

UNCLASSIFIED

TECHNICAL MANUAL  
FOR  
ANTENNA SET AN/FRA-109

DEPARTMENT OF THE NAVY  
ELECTRONIC SYSTEMS COMMAND

UNCLASSIFIED

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SECTION 1  
GENERAL INFORMATION

1-1. GENERAL.

1-2. This manual contains operating and maintenance instructions for the Antenna Set, AN/FRA-109 (Granger Associates Model 788-3), manufactured by Granger Associates, Palo Alto, California. The antenna set is shown in figure 1-1. This manual is divided into six sections. Section 1 presents general information describing the equipment, electrical performance, and physical characteristics of the antenna set. Section 2 contains instructions for unpacking, siting, installation, and cabling. Section 3 defines procedures for normal and emergency operation. The controls and indicators are also described. Section 4 presents functional descriptions of the equipment and provides background information required by maintenance personnel to troubleshoot equipment malfunctions. Section 5 defines preventive maintenance and repair procedures. Section 6 is a list of replaceable parts.

1-3. EQUIPMENT IDENTIFICATION.

1-4. The antenna set is an omnidirectional or a selectively directional high-power HF transmitting antenna capable of handling input power of 300 kw average and 1200 kw instantaneous peak throughout a frequency range of 4 MHz to 30 MHz. The antenna set is divided into two separate monopole antennas and auxiliary equipment which covers the frequency band. One monopole antenna covers the 4 MHz to 11 MHz range while the second monopole antenna covers the 11 MHz to 30 MHz range. Each monopole antenna is surrounded by 16 equally spaced pneumatically controlled reflectors which direct the transmitted signal into a wide or narrow beam in any of eight compass bearings (N, NE, E, SE, S, SW, W, NW). When all the reflectors are unpressurized, the selected monopole radiates omnidirectionally. Control of the antenna set is achieved from a control panel located in the transmitter building. An interlock circuit protects the transmitter and the antenna set from damage due to arcing or malfunction. A gate interlock circuit, on the fence gates, protects personnel from serious injury or death caused by the presence of high voltages and intense RF fields near the antenna. This interlock circuit automatically disables the transmitter if the gate of the active antenna is opened while transmitting.

1-5. Table 1-1 lists the equipment which is supplied to make up the antenna system. Table 1-2 lists additional equipment required for installation but not supplied and table 1-3 lists test equipment required to perform initial and periodic checks of the system.

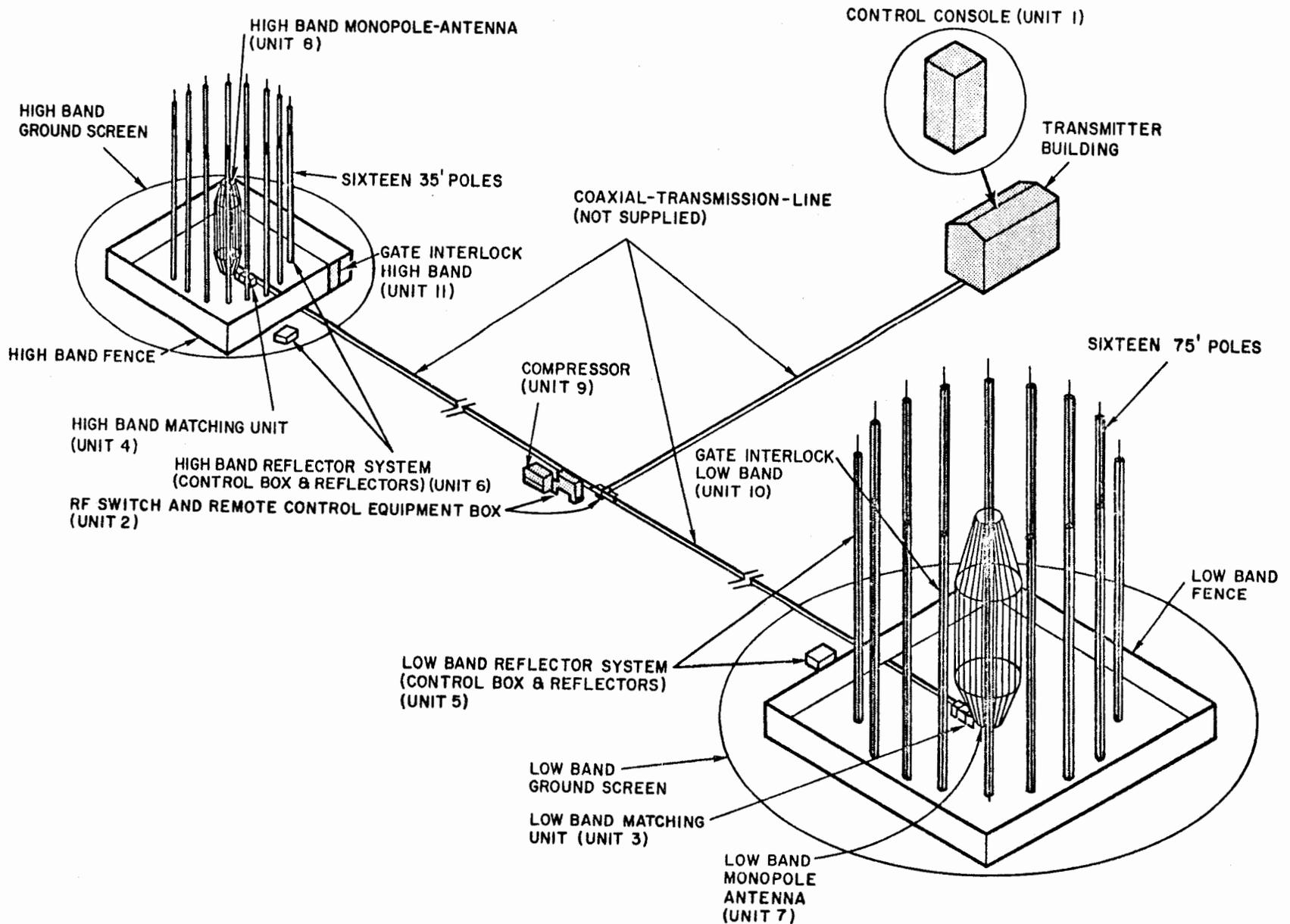


Figure 1-1. Antenna Set, AN/FRA-109.

1-6. SPECIFICATIONS.

1-7. Table 1-4 summarizes system specifications and capabilities.

1-8. DESCRIPTION OF EQUIPMENT.

1-9. The following paragraphs describe the antenna set and its corresponding components. A simplified block diagram of the antenna set is shown in figure 1-2.

1-10. CONTROL CONSOLE (UNIT 1).

1-11. The control console, shown in figure 1-3, is located near the transmitter in the transmitter building and consists of a control panel which houses the switches, indicators, and associated circuits that control the antennas. The control panel, shown in figure 1-4, is arranged into three functional groupings: FREQUENCY control assembly, DIRECTION control assembly, and STATUS AND CONTROL assembly.

1-12. FREQUENCY CONTROL ASSEMBLY. The FREQUENCY controls are arranged into two groups of pushbuttons labeled BAND-MHz and CHANNEL MHz. The BAND-MHz group selects the band: either low band (4-11 MHz) or high band (11 to 30 MHz). The CHANNEL MHz group divides each of these bands into ten smaller frequency channels as designated on each pushbutton. When a BAND MHz or a CHANNEL MHz button is pressed, stepping switches and relays are programmed in the actuating and sensing unit to prepare for a change in antenna configuration. The desired frequency in band changes are carried out only when the ANTENNA CHANGE/TRANSMIT key switch, located in the STATUS AND CONTROL group, is in the ANTENNA CHANGE position and the START button (located in the DIRECTION group) is depressed. The indicators, however, show the system's condition continuously. A LAMP TEST toggle switch is provided for testing of the lamps in the FREQUENCY group.

1-13. DIRECTION CONTROL ASSEMBLY. The DIRECTION controls are arranged into three groups of pushbuttons. The first group of pushbuttons selects the type of beam to be used (NARROW, WIDE, or OMNI). A second group of nine pushbuttons selects the direction toward which the beam will be aimed (N, NE, etc.), including omnidirectional. The third group consists of one pushbutton labeled START. The upper half of the START button is marked TUNE, the lower half of the button is marked STEER. Pressing the START button effects the changes at the antenna site that have been set up on the control panels. Before the START button is pressed, the frequency and direction control buttons have only been setting up the control components in the actuating and sensing assembly in the equipment box near the tee of the transmission line. No actual changes at the antenna itself, except for the rf switch, have taken place. This gives the operator an opportunity to review what will become the final condition of the system and to correct any errors without causing unnecessary motions of the antenna mechanisms. When a beamwidth or a direction

pushbutton is pressed, switches and relays are programmed in the actuating and sensing unit to prepare for a change in antenna configuration. When the START button is pressed, the frequency and direction commands which have been programmed are carried out at the antenna site. The desired configuration changes are carried out only when the ANTENNA CHANGE/TRANSMIT key switch, located in the STATUS AND CONTROL assembly, is in the ANTENNA CHANGE position. The indicators continuously show the system's condition. A LAMP TEST switch is provided for testing of the lamps in the DIRECTION group.

1-14. STATUS AND CONTROL ASSEMBLY. The STATUS AND CONTROL assembly provides the control voltage ( 48 vdc) for the control panel, and is used for antenna interlocking, arc protection, personnel protection, and selection of the air compressor to be used, when necessary.

Table 1-1. Equipment Supplied.

Qty per Equip.	Nomenclature	Over -all Dimensions			Unit No.	Weight
		Height	Width	Depth		
1	Control Console	69"	23"	33"	1	
1	Coaxial RF Switch & Remote Equipment Box					
	Remote Equipment Box	48"	30"	12"	2	
	Coaxial RF Switch	8.125"	13.625"	18.50"		
1	Low Band Matching Unit				3	
1	High Band Matching Unit				4	
1	Low Band Reflector System				5	
	(a) 16 Reflectors	69'	--	--		
	(b) 1 Control Box	35.76"	12"	25.76"		
1	High Band Reflector System				6	
	(a) 16 Reflectors	25'	--	--		
	(b) 1 Control Box	35.76"	12"	25.76"		
1	Low Band Monopole	52'11"		--	7	
1	High Band Monopole	19.17'		--	8	
1	Low Band Fence	89'	89'	6'	--	
1	High Band Fence	38'	38'	6'	--	
1	Air Compressor				9	
1	Low Band Ground Screen		246' diameter		--	
1	High Band Ground Screen		90' diameter		--	
1	Maintenance Standards Book for Antenna Set AN/FRA-109	11"	8.5"	--	--	
1	Technical Manual for Antenna Set, AN/FRA-109	11"	8.5"	--	--	

Table 1-2. Equipment Required but not Supplied.

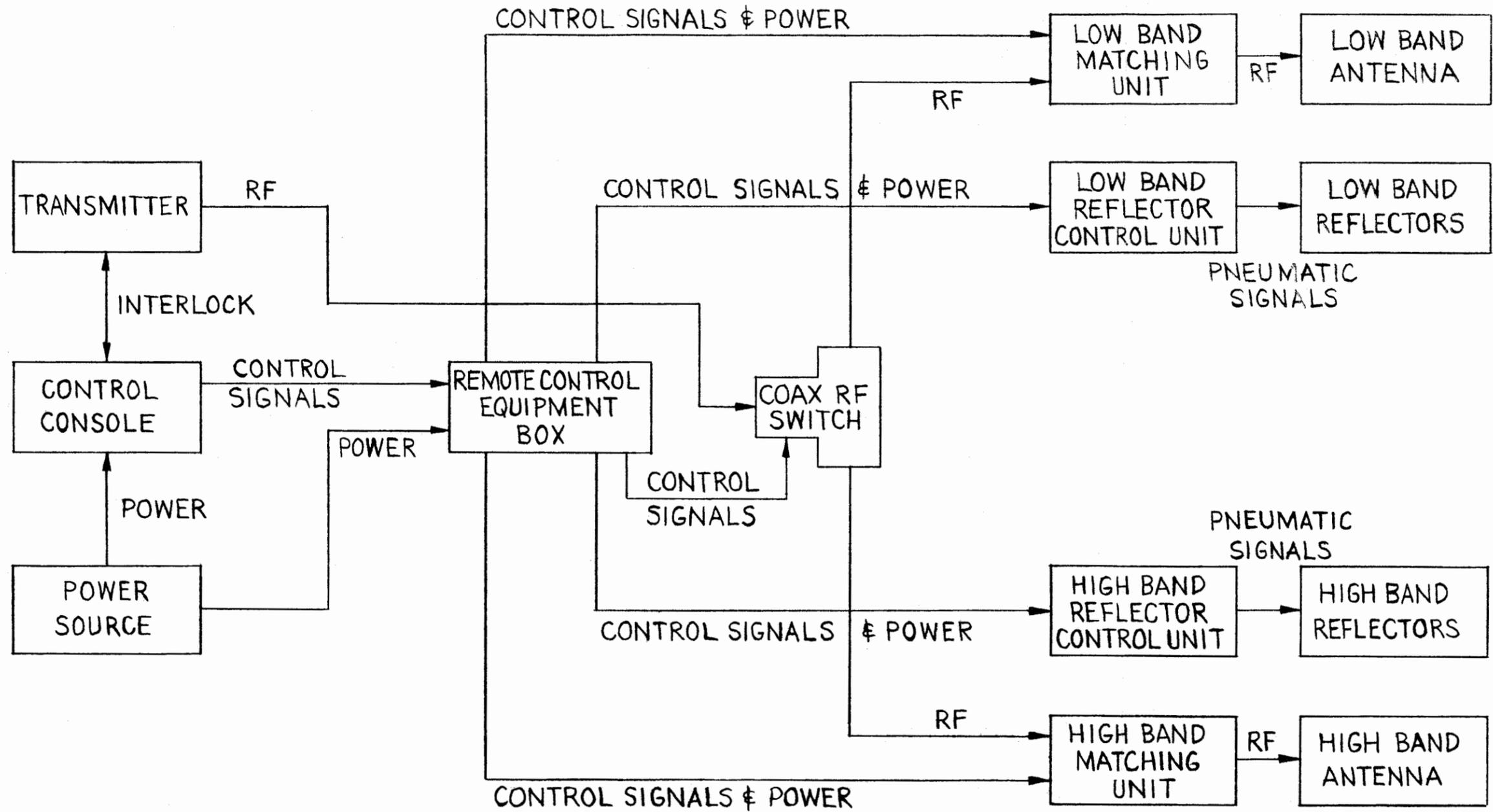
Item No.	Description
1	Crane or other means for hoisting low band tower
2	Concrete
3	Sand
4	Gravel
5	Reinforcing Bars (#4, #5, #6)
6	Wood Forms
7	Air Dehydrator (Inside transmitter building)
8	Power and Control Cables
9	Cable Markers
10	Coaxial Transmission Line (6 1/8")

Table 1-3. Test Equipment Required but Not Supplied.

Qty per Equip.	Nomenclature		Required Use	Characteristics
	Name	Designation		
1	High Frequency Receiver	Collins 51J4 or equivalent	Maintenance Troubleshooting	
1	High Frequency Signal Generator	Hewlett-Packard 606A or equivalent	Maintenance Troubleshooting	
1	High Frequency Impedance Bridge	General Radio 1606A or equivalent	Maintenance Troubleshooting	
1	Multimeter	AN/PSM4C Simpson 630 or equivalent	Maintenance Troubleshooting	
1	Dynamometer	Dillon (0-2500) or equivalent	Maintenance	
1	Oil Test Set	General Electric 9T11Y8454 or equivalent	Maintenance Troubleshooting	
1	6-1/8" to 3-1/8" EIA Flange both ends	Andrew type 1872 or equivalent	Maintenance	
1	3-1/8" to 1-5/8" EIA Flange both ends.	Dielectric Prod. 370-60 or equivalent	Maintenance	

Table 1-4. Specifications

Function	Description
Frequency Range	4 to 30 MHz in two bands, (4 to 11 MHz and 11 to 30 MHz)
Polarization	Vertical
Omni Mode, Directive Gain	Not less than 4.5 db above an isotropic radiator
Wide (180 degree) Mode, Directive Gain	Not less than 8.5 db above an isotropic radiator
Narrow (45 degree) Mode, Directive Gain	Not less than 9.5 db above an isotropic radiator
Power Handling Capability	1200 kw Instantaneous peak envelope power, 300 kw average
Nominal Antenna Input Impedance	50 ohms (Unbalanced to ground)
VSWR	2.0:1 or less with respect to 50 ohms throughout the frequency range
Configuration Change Time	2 minutes maximum
Power Requirements	120 and 240/480 VAC $\pm 10\%$ , single phase, 50/60 cycles, 15.0 amperes, maximum current draw
Minimum Area	Low Band Monopole, 123-foot radius High Band Monopole, 45-foot radius Control Equipment, 10' x 10' (approx.)
Environment	125 mph wind (km/hr) with no ice 90 mph wind (km/hr) with 1/2-inch (1.27 cm) of radial ice
Operating Temperature	-54 to +65 degree C.



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Figure 1-2. Antenna Set AN/FRA-109,  
Simplified Block Diagram.

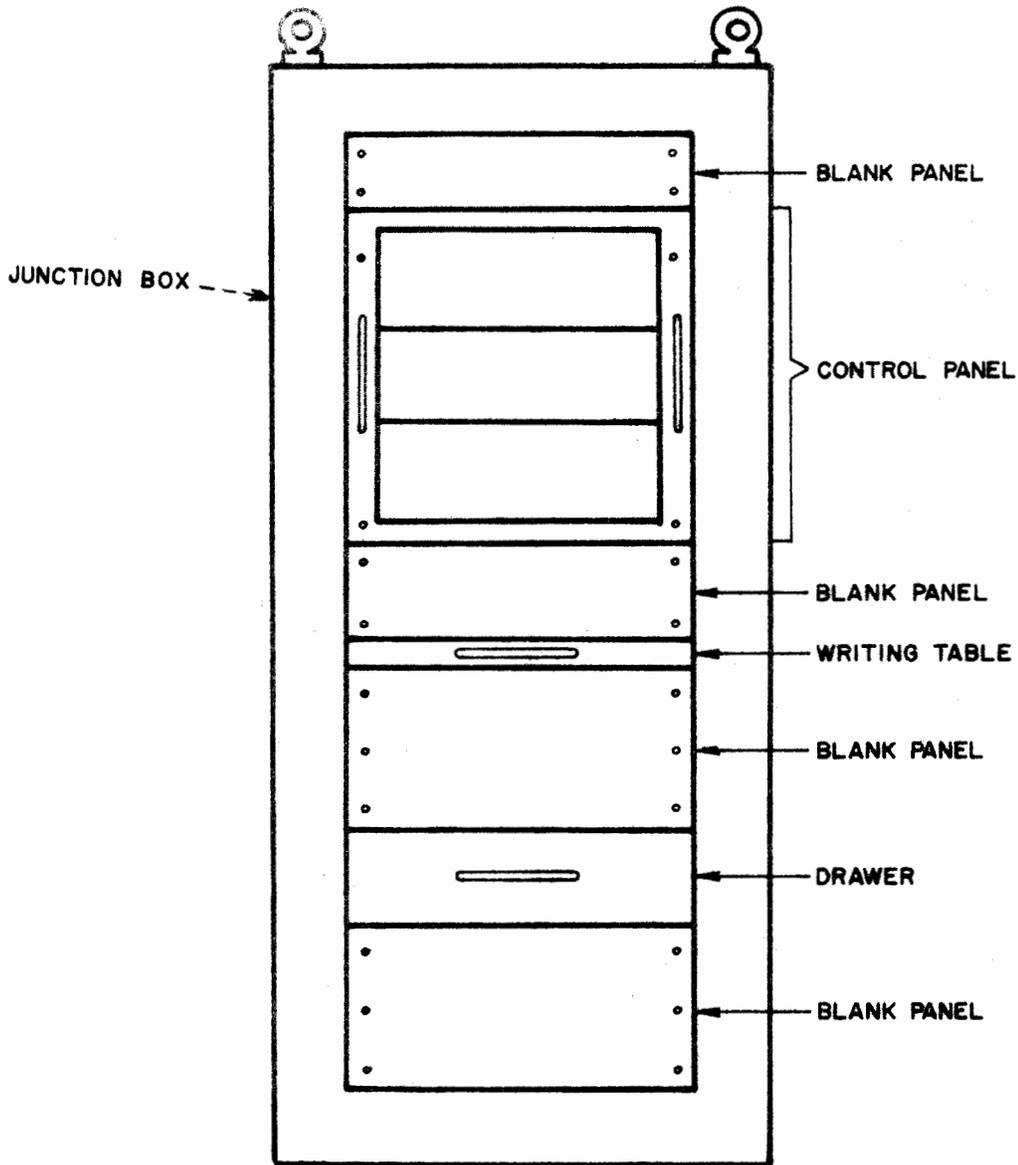


Figure 1-3. Control Console (Unit 1).

