springs. These covers protect the jacks from dirt and moisture. In the upper left-hand corner of the panel is the GND (ground) connecting post for the counterpoise lead. The counterpoise is used with the vertical antenna. The tuning knob has a device incorporated on the panel by which it may be locked at any desired dial position.

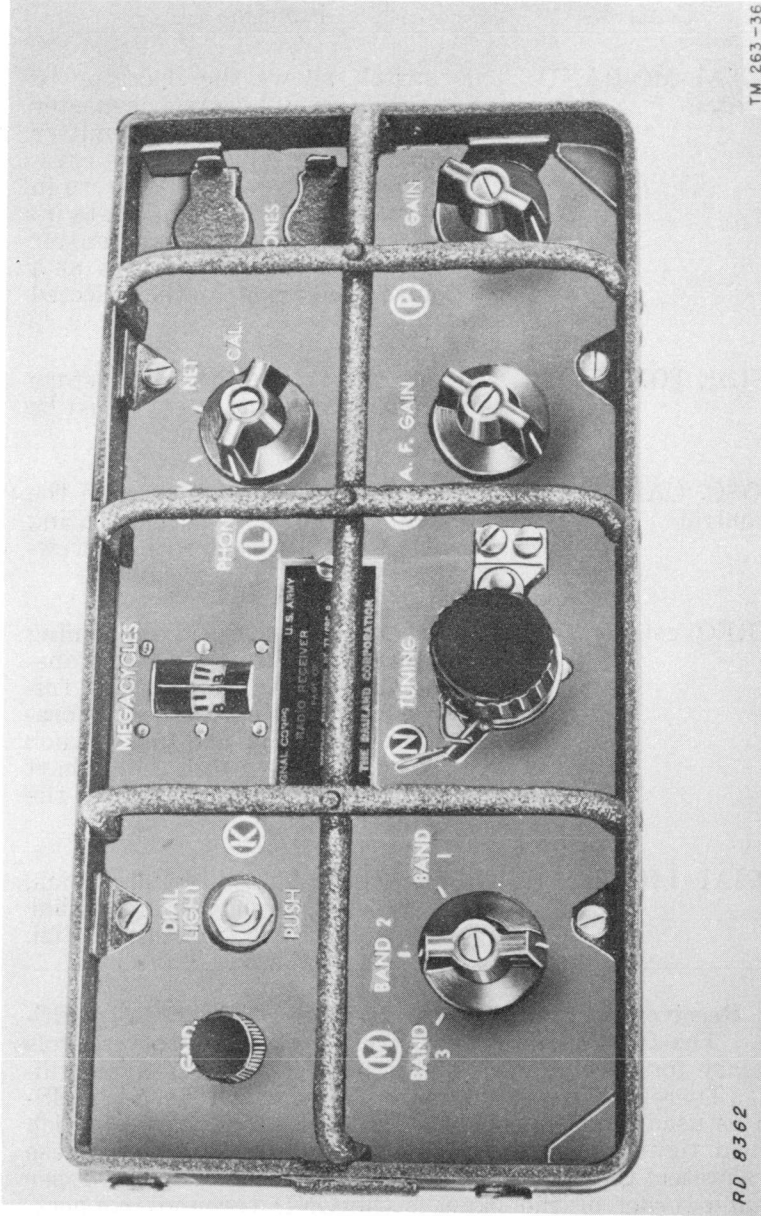


Figure 26.—Receiver Section, RT-77/GRC-9.

b. Some of the control knobs have a white line on only one side of their centers. Knobs with one white line cannot be turned continuously in one direction, but upon reaching the stop position, they must be rotated back in the opposite direction. Knobs having two white lines indicate that the controls can be rotated in either direction continuously without having to stop. A knob with one white line must never be forced beyond the stop position or it will break.

c. The controls for the receiver are illustrated in Figure 26 and their functions are described in the following chart.