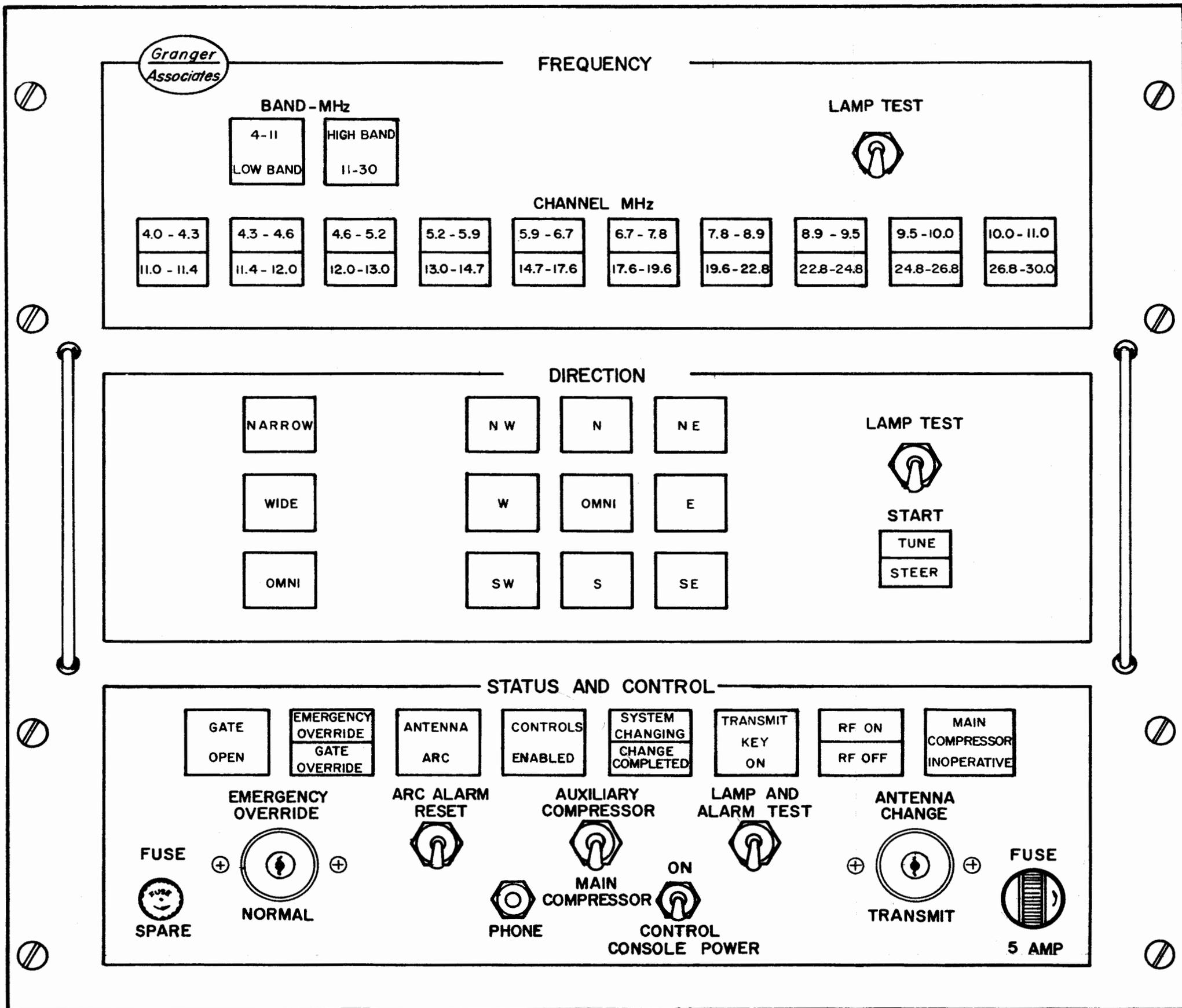


Figure 1-4. Control Panel.

1-15. Antenna Interlock. An antenna interlock control circuit is connected to the control circuitry of the transmitter. The interlock prevents unsafe operation of the system and provides a means of emergency operation. The EMERGENCY OVERRIDE/NORMAL key switch, when in the EMERGENCY OVERRIDE position, bypasses the normal interlock circuits, except the gate interlock, to allow transmitter operation during an emergency even when an unsafe condition is known to exist. The EMERGENCY OVERRIDE lamp illuminates. The ANTENNA CHANGE/TRANSMIT key switch readies the system for changes in frequency, direction, and beamwidth when in the ANTENNA CHANGE position. This switch opens the transmitter interlock circuit and permits control voltages to be supplied to the remote units to allow antenna changeover.

1-16. Arc Protection. The STATUS AND CONTROL assembly also includes arc protection control. Its components are a warning bell which sounds when a fault has occurred, an ANTENNA ARC indicator lamp, and an ARC ALARM RESET toggle switch. When an arc or other cause for high VSWR occurs at the antenna, the bell rings and the ANTENNA ARC lamp lights. At the same time the transmitter interlock opens and the transmitter is automatically shut off. This action causes the RF ON lamp to switch off and the RF OFF lamp to illuminate. The bell continues to ring, the ANTENNA ARC lamp remains illuminated, and the transmitter interlock remains open until the ARC ALARM RESET button is pressed. The ARC ALARM RESET button has no effect on the interlock condition until the arc or other antenna fault has been cleared.

1-17. The SYSTEM CHANGING lamp is illuminated when any band, channel, beamwidth or direction indicator/switch is activated. The ANTENNA CHANGE/TRANSMIT switch must be in the ANTENNA CHANGE position. This illuminates the CONTROLS ENABLED indicator.

1-18. The CHANGE COMPLETED lamp is illuminated when the desired antenna change is completed. The START lamp goes out simultaneously along with the SYSTEM CHANGING lamp.

1-19. The TRANSMIT KEY ON lamp is illuminated when the ANTENNA CHANGE/TRANSMIT key switch is turned to the TRANSMIT position. The CONTROLS ENABLED light will go out.

1-20. The MAIN COMPRESSOR INOPERATIVE lamp is illuminated when the pressure in the compressor accumulator tank drops below 40.0 psig.

1-21. The AUXILIARY COMPRESSOR/MAIN COMPRESSOR toggle switch permits the operator to activate the auxiliary compressor when the main compressor is unable to maintain the required pressure in the accumulator tank.

1-22. The LAMP AND ALARM TEST (momentary-action) toggle switch permits all the indicator lamps and the alarm bell to be tested, on the STATUS AND CONTROL segment of the control panel.

1-23. The CONTROL CONSOLE POWER ON toggle switch, when activated, supplies 120 vac to the power supply which in turn provides 48 vdc to illuminate the indicators and to serve as the relay control voltage.

1-24. Other indicators in the STATUS AND CONTROL assembly include the GATE OPEN lamp, a GATE OVERRIDE lamp and an RF ON/RF OFF indicator. The GATE OPEN lamp shows that the gate of the enclosure of the active antenna has been opened. A GATE OVERRIDE lamp shows that the gate interlock has been deliberately overridden at the antenna site. The RF ON/RF OFF indicator shows whether or not RF power is present at the active antenna. A front-panel jack permits sound-powered telephone communication to other remote units in the system. A 5 ampere main line fuse and a spare fuse are provided.

1-25. COAXIAL RF POWER TRANSFER SWITCH AND REMOTE CONTROL EQUIPMENT BOX (UNIT 2).

1-26. The coaxial RF power transfer switch and remote control equipment box, shown in figure 1-5 are located between the antennas at the tee of the transmission lines. The RF switch is a vacuum sealed SPDT coaxial power transfer switch that connects the transmitter output to the low or high band matching unit under control of band change commands from the control console. Two pushbuttons located on the switch housing permit manual operation during maintenance, or in an emergency. The actuating and sensing assembly, located in the remote control equipment box, processes the frequency and direction information from the control panel in the transmitter building and programs both antennas with their associated matching units, and reflector control units for the desired changes. When the START push-button on the control console is pushed, commands are sent to the appropriate matching unit to become adjusted for the frequency channel indicated, and to the appropriate reflector control unit to activate the reflectors for the desired configuration. The inactive antenna is placed in the omnidirectional mode. The status of the RF switch, the matching unit, and reflectors are monitored by interlock circuits in the actuating and sensing assembly which holds the transmitter interlock circuit open until all changes are correctly completed. Table 1-5 summarizes electrical, mechanical, and environmental data for the coaxial RF power transfer switch.

1-27. The equipment box also contains power distribution equipment. It steps down the voltage (either 240 or 480 vac), delivered by the facility power cable, from the transmitter building, to the 120 volt level required for operation of the antenna equipment. There are circuit breakers for the main transformer secondary line and for the secondary circuits to the main and auxiliary compressors and to the low and high band reflector control units. The 120 volt output of the power distribution equipment is also applied to a dc power supply in the actuating and sensing unit, the output of which is a 48 vdc control voltage.

1-28. An indicator panel in the equipment box displays the status of the matching units and reflector systems. This panel displays the positions of critical memory relays, the commands being transmitted from the equipment box to the other items of the remote equipment, and the status of various sections of the interlock system. The controls and indicators of the actuating and sensing assembly indicator panel are described in Section 3.

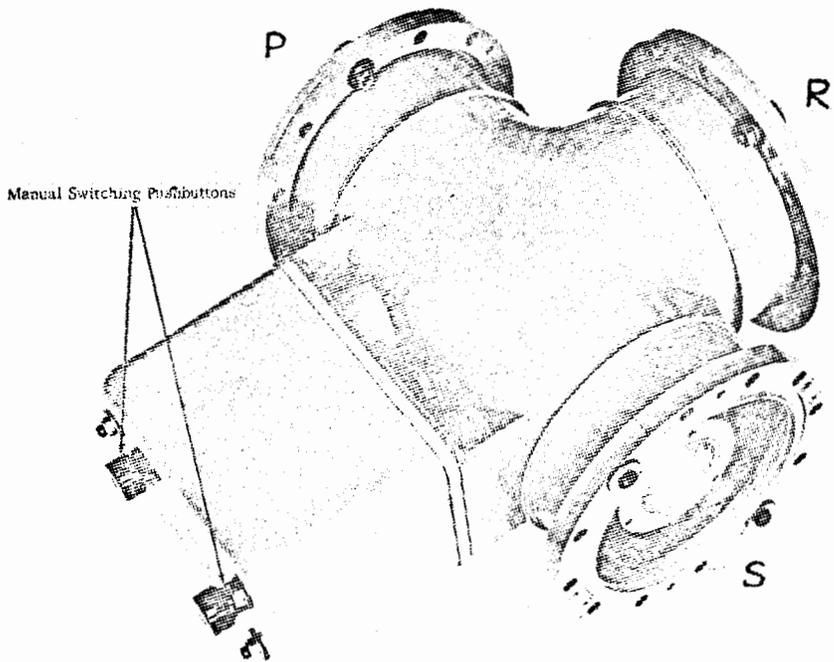
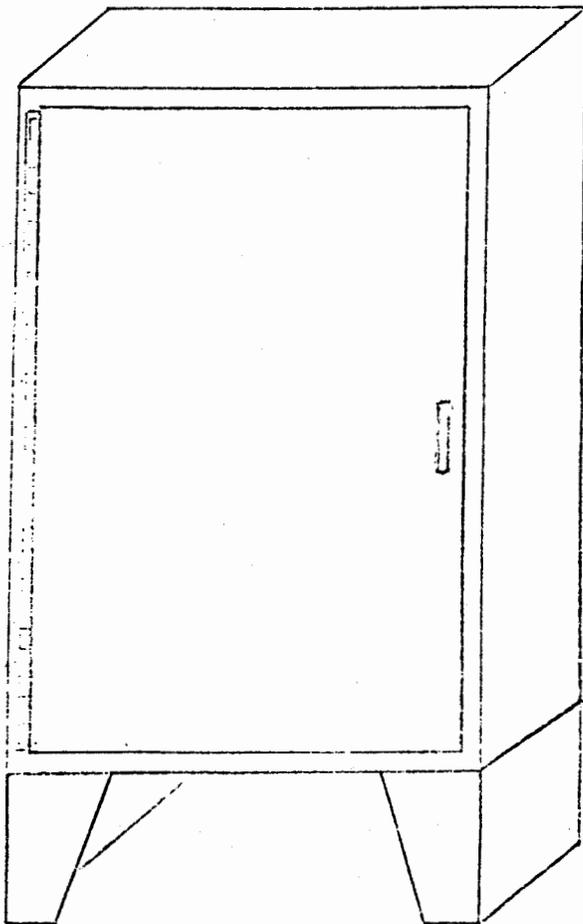


Figure 1-5. Coaxial RF Power Transfer Switch and Remote Equipment Box (Unit 2).

Table 1-5. Electrical, Mechanical, and Environmental Specifications, Coaxial RF Power Transfer Switch.

Characteristics	Specifications
<u>ELECTRICAL</u>	
Contact Configuration	SPDT
Frequency Range	0 to 30 MHz
Characteristic Impedance	50 ohms
VSWR (Insertion)	1.1:1, 0 to 30 MHz
Crosstalk	Greater than 43 db isolation, 0 to 30 MHz
Insertion Loss	0.01 db maximum
Power Handling	325 kw CW, (600 kw PEP) 0 to 30 MHz at 1.1:1 VSWR
Actuating Voltage	115 vac continuous
External Connector	MS-3114E-22-21P per MIL-C-26482 (21 #16 AWG contacts)
Actuator Type	Latching Intermittent duty
Actuator Coil Resistance	42.7 ohms
Auxiliary Contact Configuration	Four SPDT
Auxiliary Contact Rating	125/230 vac 7 amps. max, 48 vac 4 amps inductive (sea level) max 7 amps resistive max. Maximum Continuous Current through auxiliary contacts--2 amp
<u>MECHANICAL</u>	
RF Connection	6-1/8-inch standard EIA flange capable of withstanding 15 psi gas pressure
Transfer time	100 ms maximum
Transfer Rate	One transfer per 1.5 seconds min.
Mechanical Actuation of RF Contacts	Manually operated pushbuttons
<u>ENVIRONMENTAL</u>	
Operating Temperature Range	-54 degrees to 65 degrees C
Weather Protection	Unit is sealed so that exposure to the weather will not interfere with its operation.

1-29. LOW AND HIGH BAND MATCHING UNITS (UNITS 3 AND 4).

1-30. Typical low and high band matching unit assemblies are shown in figure 1-6. The unit matches the input impedance of the active antenna to the characteristic impedance of the transmission line (50 ohms). Because the antenna impedance and VSWR vary with the selected frequency and beamwidth, the matching units are constructed to provide a variable impedance under command of the signals from the control console.

1-31. Each matching unit consists of three large housings connected together by sections of coaxial transmission line and a control box. Each of the housings has the required reactive elements (inductors and capacitors) for impedance matching, and two motor-driven vacuum switches to connect the reactive elements to the coaxial line. All the components, except the inductors, are secured on a mounting plate inside each housing. For each frequency channel selected, the appropriate reactive elements are connected to the center conductor of the coaxial line by the motor-driven vacuum switches. The particular circuit arrangement is established by the pushbuttons on the control panel. Each matching unit is filled with transformer oil to act as a coolant and also to prevent voltage breakdown.

1-32. The control box, located at the input end of each matching unit, has three functions. It controls the vacuum switches within the housings in response to commands from the control console, thus connecting the required reactive elements to the coaxial line. The control box places the inactive antenna in the omni mode while the other antenna is in operation and it tunes the motor-driven variable capacitor to one of five possible values.

1-33. LOW AND HIGH BAND REFLECTOR SYSTEMS (UNITS 5 AND 6).

1-34. LOW AND HIGH BAND REFLECTOR CONTROL UNITS. Typical low and high band reflector control units are shown in figure 1-7. The units are located outside the fenced area of each antenna. The reflector control units establish the directional and beam width characteristics of the active antenna by activating groups of reflectors in response to command signals from the control console. The command signals are routed by way of the actuating and sensing unit in the remote equipment box. The directional characteristics are determined by the physical location of the reflectors that constitute an active group as well as the frequency of operation. The beamwidth is established by the number of reflectors activated.

1-35. LOW AND HIGH BAND REFLECTORS. A typical low or high band reflector, shown in figure 1-8 consists of six lengths of copper tubing mounted end-to-end separated by five pneumatic switches. The low and high band reflectors are identical in operation, but are different in length. A total of sixteen reflectors surround each monopole antenna. The switches are operated by air pressure from a compressor which controls a movable contact within the switches. The movable contact of the switches is held open by a spring. The introduction of air pressure into a reflector overcomes the spring forces and the switch contacts will close. Decreasing the air pressure opens the switches, deactivating the

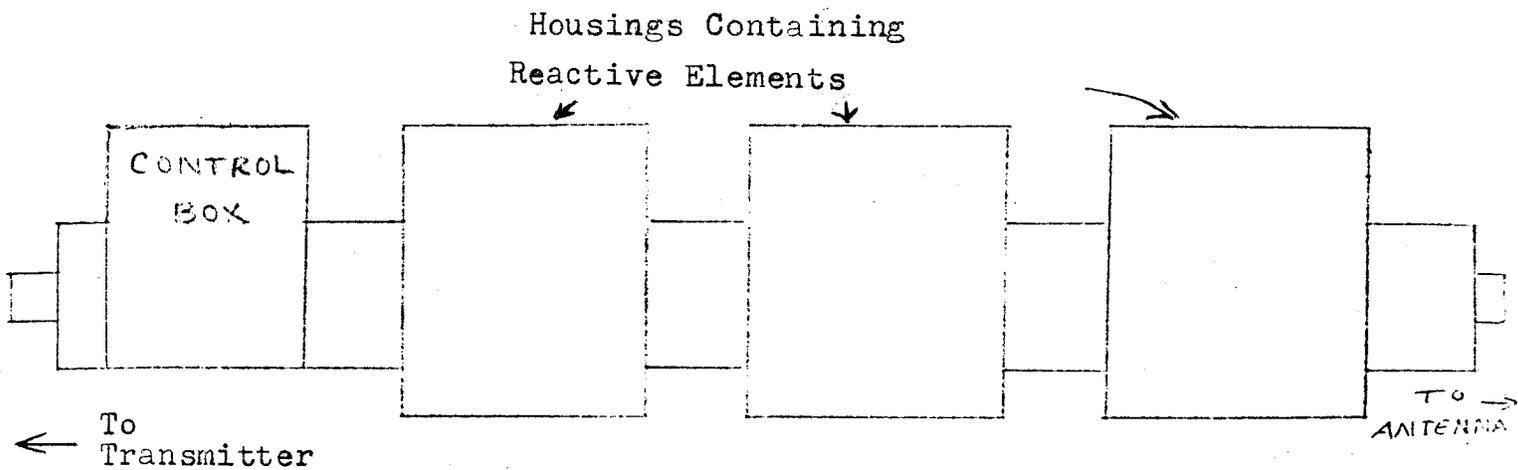


Figure 1-6. Low and High Band Matching Unit (Units 3 and 4) Typical.

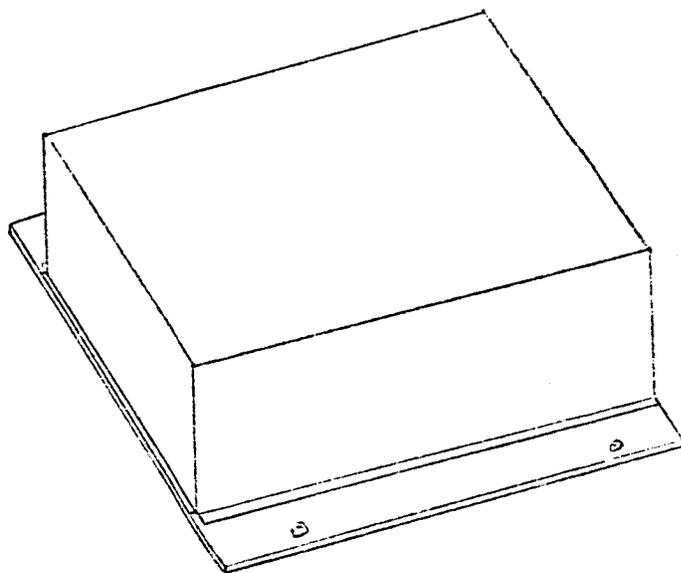


Figure 1-7. Low and High Band Reflector Control Unit (Part of Units 5 and 6) Typical.

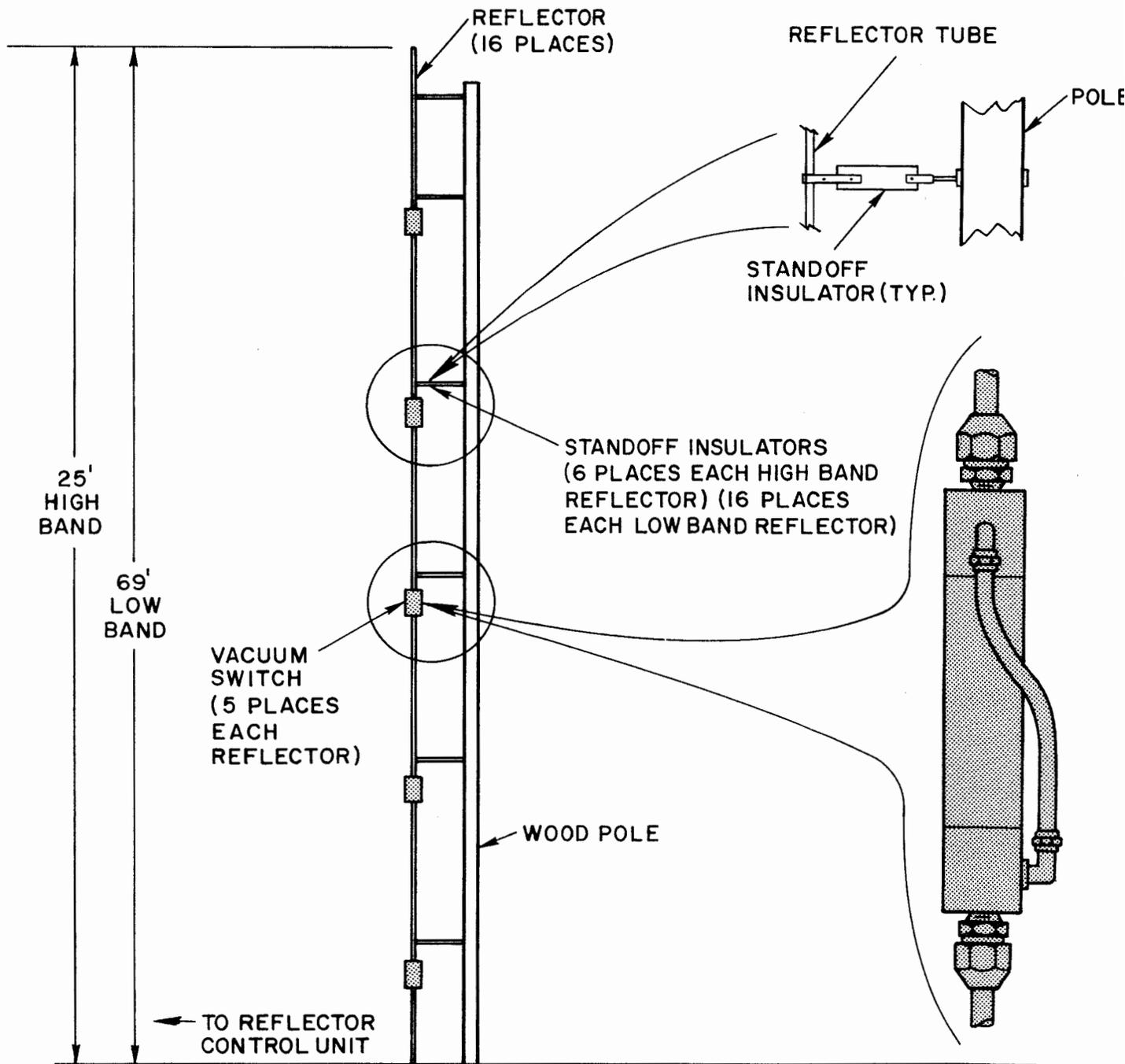


Figure 1-8. Low and High Band Reflectors, Typical (Part of Units 5 and 6).

appropriate reflector(s). The reflector assemblies are mounted on wood poles by a series of standoff insulators. The standoff insulator brackets are adjustable, thus permitting alignment of the reflector assemblies.

1-36. LOW AND HIGH BAND MONOPOLE ANTENNAS (UNITS 7 AND 8).

1-37. A typical low or high band monopole antenna is shown in figure 1-9. The monopole consists of a rigid triangular aluminum tower and thirty-six radiators. The radiators, which extend from an aluminum dome at the top of the tower, are arranged in the form of a cylinder with a truncated cone at each end and are held apart by two mid rings in the center. The entire structure is guyed at two levels with 3 guys per level, and stands on a ceramic insulator approximately 17-3/4-inches high and 6-inches in diameter. The height of the low band monopole is approximately 53-feet, while the high band monopole is about 20 feet.

1-38. AIR COMPRESSOR (UNIT 9).

1-39. The air compressor, shown in figure 1-10, located in an enclosure between the antennas near the RF switch and equipment box, forces dry air into the reflector systems. The compressor assembly consists of two capacitor start ac motors with compressors, two pressure switches, and a compressor tank. One compressor is the main source of pressure, while the other is an auxiliary. The pressure switches, designated MOTOR and WARNING control the operation of the motors. The MOTOR switch turns off the active motor when pressure in the tank reaches 100 psig and restarts the same motor when pressure falls below 60 psig. The WARNING switch illuminates the MAIN COMPRESSOR INOPERATIVE indicator on the control panel when a malfunction occurs at the main compressor. or at the MOTOR switch which would cause the pressure to drop to 40 psig. The compressor tank is a 60-gallon capacity tank with a dehydrated air pressure rating of 200 psi. A drain cock on the underside of the tank is for maintenance and bleeding purposes.

1-40. LOW AND HIGH BAND GROUND SCREEN.

1-41. The ground screen consists of 120 soft drawn, solid, copper, #8 AWG radial wires, equally spaced at 3-degree intervals. The length of each radial for the low band is 123 feet and for the high band is 45 feet; these dimensions are one-half wavelength at the lowest operating frequency of each monopole. The radials are welded to the perimeter wire and to a non-magnetic stainless steel ground plate. The outer end of every third radial is terminated by and bonded to, a copper-clad steel ground rod. A circumferential wire of the same gauge and characteristics as the radials, is bonded to the ground rods and the ends of the radials.

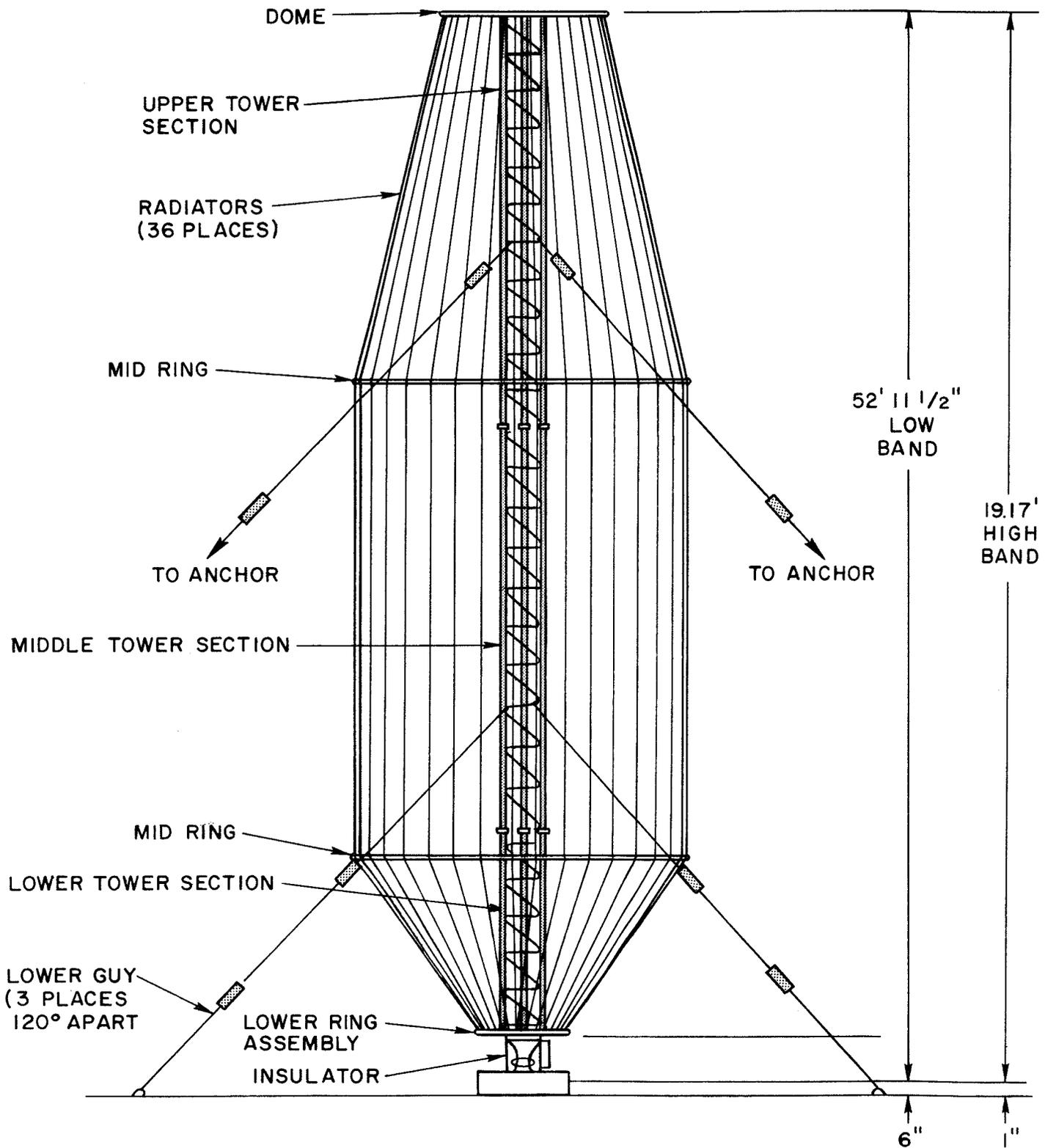


Figure 1-9. Low and High Band Monopole Antenna, Typical (Units 7 and 8).

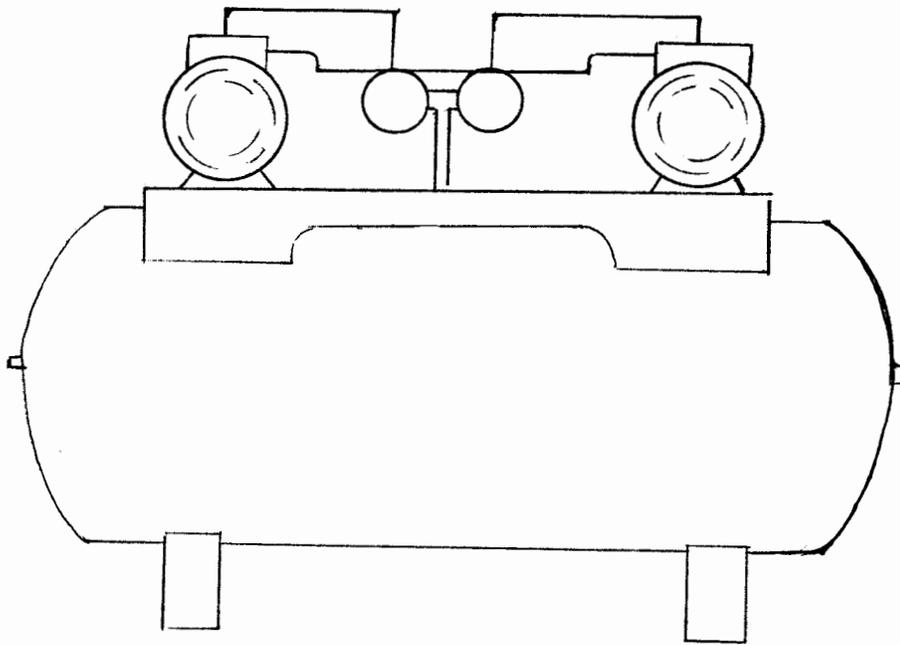


Figure 1-10. Air Compressor (Unit 9).

1-42. LOW AND HIGH BAND FENCES.

1-43. Each monopole antenna is enclosed by a 6-foot wooden fence. The low band antenna fence is 89 feet square and the high band antenna fence is 38 feet square. Each fence has a double gate which provides a 10 foot opening. The purpose of the fence is to prevent entry into the antenna area by personnel and grazing animals.

1-44. CONCRETE KIT, TOOL KIT, AND SPARES KIT.

1-45. A concrete kit, consisting of the low and high band ground plates, perforated drain pipe, anchors, and miscellaneous hardware is also provided with the antenna set. The parts of the kit are used in the installation of the antenna set.

1-46. The tool kit consists of special tools and equipment not found in a normal antenna installation kit. The tool kit serves a special purpose for this installation.

1-47. The spares kit contains spare parts for the antenna installation.

1-48. LOW AND HIGH BAND GATE INTERLOCK SYSTEM AND PERSONNEL PROTECTION  
(UNITS 10 AND 11).

WARNING

EXTREMELY HIGH VOLTAGES AND INTENSE RF FIELDS, WHICH WILL CAUSE SERIOUS INJURY OR DEATH TO PERSONNEL, ARE PRESENT IN THE IMMEDIATE VICINITY OF THE ANTENNAS. ENSURE THAT THE GATE INTERLOCK CIRCUITS AND VSWR MONITORS ARE OPERATING PROPERLY.

1-49. Because the high power radiated by this system is extremely dangerous to personnel in the immediate vicinity of the antenna, an interlock system is provided to remove transmitter power when the gate of the enclosure of the active antenna is opened. No easily accessible override capability is provided because the danger is not only of electrocution from contact with the antenna, but also of damage to sensitive body tissues by dielectric heating from the RF field near the antenna. For use under very unusual circumstances, an override switch is provided inside the control box at each matching unit.

1-50. The coaxial RF power transfer switch, remote equipment box, the reflector control units, and the compressor assembly are located outside the fenced areas and contain only control and normal power voltages and require no transmitter interlocks. Circuit breakers are provided within the remote equipment box which permit power to be removed from each unit. The coaxial RF power transfer switch has all its RF power handling parts sealed in a vacuum and requires no interlocks. The matching units are the only equipment in the system

containing accessible parts that carry RF power, and they are protected by virtue of being within the fence enclosure. They are also so close to the antenna that they cannot be safely approached with the antenna energized. Therefore they are not provided with any additional interlock, other than the gate interlock which disables the transmitter when the gate of the active antenna is opened.

1-51. The interlock switches at the gate in the fence around each antenna are arranged so that the interlock circuit opens when the gate opens. See figure 1-11 for a view of the gate interlock circuit installation. To restore the interlock, close the gate and then depress and release a reset switch connected to the gate switch. The reset switch box is located outside the fence eight feet away from the gate opening, where it cannot be reached from inside the fenced area. When the gate interlock circuit is open, a red GATE OPEN lamp on the control console lights up and the interlock circuit to the transmitter is broken.

1-52. The gate interlock circuit is routed through auxiliary contacts on the RF power transfer switch so that the gate of the antenna, which is not in operation, may be opened without turning off the transmitter. The gate to the inactive antenna must then be closed and the interlock reset before the transmitter power can be applied to that antenna. If the control cable, which connects the RF power transfer switch to the remote equipment box, becomes unplugged and the gates are closed, the transmitter interlock circuit will open. Mere replacement of the connector in the plug will not close the interlock circuit. The gate reset switch must be activated to close the interlock circuit.

1-53. The personnel protection interlock circuits are not connected directly to the transmitter, but operate through contacts of relay K4 in the control console which is energized by the closed gate interlock circuit.

1-54. As an added feature for personnel safety, VSWR monitors, in the matching units, operate indicator lamps on the control console and on the fences to indicate the presence or absence of RF power at the antenna. A directional coupler, in the gas barrier of each matching unit, will detect the presence of RF energy at the input of the active antenna matching unit. The detected RF power will cause a relay to operate whenever more than 5 kilowatts of RF power are supplied to the antenna. The relay operates two sets of indicators: a split indicator lamp on the control console indicates RF ON if either the high or low band VSWR monitor is operative, and RF OFF if neither VSWR monitor operates. A pair of aircraft-warning lamps are located on the fence near the gate for each monopole. The red indicator of the pair is illuminated when the RF power is on and the green indicator is on when the RF power is off. These indicators are of adequate intensity to be visible during the day to a person facing the gate from a reasonable distance.