Panel letter	Control	Function
K	DIAL LIGHT PUSH	This is a push-button switch which, when pressed, lights a small panel light in back of the receiver dial, illuminating it.
L	PHONE-CW- NET-CAL. switch	The function of this switch is to select the type of operation desired and to check the dial calibration of the receiver.
		PHONE: This position allows the reception of voice signals or MCW signals. The output is heard in the headset or the loudspeaker, either of which may be plugged into one of the two jacks marked PHONES.
		CW: When placed on this position, CW signals can be received.
		NET: On NET position, it is possible to tune the transmitter to the frequency of any station with which it is desired to hold communication. Also, once the receiver dial calibration is known to be accurate, the transmitter-oscillator frequency can be adjusted by matching it with the receiver dial calibration. In the NET position, the gain of the receiver is greatly reduced.
		CAL: A crystal-oscillator circuit in the receiver permits the dial calibration of the receiver. Frequency check points are available over the entire band at every 200 kc.

Panel letter	Control	Function
M	BAND 3 - BAND 2 - BAND 1 switch	<p>This switch permits the selection of any of the three frequency bands available.</p> <p>BAND 3 is the lowest frequency range while BAND 1 is the highest. As the band switch is turned from one band to another, a mechanically coupled mask operates to cover the dial calibration of the unused frequency bands.</p>
N	TUNING capacitor	<p>This knob tunes the radio receiver circuits and controls the operation of the calibrated dial which is viewed through the dial window. There are three dial scales.</p> <p>The lower scale on the dial is BAND 3 which covers the frequency range of 2.0 mc to 3.6 mc, with dial marks at each 20 kc.</p> <p>The middle scale on the dial is BAND 2, which covers the frequency range of 3.6 mc to 6.6 mc with dial marks at every 20 kc.</p> <p>The top scale is BAND 1 which covers the frequency range of 6.6 to 12.0 mc with dial marks at every 50 kc.</p> <p>A shutter exposes the portion of the dial being used by a mechanical connection to the band switch. A dial lock on the tuning knob allows the dial to be locked in a fixed position once it is set on the desired frequency.</p>
O	AF GAIN	<p>This is a volume control which varies the strength of the audio signal delivered to either the headset or the loudspeaker. The volume will be at a minimum when this control is rotated to its farthest counterclockwise position.</p>
P	RF GAIN	<p>This control varies the DC voltage on the screen grid of the first RF amplifier, thus controlling the gain of this stage to prevent overloading of the following stages on strong signals.</p>

Panel letter	Control	Function
	IMPEDANCE switch	This switch is found in the back of the receiver and is used to match the output circuit of the receiver to the headsets or to the loudspeaker. Output loads of either 250 or 4,000 ohms impedance can be matched. The switch is placed at 4,000 ohms for Loudspeaker LS-7.

26. **Vibrator Power Unit PE-237.**—a. The vibrator power unit is a vehicular operational component capable of supplying all voltage required for Receiver-Transmitter RT-77/GRC-9. It consists of two independent power supply systems: A heavy duty unit for supplying power to the receiver and transmitter for normal two-way communication, and a small unit for supplying only receiver voltage during long periods of listening. Input voltage to the vibrator unit may be 6, 12, or 24 volts, with the negative (-) grounded. A switch provided inside the cover of this unit allows the operator to change all internal connections simultaneously to correspond with the voltage of the vehicular battery. This switch is marked VOLTAGE CHANGE SWITCH. The vibrator power unit is illustrated in Figure 27.

b. A window in the side of the case permits observation of a drum on the switch, indicating the voltage for which the switch is set. The ON-OFF switch, in addition to serving as a means of starting and stopping the unit, is a circuit breaker that will open the battery input circuit when an overload is present; it is reset by pressing the ON button. The case of the unit is watertight in case of submersion. The entire unit is supported on four shockmounts through which bolts can be passed to secure it to the vehicle.

c. The vibrator output receptacle is located on the left of the front side of the unit. The contacts of the receptacle are arranged in a definite pattern so that the cable plug which fits into it will be in the correct position. Two heavy rubber covered cables emerge from outlets marked + and -. These are used to connect the vehicular battery to the vibrator power supply unit.

27. **Generator GN-58.**—a. Generator GN-58 is a hand-operated unit designed to supply power to the receiver and transmitter of the radio set when a vehicular battery is not available, as in portable field use. The generator may be used in connection with a Battery BA-48 or it may be used alone.