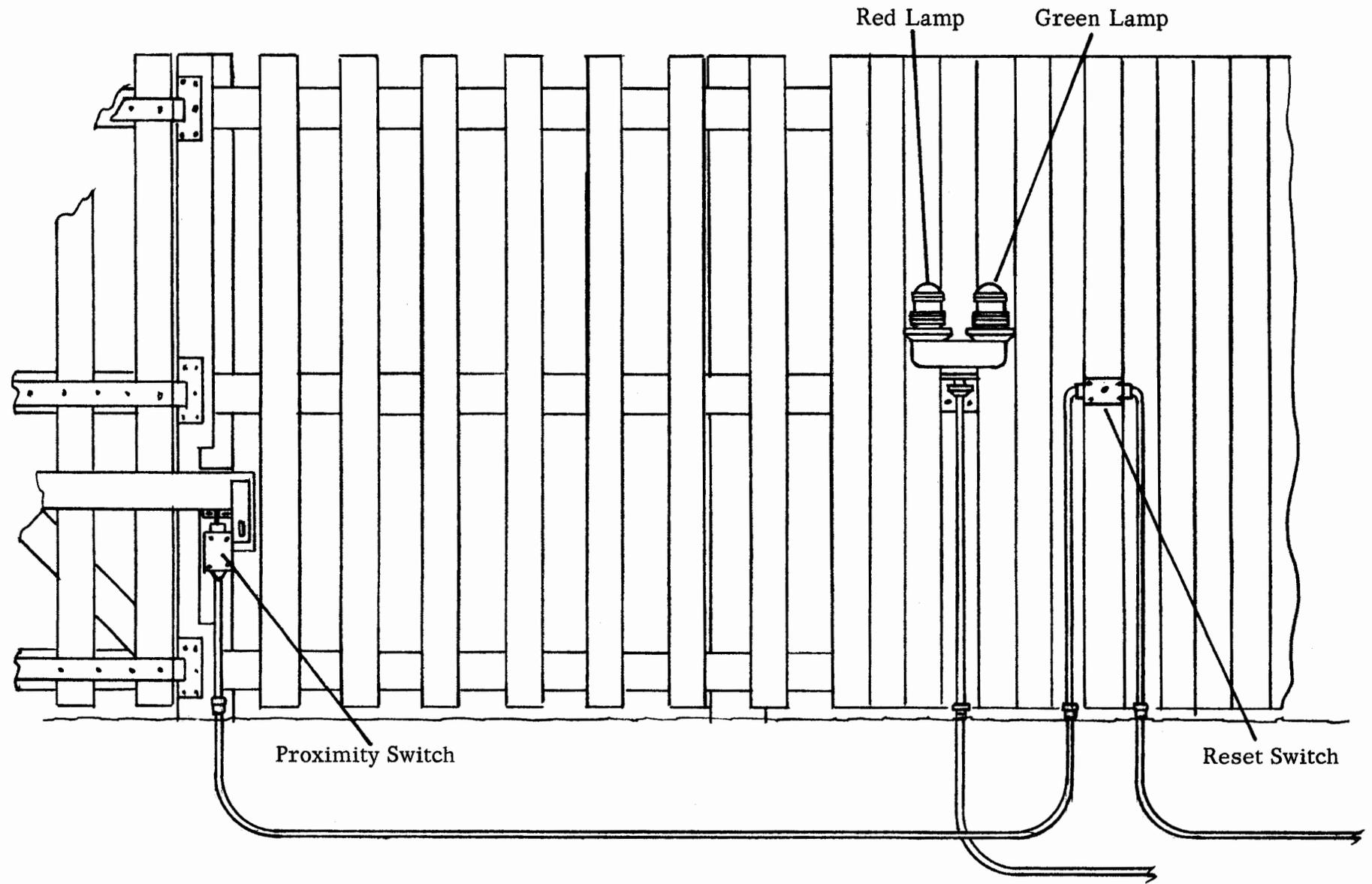


Figure 1-11. Low and High Band Gate Interlock, Typical  
(Units 10 and 11).

ORIGINAL

1-55. Dangerous voltages may be induced in the monopoles, even though no power is applied to them. For this reason care must be exercised at all times in working around the antennas. A solid ground connection must be made to the antenna itself while work is in process. Furthermore, the interlock system performs its protective function only if it is connected properly, and not bypassed or overridden.

1-56. MISCELLANEOUS COMPONENTS.

1-57. An air compressor/dehydrator (not supplied with the antenna), located in the transmitter building, forces dry air into the transmission line at a constant low pressure. Short lengths of tubing connect the main transmission line to the two output lines of the RF switch. A gas barrier in the matching unit control box seals the pressurized line from the oil-filled matching unit assemblies and the air is routed to the reflector control units. Therefore, all three sections of the coaxial line and the reflector control units are under pressure constantly. The RF switch itself is vacuum sealed.

1-58. The transmission line, not supplied with the antenna set, is a 50-ohm coaxial cable of power rating appropriate for the transmitter. The line runs from the transmitter to the common terminal of the RF switch and from the output terminals of the switch to each of the matching units.

SECTION 2  
INSTALLATION

2-1. GENERAL.

2-2. This section contains information to assist personnel in installing and interconnecting the units of the antenna set. Included in this section are unpacking, site selection and preparation, site layout, concrete installation, and antenna installation.

2-3. UNPACKING.

2-4. The components of the antenna set are shipped in wooden boxes, drums, and on reels. Inspect the boxes for shipping damage before opening them. Remove the equipment from the shipping containers and inspect the equipment for damage which might have been incurred during shipment. Report the damage on the appropriate forms. A packing slip, which lists the contents of each container, is shipped with each container. Check this packing slip to verify that the equipment is complete as listed on the slip. Report all discrepancies on the appropriate forms. Identical parts may be packed with different quantities listed. This means they go with a particular unit.

2-5. SITE SELECTION AND PREPARATION.

2-6. There are several factors to take into consideration when selecting a site for the antenna set. Ensure that the location elevation is high enough so that the omnidirectional transmitted energy will not be absorbed or reflected by obstructions such as hills, metal buildings, bridges, or power lines. Because of the high radiated power and consequent spark hazard, ensure that the antenna set is not erected near telephone lines, radar sets, munitions, or fuel supplies.

2-7. Materials and equipment for preparation of the antenna site are not supplied with the antenna. The installing agency is responsible for surveying, clearing and grading, trenching and excavating, setting of reinforcing rods, procurement and pouring of the concrete, erection of the reflector poles and reflectors, and the overall antenna installation. Table 2-1 lists the material required for complete installation of the antenna set while table 2-2 lists all installation drawings which are packed and shipped with the antenna set. Installation drawings also appear as figures in this section supporting the installation sequence of the antenna set.

2-8. SITE LAYOUT.

2-9. Units of the antenna set are installed at four principal locations. The two antennas are set up at least 350-feet apart, the coaxial RF power transfer switch, remote equipment box, and the air compressor are between the antennas, and the control console is in the transmitter building.

2-10. Figure 2-1 shows the general layout of the antenna site. The antenna towers are located at the center of each site. The towers rest on concrete piers, with the long end of the piers protruding toward the coaxial RF switch. The transmission line runs from the transmitter building to the coaxial RF switch, and from there to the input of each matching unit.

2-11. A datum plate is established at the grade level of each antenna base. This datum plate is necessary in establishing the horizontal location of the tower guy anchors.

2-12. CONCRETE INSTALLATION.

2-13. All concrete, concrete work, and reinforcing bars are supplied by the customer. Reinforcing bars of 1/2, 5/8, and 3/4-inch diameter are recommended and are to be spaced at intervals no greater than those specified in figure 2-2.

2-14. The installation drawing shows the shape and dimensions of the low band and high band tower piers and the foundations on which the other units of the antenna set are secured. The tower piers for the low band and high band antennas differ by the height of area on which the tower stands, and the location of the tower mounting bolts. This area on the low band base is raised 9-3/4 inches; on the high band this area is recessed 7-3/4 inches.

2-15. The pier excavation is to be deep enough so the bottom of the concrete will be at least 6 inches below the frost line or undisturbed soil, whichever is lowest. The ends of the bolts, which secure the tower, extend 3 inches above the surface of the concrete while the bolts which attach the other units extend approximately 2 inches above the concrete.

NOTE

The excavation depth is dependent upon the environment and climate in which the antenna is to be installed.

2-16. All guy anchors of both antennas are identical. Each anchor rod and concrete block is oriented so the anchor points directly toward the antenna tower. See figure 2-2.

2-17. ANTENNA SET INSTALLATION.

2-18. MONOPOLE INSTALLATION.

2-19. The antenna array and support structures are delivered ready for assembly in the field. The monopole antennas must be the first components to be assembled and installed because there would not be enough space left if the other units were installed first. Refer to figure 2-3 for low band monopole installation and figure 2-4 for high band monopole installation. The drawings also contain details pertinent to each installation. Erect the antennas as follows:

- a. Place the stainless steel ground plate over the tower pier.
- b. (High band) Fit the base insulator over the three tower mounting bolts in the recessed portion of the pier. The low band tower pier is not recessed therefore, the three tower mounting bolts protrude above the top surface of the concrete pier.
- c. Place the lower arm of the spark gap over one of the mounting bolts. Tighten two of the mounting bolts, leaving the third mounting bolt, which fastens the spark gap arm, adjustable.

NOTE

The high band tower sections and dome may be assembled on the ground and then raised into position by hand. The low band tower requires a crane or an erection fixture. The assembled sections of the low band tower may be assembled from the top down and then lifted into place if a crane is used. Figure 2-5 shows an erection fixture in use and how the dome is raised to the top of the tower with an erection fixture.

- d. Tie temporary rope guys to the top section of the tower, and run the ropes through the eyes of the outer ring of anchors. Tighten the rope guys evenly.
- e. Place the upper arm of the spark gap in place above the lower arm. Adjust the spark gap to 1 inch and tighten all mounting bolts.
- f. Unroll the radiator wires on the ground and remove all kinks.
- g. Station one man at the top of the tower and raise the radiators to him one at a time. Attach the radiators to the outer edge of the dome.
- h. Assemble the upper mid ring assembly around the tower and the radiator assembly.

NOTE

The upper and lower mid rings seem identical, but they are not interchangeable. Each ring is divided into three sections. One end of each section has an inner sleeve which slips into the end of the mating sections. The ends of the sections are drilled for bolting together. The mating ends are letter coded to assure that the drilled holes line up. Be sure that the three sections which are assembled into each ring all have the same letter.

- i. Pass the radiators to the outside of the mid ring.

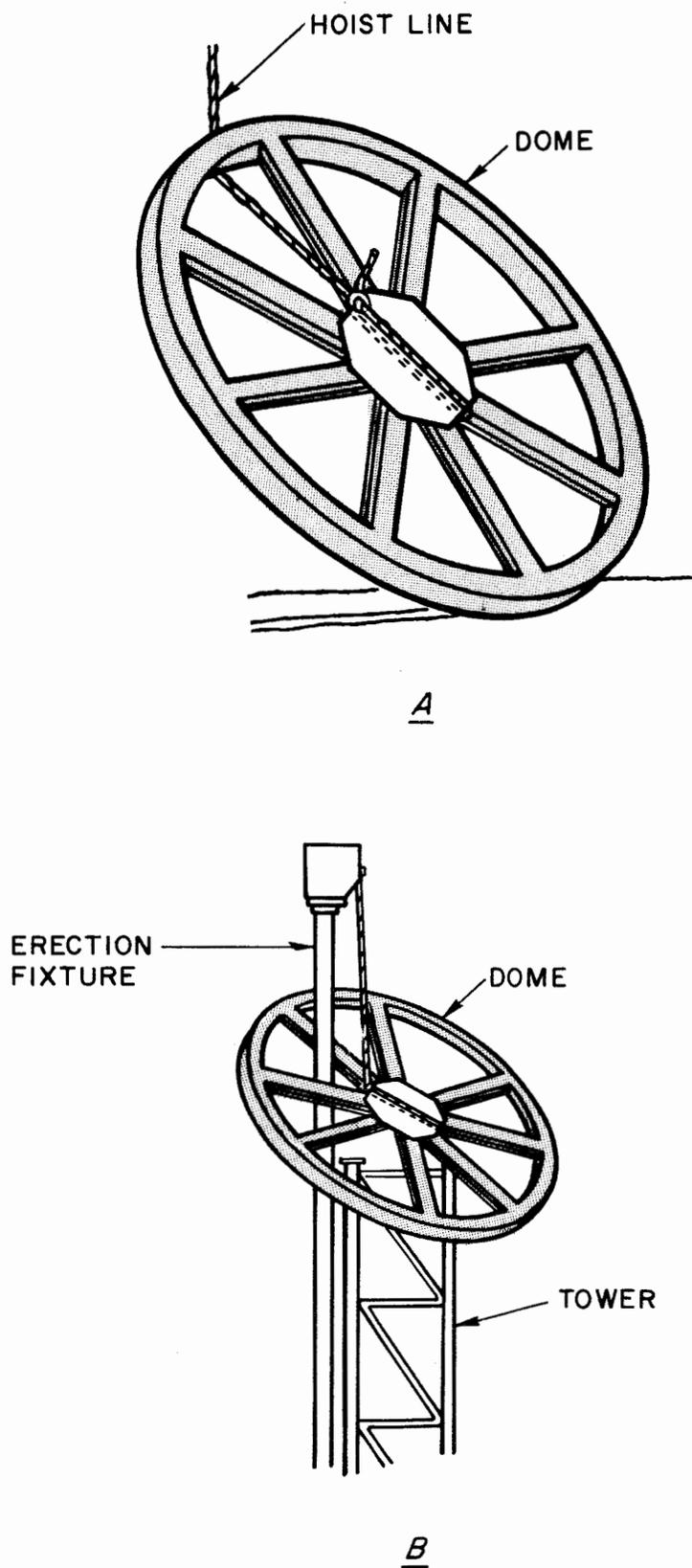
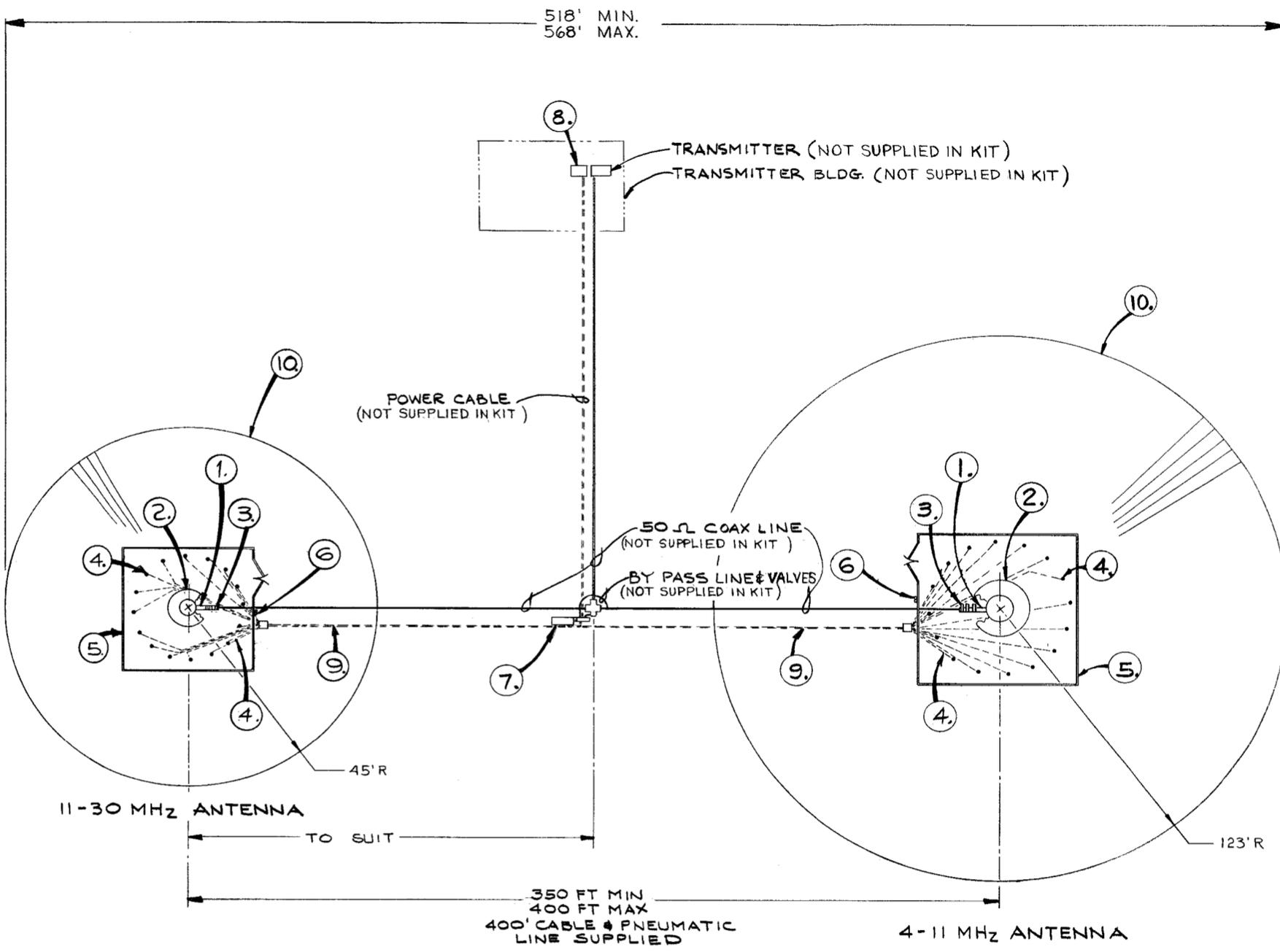


Figure 2-5. Raising of Low Band Tower Dome.

- j. Raise the upper mid ring to the upper series of bolts which are welded to the radiators. Fit these bolts through the holes in the ring; install a jumper on the radiator bolt near each guy stabilizer bracket and tighten the nuts.
- k. Attach the spokes to the spoke brackets on the mid ring, then swing them in toward the tower and attach them to the tower spoke brackets.
- m. Pass the long guy line through the U-shaped guy stabilizer bracket on the mid ring, and assembly as shown on figure 2-3 and figure 2-4. Guy grip installation is shown in figure 2-6.
- n. Attach the guys to the outer guy anchor. Remove the temporary rope guys.
- p. Using a dynamometer, as shown in figure 2-7, tension the guy lines to approximately 600 pounds for the high band and 1100 pounds for the low band. Turn the turnbuckle until the lines are taut and do not put pressure on the stabilizing bracket on the mid ring. Ensure that the tower is plumb. The upper insulator of the guy line must be a given distance from the upper mid ring; refer to figure 2-3 and figure 2-4 for the proper distance.
- q. Assemble the lower mid ring around the tower.
- r. Raise the assembled lower mid ring to the lower series of bolts which are welded to the radiators. Fit these bolts through the holes in the ring and tighten the nuts. Keep the guy stabilizing brackets oriented between the same radiators as the brackets on the upper ring.
- s. Attach the spokes to the spoke brackets on the lower mid ring, then swing them in toward the tower and attach them to the tower spoke brackets.
- t. Fit the lower guys through the guy stabilizer brackets on the lower mid ring. Attach and tension the guys to approximately 500 pounds for the high band and 800 pounds for the low band. Ensure that the tower is plumb. The upper insulator of the guy line must be a given distance from the lower mid ring, refer to figure 2-3 and figure 2-4 for the proper distance.
- u. Loosen the lock nuts securing each radiator to the lower ring and straighten the radiators. Tighten the radiators (approximately 50 pounds) by tightening the locknuts.
- v. Apply silicone rubber to the bottom of each radiator to prevent moisture from entering the lower ring.



REVISIONS		E.C.O.	DATE	APPROVED
A	RECORD CHANGE: "NOT SUPPLIED BY GIA REPLACES " BY CUSTOMER"		5-20-67	J.G.
B	CALL OUT NO. ADDED		7-12-67	J.G.
C	ADDED KIT TO STEP 9 AND ADDED SHT 2		8/4/67	J.G.



# PLAN

## LEGEND

- REFER TO NOTE
- REFER TO INSTALLATION SEQUENCE STEP FOR THIS SHEET ONLY.

NOTES: 1. PNEUMATIC LINE & CONTROL CABLES TO BE INSTALLED IN SAME TRENCH.

SUGGESTED INSTALLATION SEQUENCE		
STEP	INSTALLATION DWG	EQUIPMENT KIT
①	071-5617 CONCRETE INSTALLATION (5 SHEETS)	091-5356-01 CONCRETE KIT
②	071-5608 ANTENNA INSTL 4-11 MHz (2 SHEETS) 071-5609 GUY GRIP INSTL 4-11 MHz 071-5619 ANTENNA INSTL 11-30 MHz 071-5609 GUY GRIP INSTL 11-30 MHz	091-5352-01 BASIC ANTENNA KIT 4-11 MHz 091-5353-01 BASIC ANTENNA KIT 11-30 MHz
③	071-5763 MATCHING UNIT INSTL 4-11 MHz 071-5777 MATCHING UNIT INSTL 11-30 MHz	091-5463-01 MATCHING UNIT KIT 4-11 MHz 091-5464-01 MATCHING UNIT KIT 11-30 MHz
④	071-5618 REFLECTOR INSTL 4-11 MHz 071-5609 GUY GRIP INSTL 11-30 MHz	091-5365-01 REFLECTOR KIT 4-11 MHz 091-5366-01 REFLECTOR KIT 11-30 MHz
⑤	071-5607 FENCE INSTL	091-5359-01 FENCE KIT 4-11 MHz 091-5360-01 FENCE KIT 11-30 MHz 091-5371-01 LOCK KIT
⑥	071-5613 GATE INTERLOCK INSTALLATION	091-5355-01 INTERLOCK KIT
⑦	071-5620 COMPRESOR & RTE CONT BOX INTSL	091-5358-01 COAX SW & RTE CONT BOX KIT 091-5371-01 LOCK KIT 091-5429-01 AIR COMP KIT
⑧	071-5890 CONT CSL OUT-LINE & MOUNTING DIM	001-6676 MA CONT CSL
⑨	071-5888 PRI PWR DIST 071-5621 CABLE INSTL 071-5622 CABLE DETAIL 071-5623 071-5624 071-5625 071-5626 071-5627 071-5628  071-5630 071-5631 071-5632 071-5633 071-5634 071-5635 071-5636 CABLE DETAIL 021-9003 CABLE PREPARATION 081-0635 CONNECTOR ASSEY INSTL 071-5889 INTERCONNECT WIRING & CABLING DIAGRAM 071-5886 CABLE RUNNING SHEET	091-5358-01 COAX SW AND RTE CONT BOX KIT
⑩	071-5605 GRD SCREEN INSTL (4-11 MHz) 071-5606 GRD SCREEN INSTL (11-30 MHz)	091-5354-01 GRD SCREEN KIT
⑪	081-0695 PNEUMATIC LINE PURS.	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES		DRAWN: J.G.	DATE: 12/1/66	GRANGER ASSOCIATES PALO ALTO CALIFORNIA
TOLERANCES ON		CHECKED: HCB	DATE: 1/11/67	
DECIMALS	ANGLES	APPROVED: W.L.W.	DATE: 1/19/67	GENERAL OUTLINE MODEL 788-3 ANTENNA
000		APPROVED:	DATE:	
00		APPROVED:	DATE:	
		APPROVED:	DATE:	
QTY PER NEXT ASSY	NEXT ASSY	QTY PER TOP ASSY	TOP ASSY	CODE IDENT NO: 08935 F
APPLICATION				DRAWING NO: 071-5616
				SCALE: NONE
				SHEET: 1 OF 2

Figure 2-1. Antenna Site Layout (Part 1 of 2). 2-10

GENERAL INSTALLATION NOTES

THE MONOPOLE ANTENNAS MUST BE THE FIRST COMPONENTS TO BE ASSEMBLED AND INSTALLED BECAUSE THERE WOULD NOT BE ENOUGH SPACE LEFT IF THE OTHER UNITS WERE INSTALLED FIRST.

- A. PLACE THE STAINLESS STEEL GROUND PLATE OVER THE TOWER PIER.
- B. (HIGH BAND) FIT THE BASE INSULATOR OVER THE THREE TOWER MOUNTING BOLTS IN THE RECESSED PORTION OF THE PIER.
- C. PLACE THE LOWER ARM OF THE SPARK GAP OVER ONE OF THE MOUNTING BOLTS. TIGHTEN TWO OF THE MOUNTING BOLTS, LEAVING THE THIRD MOUNTING BOLT, WHICH FASTENS THE SPARK GAP ARM, ADJUSTABLE.

NOTE

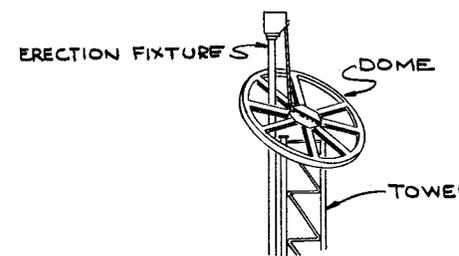
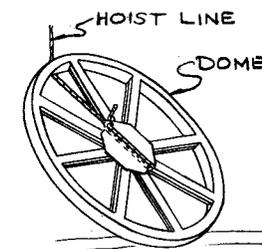
THE HIGH BAND TOWER SECTIONS AND DOME MAY BE ASSEMBLED ON THE GROUND AND THEN RAISED INTO POSITION BY HAND. THE LOW BAND TOWER REQUIRES A CRANE OR AN ERECTION FIXTURE. THE ASSEMBLED SECTIONS OF THE LOW BAND TOWER MAY BE ASSEMBLED FROM THE TOP DOWN AND THEN LIFTED INTO PLACE IF A CRANE IS USED. VIEW "A" SHOWS AN ERECTION FIXTURE IN USE AND HOW THE DOME IS RAISED TO THE TOP OF THE TOWER WITH AN ERECTION FIXTURE.

- D. TIE TEMPORARY ROPE GUYS TO THE TOP SECTION OF THE TOWER, AND RUN THE ROPES THROUGH THE EYES OF THE OUTER RING OF ANCHORS. TIGHTEN THE ROPE GUYS EVENLY.
- E. PLACE THE UPPER ARM OF THE SPARK GAP IN PLACE ABOVE THE LOWER ARM. ADJUST THE SPARK GAP TO 1 INCH AND TIGHTEN ALL MOUNTING BOLTS.
- F. UNROLL THE RADIATOR WIRES ON THE GROUND AND REMOVE ALL KINKS.
- G. STATION ONE MAN AT THE TOP OF THE TOWER AND RAISE THE RADIATORS TO HIM ONE AT A TIME. ATTACH THE RADIATORS TO THE OUTER EDGE OF THE DOME.
- H. ASSEMBLE THE UPPER MID RING ASSEMBLY AROUND THE TOWER AND THE RADIATOR ASSEMBLY.

NOTE

THE UPPER AND LOWER MID RINGS SEEM IDENTICAL, BUT THEY ARE NOT INTERCHANGEABLE. EACH RING IS DIVIDED INTO THREE SECTIONS. THE ENDS OF THE SECTIONS ARE DRILLED FOR BOLTING TOGETHER. THE MATING ENDS ARE LETTER CODED TO ASSURE THAT THE DRILLED HOLES LINE UP. BE SURE THAT THE THREE SECTIONS WHICH ARE ASSEMBLED INTO EACH RING ALL HAVE THE SAME LETTER.

- I. PASS THE RADIATORS TO THE OUTSIDE OF THE MID RING.
- J. RAISE THE UPPER MID RING TO THE UPPER SERIES OF BOLTS WHICH ARE WELDED TO THE RADIATORS. FIT THESE BOLTS THROUGH THE HOLES IN THE RING; INSTALL A JUMPER ON THE RADIATOR BOLT NEAR EACH GUY STABILIZER BRACKET AND TIGHTEN THE NUTS.
- K. ATTACH THE SPOKES TO THE SPOKE BRACKETS ON THE MID RING, THEN SWING THEM IN TOWARD THE TOWER AND ATTACH THEM TO THE TOWER SPOKE BRACKETS.
- L. PASS THE LONG GUY LINE THROUGH THE U-SHAPED GUY STABILIZER BRACKET ON THE MID RING, AND ASSEMBLY AS SHOWN ON DWG. 071-5608 AND DWG. 071-5619. GUY GRIP INSTALLATION IS SHOWN IN DWG. 071-5609.
- M. ATTACH THE GUYS TO THE OUTER GUY ANCHOR. REMOVE THE TEMPORARY ROPE GUYS.
- N. USING A DYNAMOMETER, TENSION THE GUY LINES TO APPROXIMATELY 600 POUNDS FOR THE HIGH BAND AND 1100 POUNDS FOR THE LOW BAND. TURN THE TURNBUCKLE UNTIL THE LINES ARE TAUT AND DO NOT PUT PRESSURE ON THE STABILIZING BRACKET ON THE MID RING. ENSURE THAT THE TOWER IS PLUMB. THE UPPER INSULATOR OF THE GUY LINE MUST BE A GIVEN DISTANCE FROM THE UPPER MID RING; REFER TO DWG. 071-5608 AND DWG. 071-5619 FOR THE PROPER DISTANCE.
- O. ASSEMBLE THE LOWER MID RING AROUND THE TOWER.
- P. RAISE THE ASSEMBLED LOWER MID RING TO THE LOWER SERIES OF BOLTS WHICH ARE WELDED TO THE RADIATORS. FIT THESE BOLTS THROUGH THE HOLES IN THE RING AND TIGHTEN THE NUTS. KEEP THE GUY STABILIZING BRACKETS ORIENTED BETWEEN THE SAME RADIATORS AS THE BRACKETS ON THE UPPER RING.
- Q. ATTACH THE SPOKES TO THE SPOKE BRACKETS ON THE LOWER MID RING, THEN SWING THEM IN TOWARD THE TOWER AND ATTACH THEM TO THE TOWER SPOKE BRACKETS.
- R. FIT THE LOWER GUYS THROUGH THE GUY STABILIZER BRACKETS ON THE LOWER MID RING. ATTACH AND TENSION THE GUYS TO APPROXIMATELY 500 POUNDS FOR THE HIGH BAND AND 800 POUNDS FOR THE LOW BAND. ENSURE THAT THE TOWER IS PLUMB. THE UPPER INSULATOR OF THE GUY LINE MUST BE A GIVEN DISTANCE FROM THE LOWER MID RING; REFER TO DWG. 071-5608 AND DWG. 071-5619 FOR THE PROPER DISTANCE.
- S. LOOSEN THE LOCK NUTS SECURING EACH RADIATOR TO THE LOWER RING AND STRAIGHTEN THE RADIATORS; TIGHTEN THE RADIATORS (APPROXIMATELY 50 POUNDS) BY TIGHTENING THE LOCKNUTS.
- T. APPLY SILICONE RUBBER TO THE BOTTOM OF EACH RADIATOR TO PREVENT MOISTURE FROM ENTERING THE LOWER RING.



VIEW A

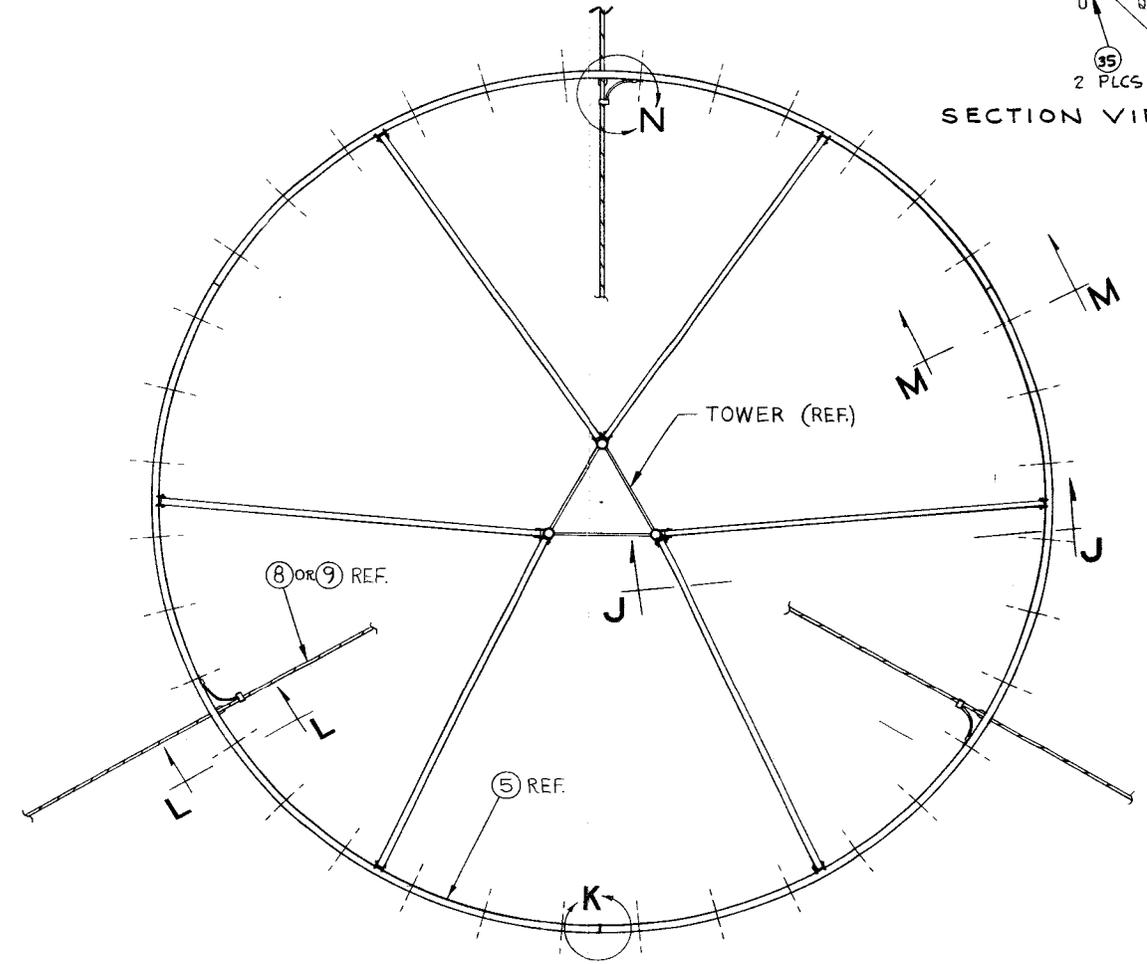
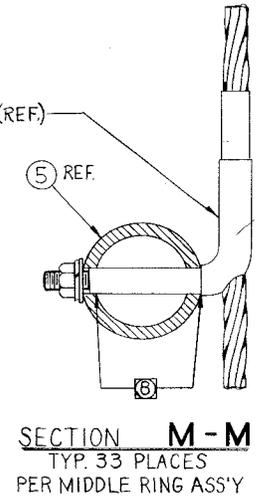
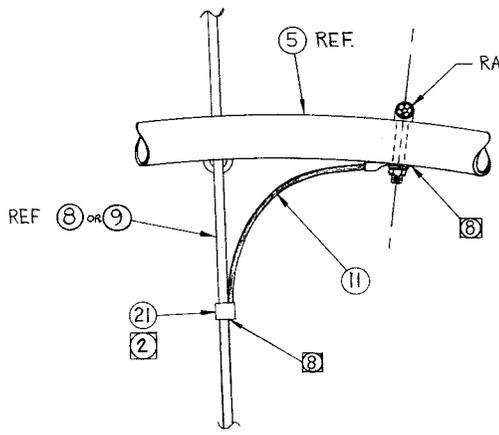
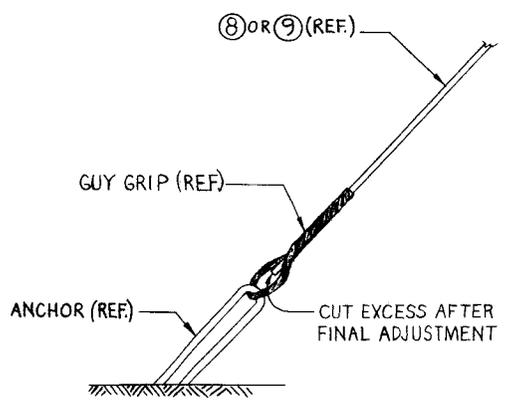
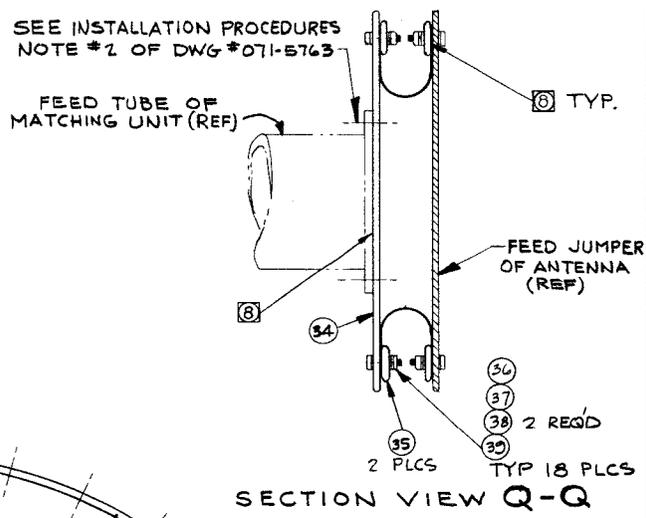
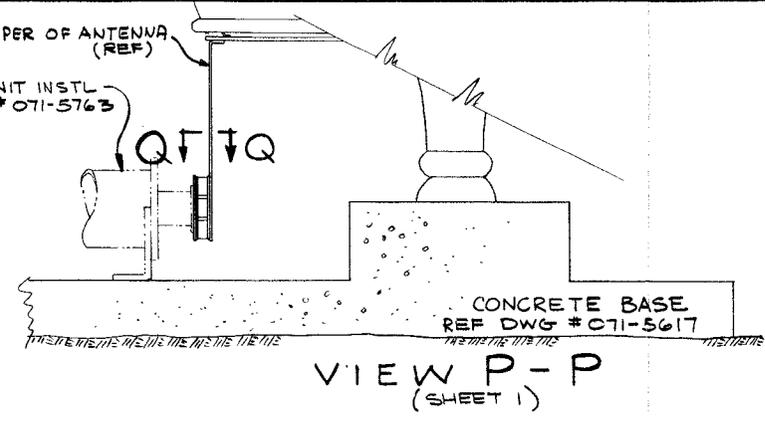
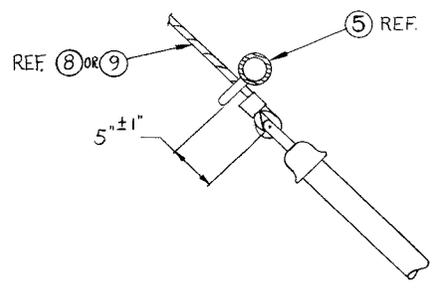
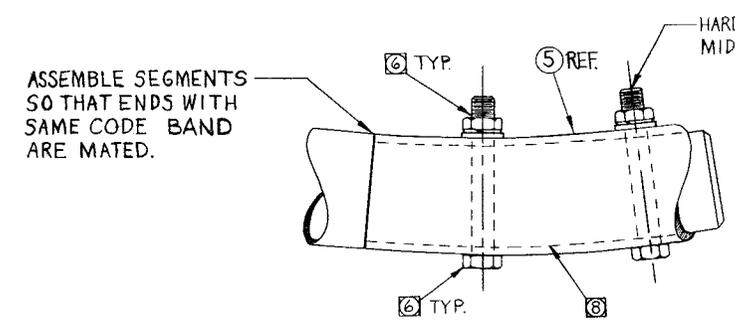
RAISING OF LOW BAND TOWER DOME

NOTES: 1.