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Figure 27.—Vibrator Power Unit PE-237.

b. When using the generator alone to furnish power to the radio set, the generator operator must turn the hand cranks continually in order to receive or transmit. If the generator is used in conjunction with the dry battery, the power to the receiver is furnished by the dry battery and it is not necessary to crank the generator except when transmitting.

c. The generator must be cranked at 50 to 60 rpm in order to furnish necessary power. When using the generator, the transmitter output is not as great as when the vibrator power unit is used. A canvas carrying bag is provided for carrying the generator while the accessories, such as the seat, legs, and crank handles, are carried in the antenna equipment roll.

28. **Antenna Components.**—a. Antenna AT-101/GRC-9 is a straight stranded copper wire, 107½ feet long, sectionalized by means of eight ceramic insulators and sets of jumpers. It



Figure 28.—Generator GN-58.

may be adjusted to any required frequency between the ranges of 4,300 and 12,000 kc by opening and closing these jumpers as indicated on the calibration chart attached to the antenna.

b. Antenna AT-102/GRC-9 is a similar type of antenna which is sectionalized by eight ceramic insulators and eight sets of jumpers. It is added to Antenna AT-101/GRC-9 so that the frequency range can be extended to cover the frequencies between 2,000 and 4,300 kc. Both antennas are supplied with rope and an insulator at one end to secure the antenna between such supports as trees, buildings, or fence posts.

c. The whip antenna consists of five sections of metal tubing. These sections are screwed together to form the whip antenna and can be used as a vehicular antenna or for portable field use. As a vehicular antenna, it is screwed into a mast base that is installed permanently on the vehicle and requires no further support. When used as a portable antenna, it fits into an insulator which is fastened to the case of the receiver-transmitter by means of a bracket. The whip antenna is then further supported by the use of guys and ground stakes. A short length of wire connects the whip antenna mast to the post marked ANT. on the transmitter panel.

d. When Receiver-Transmitter RT-77/GRC-9 is used as a portable unit with the whip antenna, Counterpoises CP-12 and CP-13 are fitted together forming a radial network of eight wires and placed on the ground beneath the whip antenna. They are used to act as a more efficient ground and are made up of heavy flexible, rubber-covered wires.

29. Selection of Antenna Equipment for Field Operation.—

a. Most satisfactory performance will be obtained with the selection of the proper antenna. When determining which type antenna to use, the following factors should be considered:

(1) When a permanent or semipermanent installation can be made, the long-wire antenna should be used. It will transmit farther and receive weak signals more satisfactorily than the whip antenna.

(2) However, when the equipment must be moved rapidly and frequently from one location to another or is used as a vehicular installation, the vertical mast antenna must be used.

b. The advantages of the vertical antenna are:

(1) It can be set up or taken down quickly.

(2) It will permit satisfactory transmission and reception over short distances.

(3) The space required for installation is small.

(4) The presence of tall objects for support is not required.

(5) It permits transmission equally well in all directions.

(6) The antenna can be quickly tuned from one end of the frequency band to the other.

c. The principal disadvantage of the vertical mast antenna is that it is not highly efficient for distances in excess of 25 miles, as compared to the long-wire antenna.

d. The principal advantage of the long-wire antenna is its transmission efficiency. When properly installed, it will permit satisfactory transmission and reception over comparatively long distances.