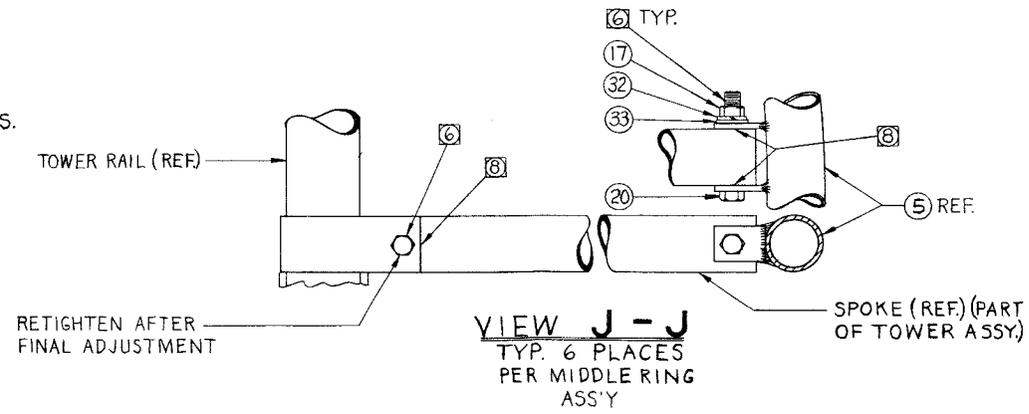
QUANTITY REQUIRED		Q/A PART NO.	DESCRIPTION	U/M	ITEM NO.
LIST OF MATERIALS					
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES					
DRAWN	J.G.	DATE	8/18/67	GRANGER ASSOCIATES	
CHECKED	CEP	DATE	8/18/67	PALO ALTO CALIFORNIA	
APPROVED	CEP	DATE	8/18/67	GENERAL OUTLINE	
PROCESS OR FINISH					
MODEL 788-3 ANTENNA					
QTY PER NEXT ASSY	NEXT ASSY	QTY PER TOP ASSY	TOP ASSY	CODE IDENT NO	SIZE
				08935	F
APPLICATION				DRAWING NO.	REV
				071-5616	
				SCALE	SHEET
				NONE	2 OF 2







- ⑥ APPLY ②⑥ LIBERALLY TO ALL ALUM. CONTACT SURFACES.
  - ⑦ USE ②③ & ②④ FOR TEMPORARY GUYING OF TOWER DURING ERECTION.
  - ⑧ APPLY ②⑤ TO SURFACES OF DISSIMILIAR METALS AFTER ASS'Y. APPLY RTV IN LIBERAL AMOUNTS TO ENCAPSULATE FASTENERS AFTER ASS'Y.
  - ⑤ SAFETY WIRE TURNBUCKLE IN POSITION.
  - ④ ASSEMBLE PER DWG. 071-5609.
  - ③ TENSION UPPER GUYS TO 1100# ± 100#.
  - ② LOWER GUYS TO 800# ± 100#.
  - ① COMPRESS CONNECTOR AT TWO PLACES. INSTALL WITH 4800079 TOOL AFTER FINAL ADJUST. SEE DETAIL "N".
- NOTES: ① ADJUST SPARK GAP TO 1" BETWEEN BALLS.

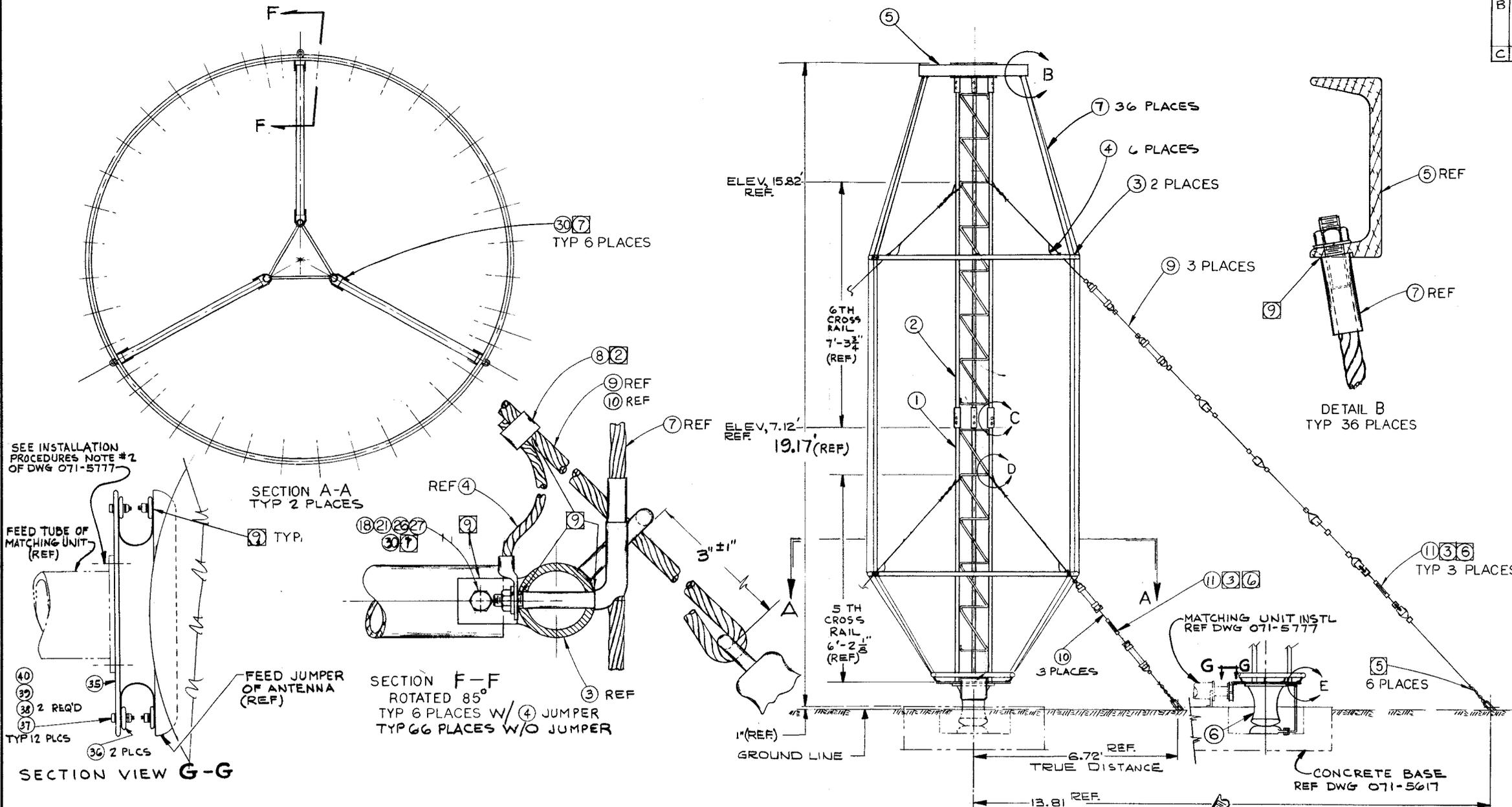


MATERIAL LIST ON SHEET #1

QUANTITY REQUIRED		G/A PART NO.	DESCRIPTION	U/M	ITEM NO.
LIST OF MATERIALS					
DRAWN DCH DATE 6-17-66		GRANGER ASSOCIATES PALO ALTO CALIFORNIA			
CHECKED HeB DATE 1/11/67		BASIC ANTENNA INSTALLATION 4-11 MHz MODEL 788-3 ANTENNA			
APPROVED [Signature] DATE 1/10/67					
PROCESS OR FINISH		CODE IDENT NO SIZE DRAWING NO REV			
		08935 F 071-5608 C			
APPLICATION		SCALE NONE SHEET 2 OF 2			

Figure 2-3. Low Band Monopole Installation (Part 2 of 2). 2-17

REVISIONS				
SYM	DESCRIPTION	E.C.O.	DATE	APPROVED
A	ITEM 17 WAS 536-0284	RS	A-1 5-7-67	J.G.
B	ADDED ELEV. DIM. REF. ADDED GROUND LINE CALLOUT, G.72, 13.81 AND LEGEND.		B-1 5-20-67	J.G.
C	TOP ASSY NO. DELETED	CI	7-12-67	M-B



**ALL MATERIALS FROM BASIC ANTENNA KIT 091-5353-01**

12	536-0339	NUT 10-32	40
12	520-0104	L. WASHER #10	39
24	517-0216	F. WASHER #10	38
12	528-0458	SCREW 10-32 x 3/4	37
2	021-8648-01	BACKING PLATE	36
1	021-8529-01	FEED JUMPER PLATE	35
1	021-8136-01	BASE PLATE ASSY	34
			33
			32
1	8235096	PENETROX	31
17	8230053	RTV SEALANT	30
9	5170007	WSHR 3/16	29
9	5170002	WSHR 1/16	28
6	5200023	LK WSHR 1/4	27
6	5170006	WSHR 1/4	26
3	5170005	WSHR 3/4	25
3	0218135-03	MANILA ROPE	24
1	6530905	BOLT 3/4-10 x 3 1/2	23
2	6530929	BOLT 3/4-10 x 2 1/2	22
6	5360257	NUT 1/2-20	21
9	5320283	BOLT 1/6-14 x 2 1/4	20
3	5200028	LK WSHR 3/4	19
6	5320281	CAP SCR 1/4-20 x 2 1/2	18
9	5320284	BOLT 5/16-18 x 2 1/4	17
3	5360265	NUT 3/4-10	16
9	5360256	NUT 1/6-14	15
9	5360258	NUT 5/16-18	14
9	5200037	LK WSHR 1/16	13
9	5200024	LK WSHR 5/16	12
1	0218137-01	SAFETY WIRE	11
3	0016699-02	GUY ASSY LOWER	10
3	0016699-01	GUY ASSY UPPER	9
6	767 0101	COMPR CONN	8
36	0016697-02	RADIATOR ASSY	7
1	4840001	INSULATOR	6
1	0016687-01	DOME ASSY	5
6	0218134-01	JUMPER	4
2	0016696-01	MID RING ASSY	3
1	0016693-01	UPPER TOWER	2
1	0016700-01	LOWER TOWER	1

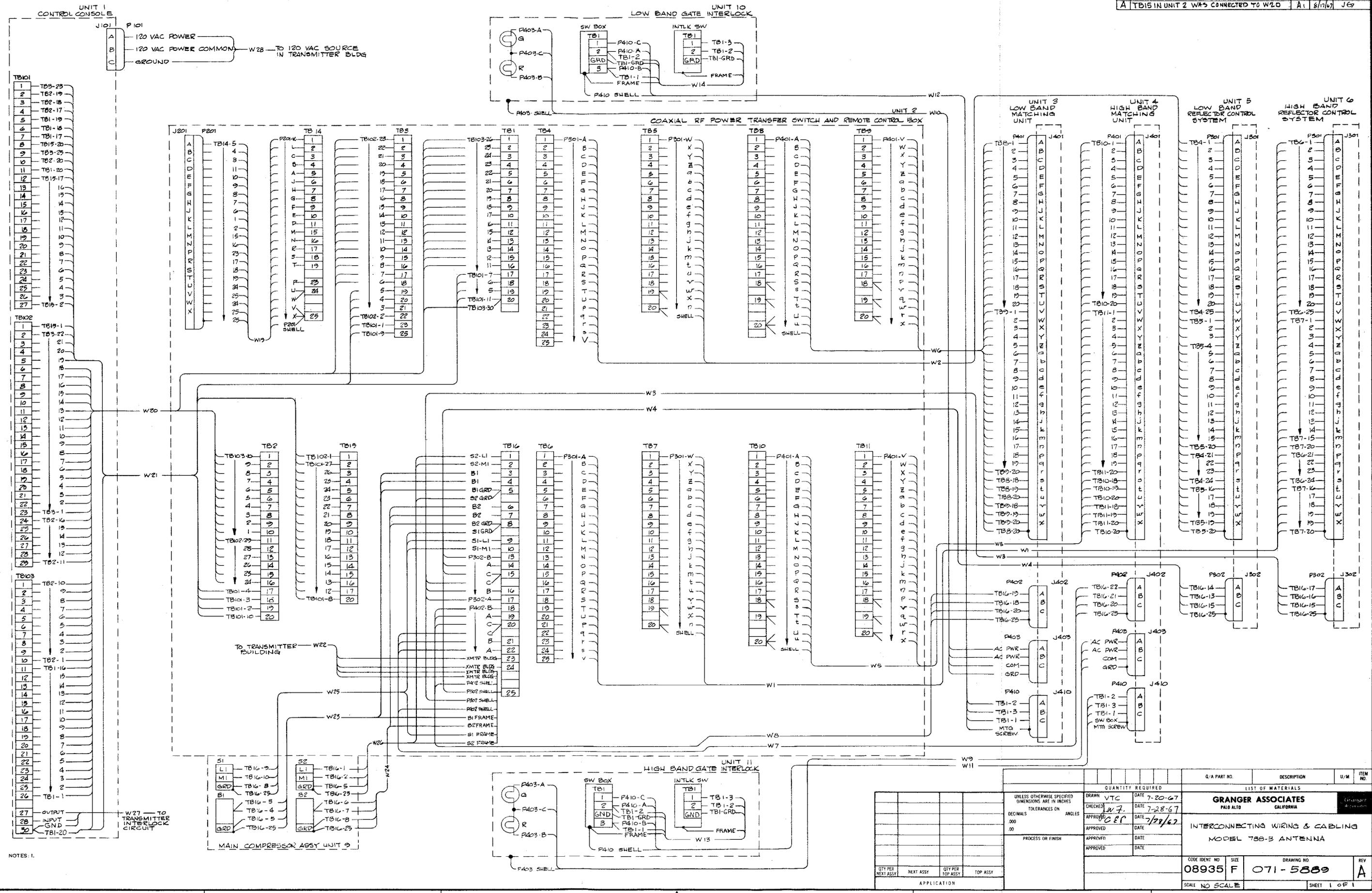
- SEE INSTALLATION PROCEDURES NOTE #2 OF DWG 071-5777
- SECTION A-A TYP 2 PLACES
- SECTION F-F ROTATED 85° TYP 6 PLACES W/ 4 JUMPER TYP 66 PLACES W/O JUMPER
- SECTION VIEW G-G
- FEED TUBE OF MATCHING UNIT (REF)
- FEED JUMPER OF ANTENNA (REF)
- DETAIL C TYP 9 PLACES
- DETAIL D TYP 6 PLACES
- DETAIL E
- LEGEND
- REF. TO NOTES.
- REF. TO ITEM NO IN MAT'L LIST.
- NOTES
- APPLY (3) LIBERALLY TO ALL ALUM. CONTACT SURFACES.
  - ADJUST SPARK GAP TO 1" BETWEEN BALLS.
  - APPLY RTV TO SURFACES OF DISSIMILIAR METALS AFTER ASSY. APPLY RTV IN LIBERAL AMOUNTS TO ENCAPSULATE FASTENERS AFTER ASSY.
  - SAFETY WIRE TURNBUCKLE IN POSITION.
  - ASSEMBLE PER DWG 071-5609.
  - CUTOFF EXCESS GUY CABLE.
  - TENSION TOP GUYS TO 600# ±100#, LOWER GUYS TO 500# ±100#
  - COMPRESS CONNECTOR 2 PLACES, INSTALL WITH 4800079 TOOL AFTER FINAL ADJUSTMENT. SEE SECT. F-F
  - USE (24) FOR TEMPORARY GUYING OF TOWER DURING ERECTION.

QUANTITY REQUIRED		DATE	
DRAWN	MLK	DATE	19 JULY 67
CHECKED	HCB	DATE	1/11/67
APPROVED	WLL	DATE	1/19/67
APPROVED		DATE	
APPROVED		DATE	

LIST OF MATERIALS			
G/A PART NO.	DESCRIPTION	U/M	REV. NO.
<b>GRANGER ASSOCIATES</b> PALO ALTO CALIFORNIA			
<b>ANTENNA INSTALLATION</b> 11-30 MHz MODEL 788-3 ANTENNA			
CODE IDENT. NO.	SIZE	DRAWING NO.	REV.
08935	F	071-5619	C
SCALE NONE		SHEET 1 OF 1	

Figure 2-4. High Band Monopole Installation. 2-18

SYMBOL		REVISIONS		ECG	DATE	APPROVED
A	TB15 IN UNIT 2 WAS CONNECTED TO W20	A1	8/1/67			JEG

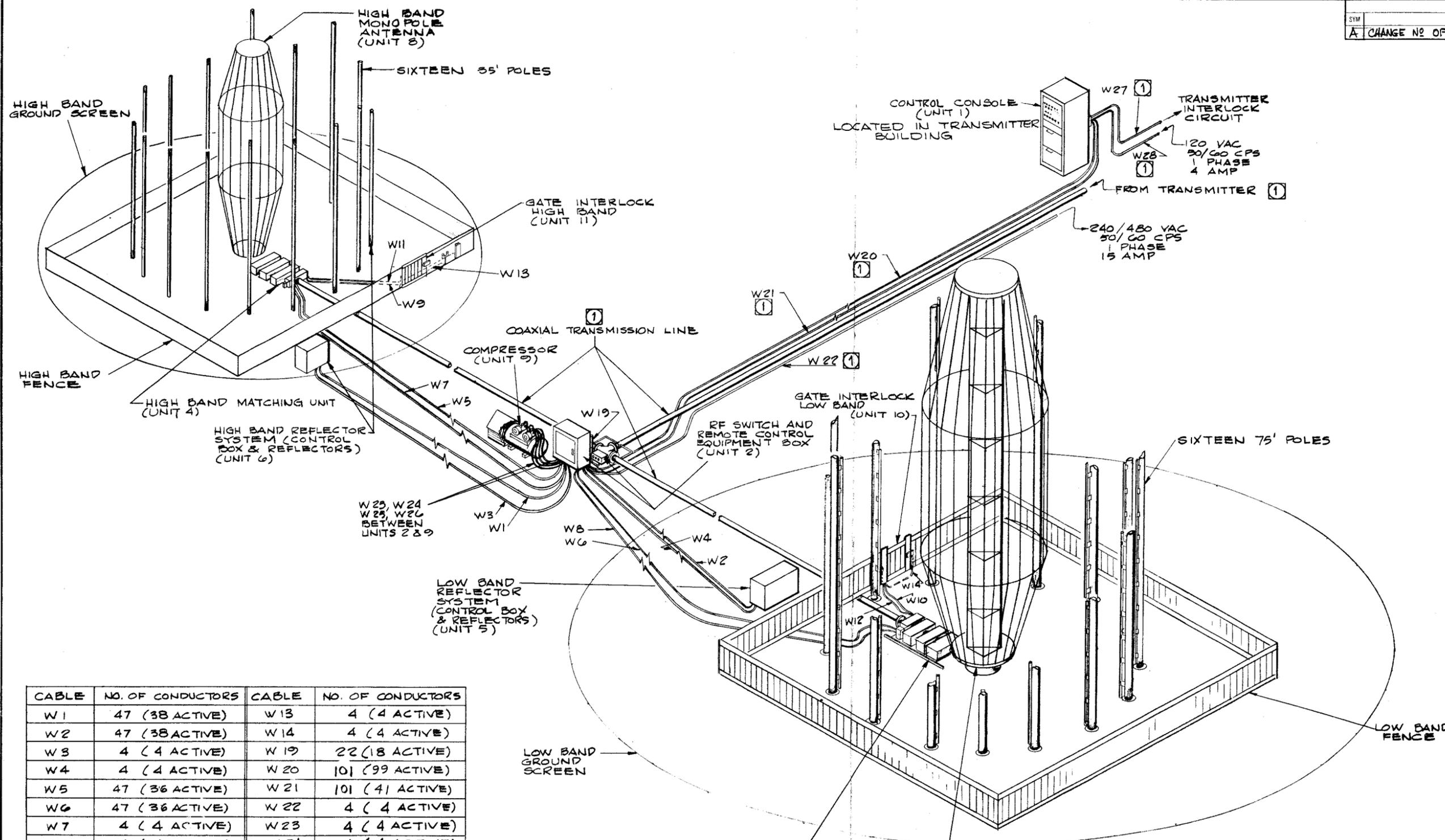


NOTES: 1.

QUANTITY REQUIRED		G/A PART NO.		DESCRIPTION		U/M	ITEM NO.
DECIMALS	TOLERANCES ON ANGLES	LIST OF MATERIALS		GRANGER ASSOCIATES PALO ALTO CALIFORNIA			
000	00	INTERCONNECTING WIRING & CABLING		MODEL 788-3 ANTENNA			
PROCESS OR FINISH		CODE IDENT NO	SIZE	DRAWING NO		REV	
		08935 F		071-5889		A	
SCALE		NO SCALE		SHEET		1 OF 1	

Figure 2-14. System Interconnect Diagram. 2-71

REVISIONS			
SYM	DESCRIPTION	E.C.O.	DATE
A	CHANGE NO OF CONDUCTOR ON W20 & W21	A1	8/17/67



CABLE	NO. OF CONDUCTORS	CABLE	NO. OF CONDUCTORS
W1	47 (38 ACTIVE)	W13	4 (4 ACTIVE)
W2	47 (38 ACTIVE)	W14	4 (4 ACTIVE)
W3	4 (4 ACTIVE)	W19	22 (18 ACTIVE)
W4	4 (4 ACTIVE)	W20	101 (99 ACTIVE)
W5	47 (36 ACTIVE)	W21	101 (41 ACTIVE)
W6	47 (36 ACTIVE)	W22	4 (4 ACTIVE)
W7	4 (4 ACTIVE)	W23	4 (4 ACTIVE)
W8	4 (4 ACTIVE)	W24	4 (4 ACTIVE)
W9	4 (4 ACTIVE)	W25	4 (4 ACTIVE)
W10	4 (4 ACTIVE)	W26	4 (4 ACTIVE)
W11	4 (4 ACTIVE)	W27	3 (3 ACTIVE)
W12	4 (4 ACTIVE)	W28	3 (3 ACTIVE)

NOTES 1. THIS ARTICLE NOT SUPPLIED IN KIT

QUANTITY REQUIRED		LIST OF MATERIALS	
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES	DRAWN VTC DATE 7-21-67	GRANGER ASSOCIATES PALO ALTO CALIFORNIA	
DECIMALS TOLERANCES ON ANGLES	CHECKED Rca DATE 7/27/67	PICTORIAL SYSTEM DIAGRAM MODEL 788-3 ANTENNA	
000	APPROVED CEP DATE 7/27/67	CODE IDENT NO	SIZE
00	APPROVED DATE	08935	D
PROCESS OR FINISH	APPROVED DATE	DRAWING NO.	REV
	APPROVED DATE	071-5885	A
QTY PER NEXT ASSY	NEXT ASSY	SCALE	SHEET 1 OF 1
		NO SCALE	

Figure 2-15. Overall Pictorial System Diagram. 2-72

SECTION 3  
OPERATION

3-1. GENERAL.

3-2. This section describes the controls and indicators, preoperational, and operating procedures for the antenna set.

3-3. DESCRIPTION OF CONTROLS AND INDICATORS.

3-4. The control panel on the control console is divided into three functional assemblies: FREQUENCY control assembly, DIRECTION control assembly, and STATUS AND CONTROL assembly. The controls and indicators for the assemblies are illustrated in figures 3-1 through 3-3 and are described in tables 3-1 through 3-3.

3-5. The controls and indicators for the actuating and sensing indicator panel are shown in figure 3-4 and are described in table 3-4.

3-6. INITIAL CHECKOUT AND CALIBRATION PROCEDURE.

3-7. VERIFICATION OF INTER-UNIT CABLING.

3-8. After the installation is completed, all inter-unit cabling should be checked with a buzzer or other continuity checker. Refer to table 2-3.

3-9. INITIAL CHECKOUT OF THE CONTROL CONSOLE.

- a. Verify that the CONTROL CONSOLE POWER/ON switch, on the STATUS AND CONTROL assembly of the control panel, is off.
- b. Connect the power input cable (W28) to a source of 120 VAC (50/60 Hz) in the transmitter building.
- c. Slide the control panel out of the control console on the chassis slides.
- d. Connect a multimeter to terminals 1 and 2 of TB3, with the multimeter scale switch set on an appropriate scale so that 52 VDC can be measured. Connect the positive lead of the meter to TB3-1 and the negative lead to TB3-2.
- e. Place the CONTROL CONSOLE POWER/ON switch in the ON position. The power supply voltage of the control console should read  $52 \pm 2$  VDC. If the power supply voltage is too low, proceed with the following steps:

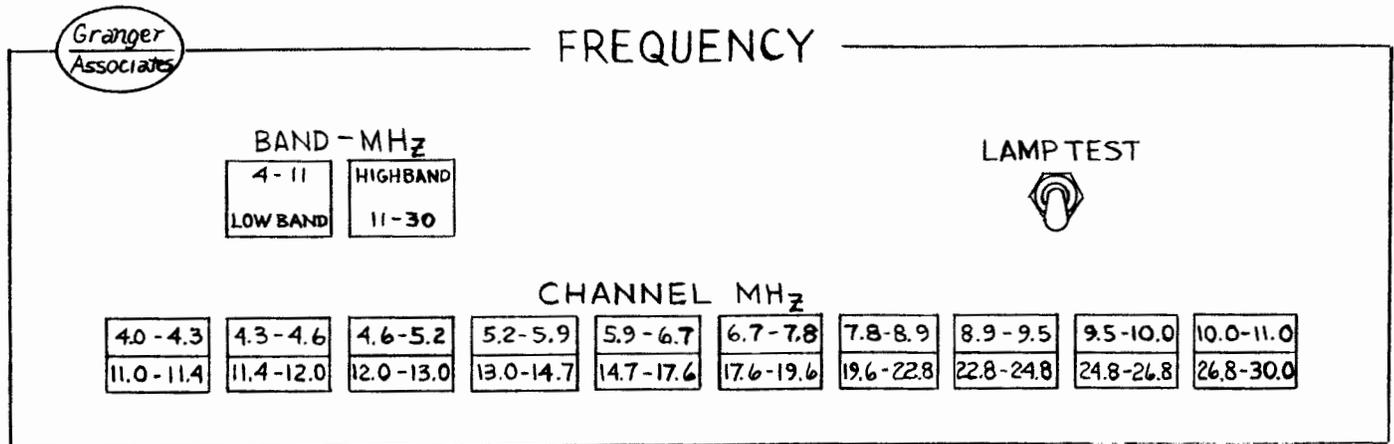


Figure 3-1. Controls and Indicators, Frequency Control.

Table 3-1. Controls and Indicators, Frequency Control

NO/ENCLATURE	DESCRIPTION	REF DES	FUNCTION
BAND-MHZ 4-11 HIGH BAND LOW BAND 11-30	Combination push operated momentary-action switch and white indicator lamps.	A1 A2	Select and indicate low or high band operation.
CHANNEL MHz 4.0-4.3 through 26.8-30.0	Combination pushbutton and white indicator lamps.	A3 thru A12	Select and indicate one of ten channels within a specified band. Upper half indicates low band channel and lower half indicates high band channels.
LAMP TEST	Momentary-action toggle switch.	S7	Applies test voltage to all BAND-MHZ and CHANNEL MHz indicator lamps.

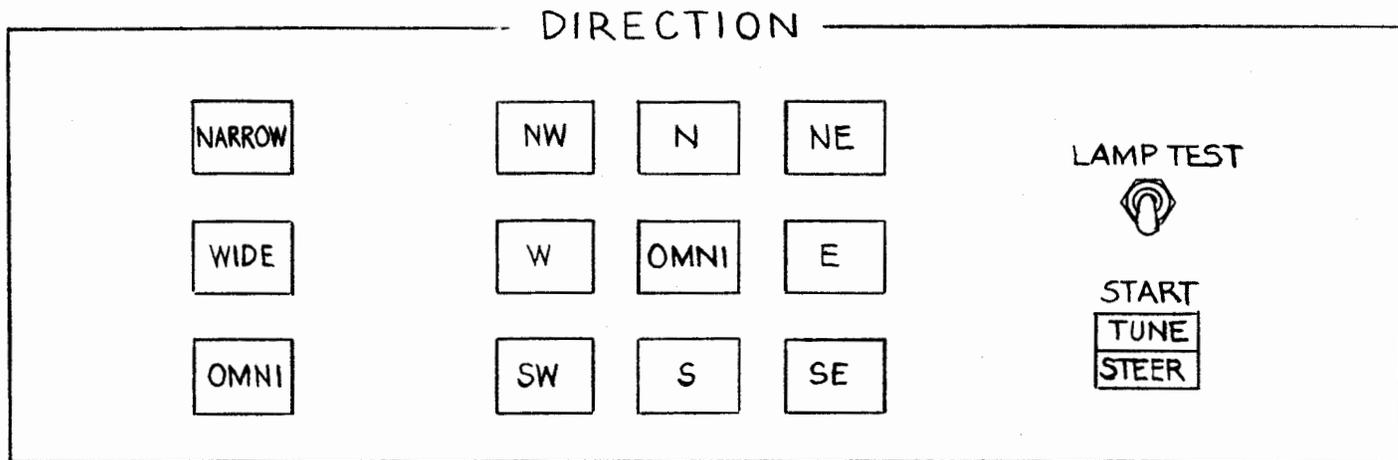


Figure 3-2. Controls and Indicators, Direction Control.

Table 3-2. Controls and Indicators, Direction Control.

NOMENCLATURE	DESCRIPTION	REF DES	FUNCTION
NARROW/WIDE/OMNI	Combination pushbutton switches and white indicator lamps.	A13 thru A15	Select and Indicate Beamwidth.
N, NE, E, SE, S, SW, W, NW	Combination pushbutton switches and white indicator lamps.	A16 thru A24	Select and Indicate beam direction.
START TUNE/STEER	Combination pushbutton switch and dual red Indicator lamps.	A25	Activates circuits that program tuning and directional commands. TUNE lamp indicates matching unit tuning is in progress. STEER lamp indicates directional change is in progress.
LAMP TEST	Momentary-action toggle switch.	38	Applies test voltage to the DIRECTION control indicator lamps.

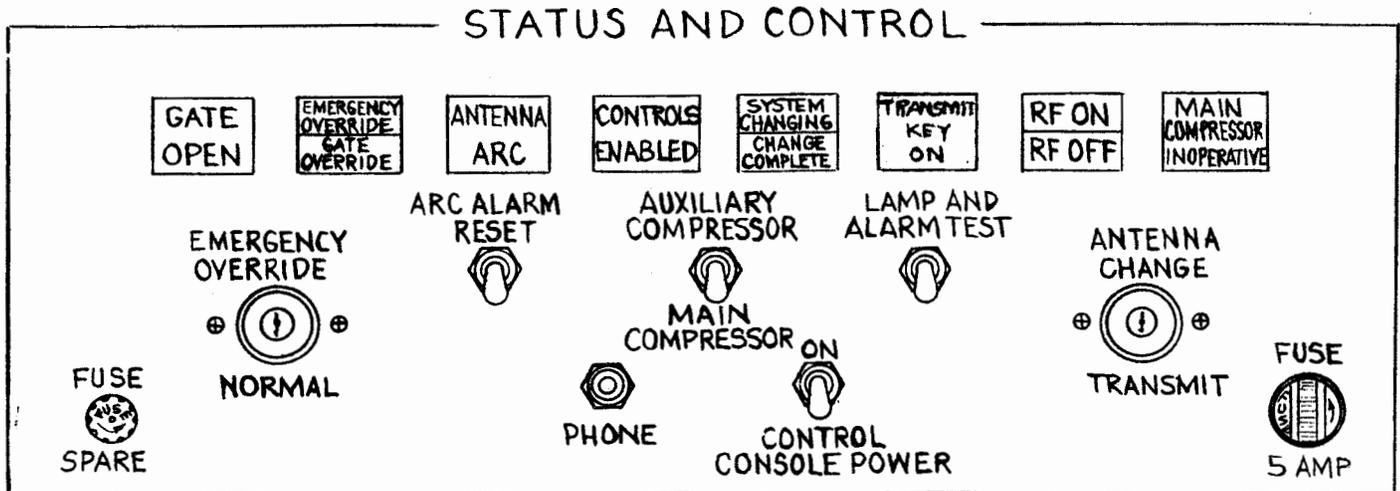


Figure 3-3. Controls and Indicators, Status and Control

Table 3-3. Controls and Indicators, Status and Control

NOMENCLATURE	DESCRIPTION	REF DES	FUNCTION
GATE OPEN	Red Indicator lamp.	A26	Illuminates when the gate of the active antenna enclosure is open.
EMERGENCY OVERRIDE/GATE OVERRIDE	Red/Yellow dual indicator lamp.	A27	Illuminates when transmitter or gate interlock circuits are intentionally being overridden.
ANTENNA ARC	Red indicator lamp.	A28	Illuminates when arc, metallic short, or malfunction occurs at the antenna.
CONTROLS ENABLED	Green Indicator lamp.	A29	Illuminates when control circuits are enabled by ANTENNA CHANGE/TRANSMIT switch to ANTENNA CHANGE.
SYSTEM CHANGING/CHANGE COMPLETED	Amber/Green dual indicator lamp.	A30	SYSTEM CHANGING lamp illuminates when any band, channel, beamwidth, or direction indicator/switch is activated. The ANTENNA CHANGE/TRANSMIT switch must be in ANTENNA CHANGE position. CHANGE COMPLETED lamp

Table 3-3. Controls and Indicators, Status and Control (Continued).

NOMENCLATURE	DESCRIPTION	REF DES	FUNCTION
TRANSMIT KEY ON	Blue indicator lamp	A31	illuminates when desired antenna change is completed.  Illuminates when the ANTENNA CHANGE/TRANSMIT switch is set to TRANSMIT.
RF ON/RF OFF	Green/Amber dual indicator lamp	A32	RF ON illuminates when transmitter is operating. RF OFF illuminates when the transmitter is not operating.
MAIN COMPRESSOR INOPERATIVE	Red indicator lamp	A33	Illuminates when pressure in the compressor accumulator tank drops below 40 psig.
ARC ALARM RESET	Momentary-action switch	S3	Resets arc indicator circuit to non-indicating condition.
EMERGENCY OVERRIDE/NORMAL	Key-operated switch	S2	Permits transmitter interlock circuit to be overridden in extreme emergencies.
ANTENNA CHANGE/TRANSMIT	Key-operated switch	S4	Activates circuits for change in antenna configuration, and restores transmitter interlock after change is complete.
AUXILIARY COMPRESSOR/MAIN COMPRESSOR	Toggle switch	S5	Applies power to the auxiliary air compressor when the main compressor is unable to maintain the required pressure in the accumulator tank.
LAMP AND ALARM TEST	Momentary-action toggle switch	S6	Applies test voltage to the alarm bell and all indicator lamps on the STATUS AND CONTROL assembly.

Table 3-3. Controls and Indicators, Status and Control (Continued).

NOMENCLATURE	DESCRIPTION	REF DES	FUNCTION
CONTROL CONSOLE POWER/ON	Toggle switch	S1	Applies 120 vac to the power supply which, in turn, provides $\pm 52$ vdc to illuminate the control console indicators and to serve as the relay control voltage.
PHONE	Bell	DS1	Rings when antenna arc is detected.
	Jack	J1	Receptacle for sound-powered phones to permit communication between various units.
FUSE/5 AMP	Fuse	F1	Control panel main line fuse.
FUSE/SPARE	Fuse		Spare

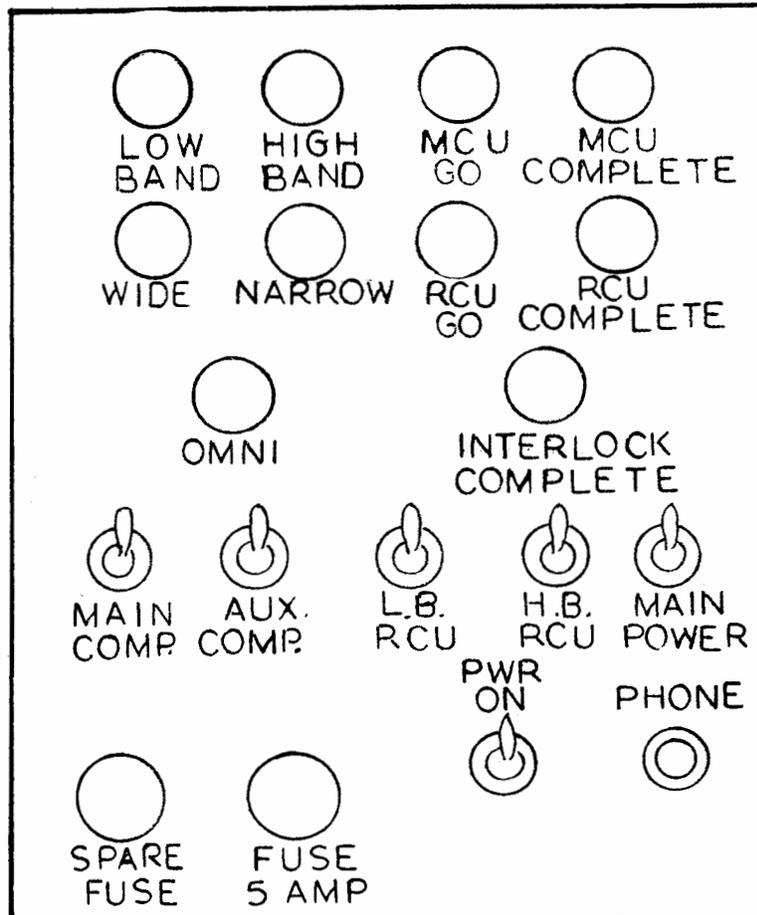


Figure 3-4. Controls and Indicators, Actuating and Sensing Assembly Indicator Panel.

Table 3-4. Controls and Indicators, Actuating and Sensing Assembly Indicator Panel.

NOMENCLATURE	DESCRIPTION	REF DES	FUNCTION
LOW BAND	Blue indicator lamp	DS1	Indicates that the low band antenna has been selected.
HIGH BAND	Blue indicator lamp	DS2	Indicates that the high band antenna has been selected.
MCU GO	Yellow indicator lamp	DS3	Indicates that both matching units are being tuned.
MCU COMPLETE	Green indicator lamp	DS4	Indicates that both matching units are tuned.
WIDE	Clear indicator lamp	DS5	Indicates wide beamwidth of active antenna.
NARROW	Clear indicator lamp	DS6	Indicates narrow beamwidth of active antenna.
RCU GO	Yellow indicator lamp	DS7	Indicates that the active reflector control unit is pressurizing the appropriate reflectors.
RCU COMPLETE	Green indicator lamp	DS8	Indicates that the reflector control unit has completed reflector selection and activation.
OMNI	Clear indicator lamp	DS9	Indicates that the active antenna is in the omni configuration.
INTERLOCK COMPLETE	Green indicator lamp	DS10	Indicates that the selected antenna is ready to transmit and that the inactive antenna is in the omni mode.
MAIN COMP.	Circuit breaker	CB1	Protects main compressor from drawing excessive current.

Table 3-4. Controls and Indicators, Actuating and Sensing Assembly Indicator Panel (Cont)

NOMENCLATURE	DESCRIPTION	REF DES	FUNCTION
AUX COMP	Circuit breaker	CB2	Protects auxiliary compressor from drawing excessive current.
L. B. RCU	Circuit breaker	CB3	Protects low band reflector control unit from drawing excessive current.
H. B. RCU	Circuit breaker	CB4	Protects high band reflector control unit from drawing excessive current.
MAIN POWER	Circuit breaker	CB5	Secondary circuit main line circuit breaker.
FUSE/5 AMP	Fuse	F1	Protects actuating and sensing assembly from drawing excessive current.
PWR ON/OFF	Toggle switch	S1	Main power switch for the actuating and sensing assembly.
PHONE	Jack	J1	Receptacle for sound-powered phones to permit communication to other units in the system.

1. Set the CONTROL CONSOLE POWER/ON switch to off.
2. Remove W28 from the 120 VAC source.
3. Remove the two leads from TB2-4 terminal, of the control panel, and connect them to TB2-3.
4. Connect W28 to the 120 vac source.
5. Place the CONTROL CONSOLE POWER/ON switch in the ON position.
6. Measure the power supply voltage on terminals TB3-1 and TB3-2. The voltage should be  $52 \pm 2$  VDC.

NOTE

The control panel power supply must deliver about 52 VDC because of the long distance (approximately 2 miles) that could exist between the control console and the actuating and sensing assembly in the remote control equipment box. This power supply voltage must not exceed 56 VDC because this will result in reduced life for the indicator lamps on the control panel.