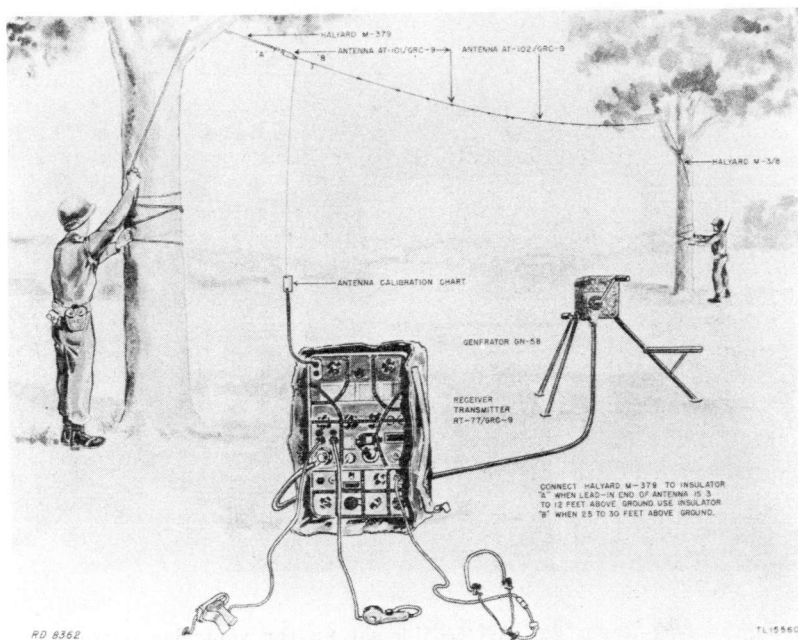


Figure 29.—Installation of long-wire Antennas AT-101/GRC-9 and AT-102/GRC-9.

e. The principal disadvantages of the long-wire antenna are:

- (1) It requires tall objects for support.
- (2) The antenna length must be changed if the frequency is to be shifted appreciably (more than 200 kc).
- (3) The direction of maximum transmission with respect to the orientation of the antenna will depend on the length of the antenna.

30. Installation of Antennas.—a. (1) In selecting a position where the long-wire antenna is to be used, an open area with two upright supports for the antenna, such as trees, must be found. A minimum length of 250 feet is required to allow for the full length of the antenna at the low frequencies.

(2) Connect Antennas AT-101/GRC-9 and AT-102/GRC-9 together and close the antenna jumpers as shown on the antenna calibration chart furnished with the set. Since the antenna length, for the best transmission and reception, is directly dependent on the frequency of the signal, it is necessary to adjust the antenna length to the frequency at which the transmitter is to be operated. The calibration chart, showing the length of the antenna required for the various frequencies, indicates which jumpers must be opened and closed for the frequencies.

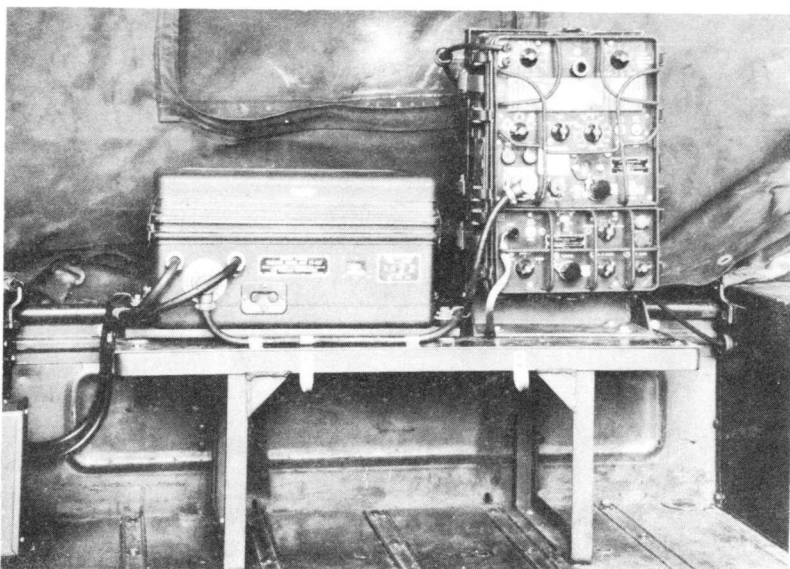


Figure 30.—Radio Set AN/GRC-9 set up for vehicular operation.

b. When the whip antenna is to be used for field operation, place the radio set in an area free of large obstructions such as trees, buildings, and power lines. Figure 24 illustrates the radio set being used with the whip antenna.

c. For vehicular installations, the mast sections are screwed into the mast base mounted on the vehicle. Care must be taken to keep the vehicle away from trees, buildings, and areas that will affect the operating efficiency of the equipment. Figure 30 illustrates the radio set and vibrator power pack mounted for vehicular operation.

31. Connections for Operation.—The cording diagram, Figure 31, illustrates the connections necessary to place the equipment in operation. The illustration shows all types of power supplies available. It should be remembered that the use of both the hand generator and the external dry battery at the same time is not necessary for operation of the radio set, although the use of both items will reduce the work of the generator operator. If the vibrator power unit is being used, neither the hand generator nor the external battery is needed.

32. Receiver Operation with Vibrator Power Unit.—a. When using the vibrator power unit, to place the receiver in operation first check the voltage of the storage battery to be used. If the voltage does not agree with that shown on the

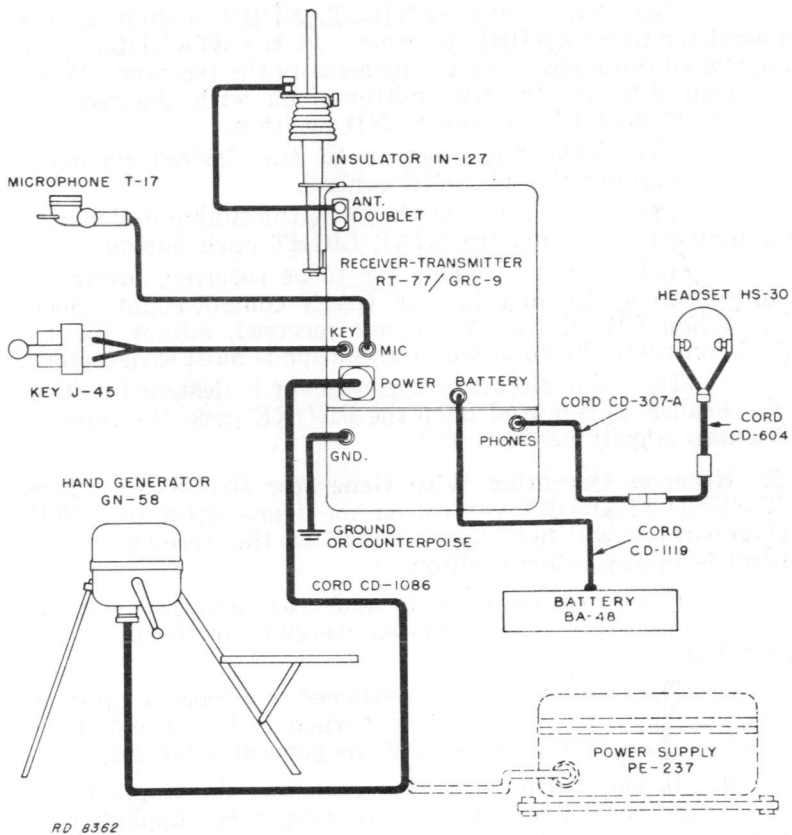


Figure 31.—Radio Set AN/GRC-9, cording diagram.

drum dial as viewed through the window on the side of the vibrator case, remove the top cover of the vibrator power unit and pull up the knob of the voltage change switch. Set the pointer to the correct voltage and reinstall the top cover.

b. The following steps should be followed:

- (1) Place the PHONE-CW-NET-CAL switch at PHONE or CW depending on the type of transmission to be received.
- (2) Set the band switch for the frequency band to be used.
- (3) Turn the AF GAIN and RF GAIN controls fully clockwise.
- (4) Connect the headphones or the loudspeaker into one of the PHONE jacks.
- (5) Press the ON button on the vibrator power unit.

(6) Turn OFF-SEND-STANDBY switch of the transmitter to STANDBY position. In the STANDBY position, the vibrator power unit supplies only the receiver. When it is desired to use the transmitter along with the receiver, the control should be at the SEND position.

(7) Tune the receiver to the desired incoming signal by turning the TUNING control.

(8) If operating in the dark, the tuning dial may be illuminated by pressing the DIAL LIGHT push button.

(9) If voice signals are to be received, lower the volume level by turning the AF GAIN control counterclockwise. When CW signals are being received, adjust the RF GAIN control to the point where reception is most satisfactory.

(10) The circuit of the receiver is designed so that if the headset is removed from the PHONE jack, the receiver will automatically be shut off.

33. Receiver Operation With Generator GN-58.—a. Turn OFF-SEND-STANDBY control on the transmitter to SEND. The generator will not supply power to the receiver if the control is in any other position.

b. Except for steps (5) and (6) above, the operation of the receiver is the same as described in the preceding paragraph.

c. The generator should be turned at a speed of approximately 60 rpm, and it should be turned in the direction indicated by the arrow on the side of the generator housing.

d. If the turning of the generator is stopped, the receiver and the transmitter will no longer be supplied with power.

34. Receiver Operation With Battery BA-48.—The battery will supply power to the receiver only and not to the transmitter. For this operation the following steps should be carried out:

a. Connect the battery to the receptacle on the transmitter panel.

b. Turn OFF-SEND-STANDBY control on the transmitter to the STANDBY position. The battery will not supply power in any other position of this switch.

c. Except for steps (5) and (6), the operation of the receiver is the same as described in Paragraph 32.

35. Receiver Operation With Generator GN-58 and Battery BA-48.—a. The radio set can be used with this combination, making it necessary to turn the cranks of the generator only when transmitting since the battery will operate the receiver. The generator will not supply any power to the receiver in this type of operation.

b. The OFF-SEND-STANDBY control must be on STANDBY for this type of operation.

c. The operation of the receiver will be the same as that described above, except that the generator must be cranked when transmitting.

36. Receiver Calibration.—a. This operation is a means to check whether the dial reading for the tuning control actually gives the true frequency to which the receiver is tuned.

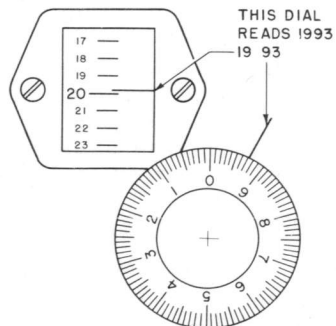
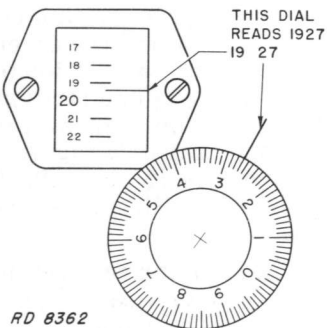
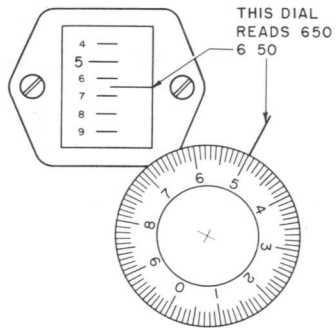
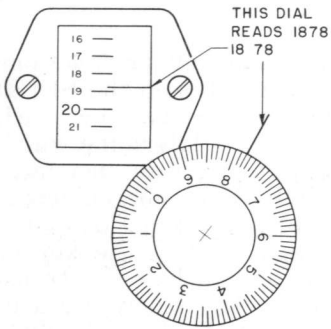
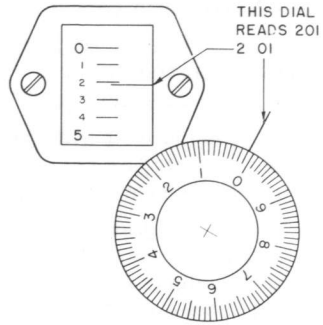
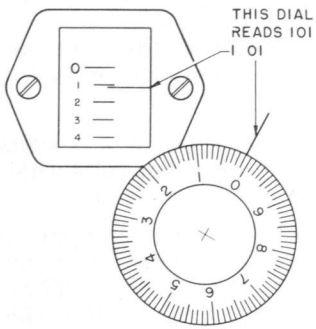
b. A 200 kc crystal installed in the receiver supplies a series of crystal-controlled check frequencies against which to check the calibration of the receiver and transmitter. These check frequencies are all harmonics of 200 kc. The calibration check points are 2,000 kc, 2,200 kc, 2,400 kc, and up to 12 mc, thus covering the entire band of the radio set. The radio operator should be familiar with the instructions contained in the technical manuals issued with each equipment prior to checking the calibration of the radio set.

37. Transmitter Operation.—a. The transmitter functions only when the OFF-SEND-STANDBY control is on the SEND position. In this position, the receiver also may be used. Special circuits and relays in the transmitter determine which section of the receiver-transmitter will be placed in operation. When the key or the press-to-talk switch on the microphone is not depressed, the receiver automatically functions and receives all signals to which it is tuned. When the key or microphone switch is closed, power is supplied to the transmitter and removed from the receiver. The receiver ceases to function while the transmitter sends out the desired signal. Before the operations of the transmitter are described, the use of the transmitter dial and dial charts should be understood.

b. The tuning dial control consists of two graduated scales; one scale is located behind a glass window and the other scale is marked around the edge of the tuning control knob. The numbers on both of these scales are taken as one reading and they determine the frequency to which the transmitter is tuned. The numbers are not the actual transmitting frequencies but are related to these frequencies by the chart on the transmitter panel. Several dial settings with the corresponding dial readings are shown in Figure 32.

c. On the transmitter panel is a dial reading calibration chart, which relates the different frequencies of transmission to the dial settings. This chart will not be the same on the different models of the transmitter. Each individual set must be tuned by the chart on its panel.

d. The oscillator section of the transmitter may be either crystal-controlled or controlled by a self-sustaining oscillator called a **master oscillator**. The master oscillator can



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Figure 32.—Transmitter dial readings.

tune over the entire band, while the transmission frequencies with the crystal oscillator are fixed. The crystal oscillator is more stable however, and should be used when there is no necessity of changing rapidly from one frequency to another.

e. Positions have been provided for the installation of a total of six crystal units on the transmitter chassis. In crystal operation, only six frequencies of transmission are possible depending on the crystals inserted.

f. A frequency doubler circuit is incorporated in the transmitter; because of this, the transmission frequency will be twice the natural frequency of the crystal. Therefore, if it is desired to transmit on a frequency of approximately 3,000 kc in BAND 3, a crystal with a natural frequency of 1,500 kc should be installed in the appropriate socket. Two crystal oscillator frequencies are available for each of the three bands. Either of the crystals in any one band may be inserted in either of the two sockets available for that band. The 1,500 kc crystal should be inserted in either socket 3A or 3B. The transmitted frequency (2x crystal frequency) with the corresponding dial setting for each of the six crystals, should be written on the small white chart on the transmitter panel.

(1) For crystal operation of the transmitter, first connect antenna, key, microphone, power cables, and headset to the receiver-transmitter. Determine the type of operation desired, PHONE, MCW, or CW, and set the switch accordingly. Either low or high power may be used depending upon the distance to be covered.

(2) The BAND switch should be set to the XTAL position for the frequency band selected. Adjust the FREQ CONTROL to the proper dial setting as indicated on the crystal chart, on which the transmission frequency with corresponding dial setting is recorded.

(3) The ANT SELECTOR control should be turned to the highest numbered position for the type of antenna being used and the outer barrel of the INDICATOR turned clockwise until the two red dots on the side of the barrel are in line.

(4) Turn the OFF-SEND-STANDBY switch to SEND or STANDBY depending on the type of power supply being used. Turn the PHONE-CW-NET-CAL control on the receiver to either PHONE or CW position.

(5) The button on the microphone should be depressed or the key closed and the ANTENNA TUNING control rotated until the indicator reaches its maximum glow. This tunes the antenna to the frequency being used.

(6) The SIDE TONE VOL control may then be adjusted for the desired volume. The transmitter is now ready for operation.

g. To transmit using the master oscillator, the same procedure as outlined above should be carried out with the following exceptions:

(1) Turn the BAND switch to the MO position of the band being used instead of to a XTAL position.

(2) The FREQ CONTROL knob is then adjusted to correspond with the transmitting frequency as shown on the calibration chart.

h. For any type of transmission or reception, the stopping procedure for the transmitter and receiver is exactly the same.

(1) Turn the OFF-SEND-STANDBY switch to the OFF position.

(2) Stop cranking the hand generator or press the OFF switch on vibrator power unit, whichever is being used.