3-10. ACTUATING AND SENSING UNIT POWER SUPPLY CHECK. To check the power supply of the actuating and sensing unit proceed with the following steps:

- a. Open the door of the remote control equipment box.
- b. Measure the AC voltage between terminals TB16-23 and TB16-24. This voltage must measure either  $240 \pm 24$  VAC or  $480 \pm 48$  VAC (50/60 Hz). The supply voltage must be within these limits, otherwise a boost transformer must be installed to provide the required voltage level. The actuating and sensing unit is wired for 480 VAC operation at the factory. If the supply voltage at the site is 240 VAC, perform steps 1 through 4 to convert the unit to 240 VAC operation:
  1. Disconnect the main power cable (W22) from the AC supply at the transmitter building.
  2. Remove the jumper from T1-2 to T1-3.
  3. Connect a jumper from T1-1 to T1-3, and from T1-2 to T1-4 using No. 12 AWG wire from a voltage rating of 1000 volts.
  4. Connect W22 to the source of main power and measure the voltage at TB16-23 and TB16-24 to verify that it is  $240 \pm 24$  VAC.

- c. Connect the multimeter to terminals 1 and 6 of TB12 with the multimeter scale switch set on an appropriate scale such that 56.0 VDC can be measured. Connect the positive lead of the meter to TB12-1 and the negative lead to TB12-6.
- d. Place the PWR ON/OFF switch, on the indicator panel in the actuating and sensing unit assembly, in the ON position. The voltage should read between 52 and 56 VDC.
- e. If the voltage is too low, proceed as follows:
  1. Turn off the MAIN POWER circuit breaker, CB5, on the indicator panel.
  2. Place the PWR ON/OFF switch in the OFF position.
  3. Disconnect the lead from transformer terminal T2-4 and connect it to T2-3.
  4. Place the MAIN POWER circuit breaker and the PWR ON/OFF switch in the ON position.
  5. Measure the power supply voltage to verify that it is between 52 and 66 VDC.
  6. If the voltage is still too low, repeat steps 1 through 5 as before except that the lead must be moved from T2-3 to T2-2.

3-11. CHECKOUT OF THE MAIN/AUXILIARY COMPRESSORS AND THE PRESSURE SWITCHES. The procedure for checking out the main compressor and associated components is described in Section D of the Maintenance Standards Book.

3-12. PRE-OPERATING PROCEDURES.

3-13. TURN-ON PROCEDURE.

WARNING

BE SURE THAT THE TRANSMITTER POWER REMAINS OFF  
UNTIL THE ANTENNA CONTROL SYSTEM IS OPERATING.

- a. Place the CONTROL CONSOLE POWER/ON switch, on the STATUS AND CONTROL assembly, in the ON position. One of the BAND-MHz indicators on the FREQUENCY control assembly will be illuminated. The lower or upper half of one of the CHANNEL MHz indicators will also be illuminated as determined by the particular band that has been activated. One of the beamwidth and bearing indicators in the DIRECTION control assembly will also be illuminated.
- b. Momentarily actuate the LAMP TEST switch on the FREQUENCY control assembly to verify that all the indicators on that assembly are lit.

- c. Momentarily actuate the LAMP TEST switch on the DIRECTION control assembly to verify that all the indicators on that assembly are lit.
  - d. Momentarily actuate the LAMP AND ALARM TEST switch on the STATUS AND CONTROL assembly to verify that all the indicators on that assembly are lit and that the alarm bell rings. Release the switch and the indicators will go out and the alarm bell will cease to ring. Only those indicators that were previously lit remain on.
  - e. Turn the ANTENNA CHANGE/TRANSMIT key-operated switch to the TRANSMIT position. Note that the TRANSMIT KEY ON indicator is on and the RF OFF indicator is lit.
  - f. Turn the ANTENNA CHANGE/TRANSMIT key-operated switch to the ANTENNA CHANGE position. The CONTROLS ENABLED indicator lights and the TRANSMIT KEY ON indicator goes out.
  - g. Turn the EMERGENCY OVERRIDE/NORMAL key-operated switch to the EMERGENCY OVERRIDE position. The EMERGENCY OVERRIDE indicator will light.
  - h. Turn the EMERGENCY OVERRIDE/NORMAL key-operated switch to the NORMAL position. The EMERGENCY OVERRIDE indicator will go out.
- 3-14. CHECK OF FREQUENCY CONTROL OPERATION. Perform the following procedure:
- a. Turn the ANTENNA CHANGE/TRANSMIT key-operated switch to the ANTENNA CHANGE position. The TRANSMIT KEY ON indicator will be off and the CONTROLS ENABLED indicator will be lit.
  - b. Press and hold the 4-11 LOW BAND pushbutton indicator until it lights and then release it. (If the 4-11 LOW BAND indicator was previously lit, no change occurs. If the HIGH BAND 11-30 indicator was lit, this indicator goes out and the 4-11 LOW BAND indicator lights.) The SYSTEM CHANGING indicator also lights. The upper portion of the selected CHANNEL MHz indicator is lit to indicate the selected frequency in the low band. The lower half of this channel indicator is off.
  - c. Depress and hold the channel 1 (4.0 - 4.3/11.0 - 11.4) indicator until the 4.0 - 4.3 portion is illuminated. All other channel indicators will be off.
  - d. Depress and hold each CHANNEL MHz pushbutton in turn. The upper half of the selected indicator lights.
  - e. Depress and hold the HIGH BAND 11-30 indicator until it lights. The 4-11 LOW BAND indicator will be extinguished.

- f. Depress and hold the channel 1 (4.0 - 4.3/11.0 - 11.4) indicator until the 11.0 - 11.4 portion is illuminated. All other channel indicators will be off.
- g. Depress and hold each CHANNEL MHz pushbutton in turn. The lower half of the selected indicator will light.

NOTE

During checkout procedures when the frequencies are increased, the time required for a change is less than when the frequencies are decreased. This is normal. For decreasing frequency changes, the frequency memory stepping relay must make one complete revolution rather than advance just one step as for an increasing frequency change.

3-15. CHECK OF DIRECTION CONTROL OPERATION. Perform the following procedure:

- a. Press the OMNI button of the beam group (NARROW, WIDE, OMNI). If the system were previously in the OMNI condition, no action will occur. Otherwise, the WIDE or NARROW indicators and the direction indicator previously lit, will go out.

NOTE

In the OMNI condition, the OMNI indicator in the beam group and in the bearing group will be lit and all other direction indicators will be extinguished.

- b. Press the WIDE button of the beam group. Both OMNI indicators will go out and the WIDE indicator will light. At the same time, one of the bearing indicators will also be illuminated.
- c. Press the NARROW button in the beam group. All indicators will remain lit as in the previous step, except the WIDE indicator will go out and the NARROW indicator will light.
- d. Depress and hold the N (NORTH) indicator, of the bearing group, until it is illuminated. If the system was in the north condition, no action will occur. Otherwise, the previously lit indicator will go out and the north indicator will light.
- e. Depress and hold each bearing indicator (NW, W, SW, etc.) in turn and note that each indicator will light.
- f. Repeat steps d and e for the WIDE beamwidth position.

3-16. CHECK OF START BUTTON OPERATION. To check the START button operation, perform the following procedure:

a. Switch the antenna to the following configuration:

1. Low Band
2. Channel 1 (4.0 - 4.3/11.0 - 11.4)
3. Wide
4. North

NOTE

The indicators, CONTROLS ENABLED, SYSTEM CHANGING, and RF OFF, of the STATUS AND CONTROL assembly are illuminated. Other indicators may be lit but their condition is unimportant for this sequence of tests.

b. Depress the START button on the DIRECTION control assembly. Both halves (TUNE and STEER) of the indicator are illuminated. This is an indication that reflector and/or matching unit changes are taking place. Within two minutes both portions of the indicator will go out.

NOTE

When the START indicator goes out, the CHANGE COMPLETED indicator will be illuminated, and the SYSTEM CHANGING indicator will go out.

3-17. CHECK OF PROGRAMMING. Check the programming of the matching units and the reflector control units as described in Section A of the Maintenance Standards Book. In addition check reflector switch operation as outlined in Section 5 paragraphs 5-19 through 5-20 of this manual.

3-18. CHECK OF GATE INTERLOCK CIRCUITS. The gate interlock circuits are designed to disable the transmitter when the gate to the active antenna is opened. Each circuit is arranged so that the gate must be closed first and then the interlock reset switch be actuated from outside the fence. The interlock reset switch is a momentary-action toggle switch that is located on the gate interlock junction box which is eight feet away from the gate interlock proximity switch. This reset switch prevents operating personnel from simply opening the gate, going into the active antenna site and closing the gate behind them to close the interlock circuit. The procedure for checkout of the gate interlock circuits is described in Section A of the Maintenance Standards Book.

3-19. CHECK OF TRANSFORMER OIL.

CAUTION

CLEANLINESS IS EXTREMELY IMPORTANT. EVERY EFFORT MUST BE MADE TO PREVENT OIL CONTAMINATION AND TO KEEP FOREIGN PARTICLES OUT OF THE INTERNAL PORTION OF THE MATCHING UNITS. TO PREVENT CONTAMINATION BY ATMOSPHERIC MOISTURE, KEEP THE HOUSINGS COVERED EXCEPT WHEN MAINTENANCE WORK IS IN PROGRESS.

3-20. The procedures for checking the level of the transformer oil and the dielectric properties of the oil are described in Section B of the Maintenance Standards Book.

3-21. IMPEDANCE MEASUREMENT AND CALIBRATION OF THE MATCHING UNITS.

WARNING

WHENEVER WORKING ON THE ANTENNA STRUCTURE OR THE TRANSMISSION LINE, TURN OFF AND DISABLE THE TRANSMITTER SO IT CANNOT BE TURNED ON BY UNAUTHORIZED PERSONNEL. WHEN THE TRANSMITTER IS ENERGIZED, THE RF VOLTAGE ON THE ANTENNA WILL BE ABOUT 6000 VOLTS. DO NOT ENTER THE FENCED-IN AREA OF EITHER MONOPOLE WHEN THE TRANSMITTER IS ENERGIZED BECAUSE OF THE GREAT AMOUNT OF RADIATING ENERGY PRESENT. FAILURE TO OBSERVE THIS WARNING WILL RESULT IN DEATH OR SERIOUS INJURY TO PERSONNEL.

3-22 The impedance of both the high band and the low band monopoles must be measured immediately after the initial installation to verify that the matching units are "tuning" the antenna to the transmitter. The impedance test is not required at other times unless a component (such as a variable capacitor, a vacuum switch, or an inductor), is replaced in the matching unit proper. If one of the vacuum switches is replaced, the impedance is measured at those frequencies where the switch is used to connect a component into the circuit. The impedance is measured at the two limit frequencies and the center frequency of each range as marked on the corresponding pushbutton. Enter the numerical results in the appropriate columns of the table provided for this purpose in the Maintenance Standards Book. This table will be a permanent written record of impedance over the entire frequency band of the antennas. Plot the values on the Smith charts which also become permanent records for these particular monopoles. The entire test is made in both beamwidths and at two orthogonal directions and repeated entirely for the omnidirectional mode. Impedance measurement requires two men. One man is stationed at the matching unit to observe the operation of the various components, perform the

impedance test, and relay instructions, over the sound-powered phones, to the second man located at the control console. The procedure for impedance measurement is described in Section B of the Maintenance Standards Book.

3-23. Table 3-5 shows what components (capacitors and inductors) that are used in each of the frequency bands for both the high and low band matching units. If the low band antenna is selected for a frequency of 4.0 - 4.3 MHz, the mounting plate assembly, A4 of the matching unit becomes operational. The six dog washer shaft assemblies, on the meter assembly plate of A4 rotate until the shaft adjacent to the microswitch S1 becomes "locked in" by the actuating cam as shown in figure 3-5. Table 3-5 also shows that the stepping relay, K1, is in position 1. When a frequency change is desired, for example, to 8.9 - 9.5 MHz, the stepping relay moves to position 8 and the tuning capacitor, C1, of mounting plate assembly, A2 is tuned in the circuit. The previous condition of A4 remains the same until a frequency change is performed to cause the dog washers to rotate to a different position.

#### 3-24. PLOTTING ANTENNA IMPEDANCE ON A SMITH CHART.

The Smith chart, a circular graph shown in the Maintenance Standards Book can be used to plot impedances of transmission lines and antennas. Charts are made for different characteristic impedances of equipment under test. Charts differ in the coordinate numbering and are identified in the title as to the characteristic impedance for which they are designed. The coordinates for resistance are the values on the straight centerline of the chart. The values on the right half of the chart are the coordinates for inductive reactance and the values on the left half of the chart are the coordinates for capacitance reactance. The chart pictured is designed for 50 ohm characteristic impedance.

3-25. For unbalanced transmission, take resistance and reactance readings from the General Radio Impedance Bridge Test Instrument. Find out whether the reactance value is inductive or capacitive reactance by comparing the reactance value with the initial setting of the instrument. If the reading is larger than the initial setting, the difference is positive which means inductive reactance. If the reading is less than the initial setting, the difference is negative which means capacitive reactance.

3-26. To plot a point on the chart, find the resistance value on the straight centerline of the chart; the circle intersecting at this point is the resistance circle. Find the reactance value at the rim of the outer circle remembering that inductive reactance is to the right of the straight centerline and capacitive reactance to the left of the straight centerline. Follow the reactance line from the rim of the outer circle to the point where it intersects with the resistance circle found. Place the dot at this intersection point and label it with the test frequency used.

3-27. To determine the VSWR at a given frequency, set the pointed leg of a compass at the point marked 50 on the straight centerline. Place the pencil on the dot previously plotted representing the frequency. Swing an arc from the dot toward the centerline (bottom half, where the circles get smaller). The value, read directly from the resistance line, divided by 50, is the VSWR.

Table 3-5. Matching Unit Elements by Program.

KI MCU POSITION	CHANNEL MHZ		BEAM	LOW BAND						HIGH BAND					
				A2		A3		A4		A2		A3		A4	
				A1 S L	A2 S C										
1	1	4.0-4.3 11.0-11.4	WIDE/ NARROW						S1						S1
2	2	4.3-4.6 11.4-12.0	WIDE/ NARROW	X	X				S2	X					S2
3	3	4.6-5.2 12.0-13.0	WIDE/ NARROW	X					S3	X					S3
4	4	5.2-5.9 13.0-14.7	WIDE/ NARROW	X					S4	X					S4
5	5	5.9-6.7 14.7-17.6	WIDE/ NARROW	X						X					
6	6	6.7-7.8 17.6-19.6	WIDE/ NARROW			X						X			
7	7	7.8-8.9 19.6-22.8	WIDE/ NARROW					X						X	
8	8	8.9-9.5 22.8-24.8	WIDE/ NARROW		X						X				
9	9	9.5-10.0 24.8-26.8	WIDE/ NARROW				X					X			
10	10	10.0-11.0 26.8-30.0	WIDE/ NARROW						S5						S5
11	1 THRU 4	4.0-4.3 11.0-11.4 5.2-5.9 13.0-14.7	OMNI												
12	5	5.9-6.7 14.7-17.6	OMNI	X	X					X	X				
13	6 AND 7	6.7-7.8 17.6-19.6 7.8-8.9 19.6-22.8	OMNI			X	X					X	X		
14	8 AND 9	8.9-9.5 22.8-24.8 9.5-10.0 24.8-26.8	OMNI		X						X				
15	10	10.0-11.0 26.8-30.0	OMNI												

OPERATION

AN/FRA-109  
OPERATION

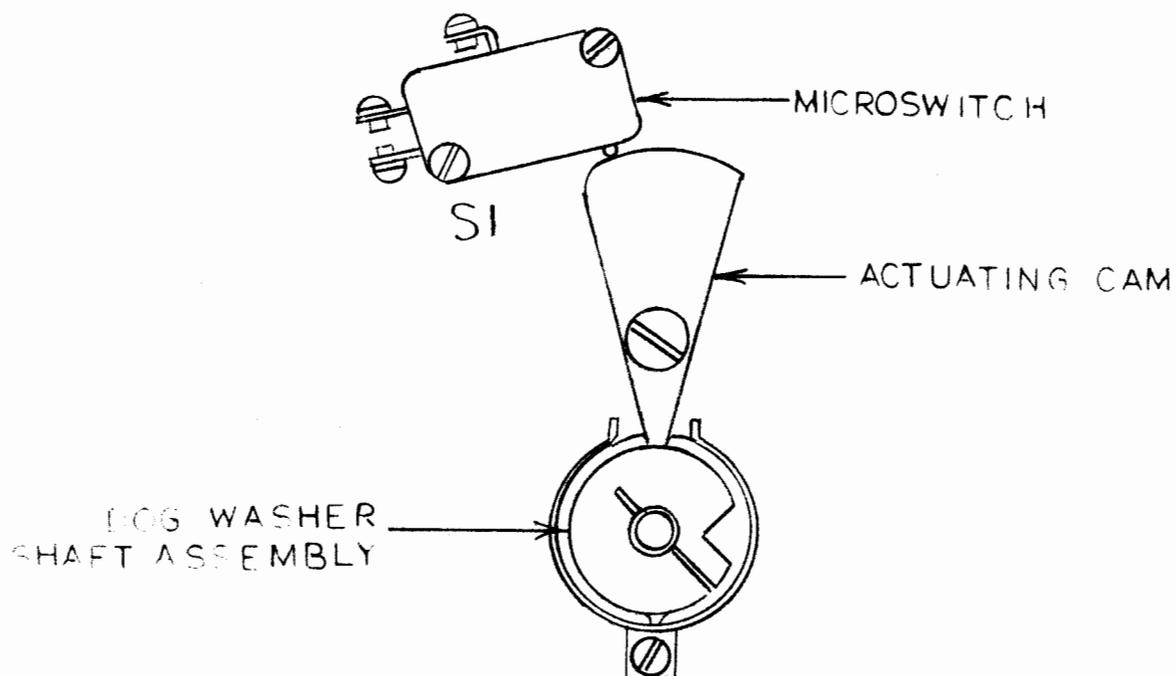


Figure 3-5. Tuning of Plate Assembly A-4, Typical.

NOTE

On charts designated for specific characteristic impedances, the resistance line reading must be divided by the characteristic impedance to obtain the correct VSWR value.

3-28. VARIABLE CAPACITOR AND MOTOR-DRIVEN CAPACITOR ADJUSTMENT FOR HIGH INPUT VSWR.

3-29. If the impedance measurements indicate the input VSWR being greater than that 2.0:1, noted in the Maintenance Standards Book, a change in the setting of the variable capacitors and the motor-driven capacitor may be indicated. A correct capacitance setting will cause approximately equal VSWR to be obtained at the lower and upper extremes of a particular frequency range. Be sure that the positioning of other components of the system, such as the reflectors, is correct before changing any capacitance setting.

3-30. The procedure for adjustment of the variable capacitors on plates A2 and A3 is as follows:

- a. Set the impedance test equipment to the frequency, in a particular band, where the high VSWR occurred. Refer to table 3-5 for components to be adjusted.
- b. Refer to figure 3-6. Loosen the cable clamp which holds the variable capacitor shaft and prevents it from turning. Slip the clamp off the shaft.

NOTE

The end of the capacitor shaft is slotted so it can be turned with a screwdriver.

- c. Rotate the shaft about one turn and recheck the impedance to see if the capacitance change was in the right direction. The capacitor must be adjusted so that the VSWR is less than 2.0:1 at both ends of the frequency channel and in both the wide and narrow beamwidths.
- d. Secure the cable clamp on the capacitor shaft.

3-31. The procedure for adjustment of the motor-driven capacitor on plate A4 is as follows:

- a. Set the impedance test equipment to the frequency at which the high VSWR occurred. Refer to table 3-5 for components to be adjusted.
- b. Check whether the microswitch, for the particular capacitor setting, is opened or closed by the actuating cam when the capacitor drive motor is stopped. Refer to figure 3-7.

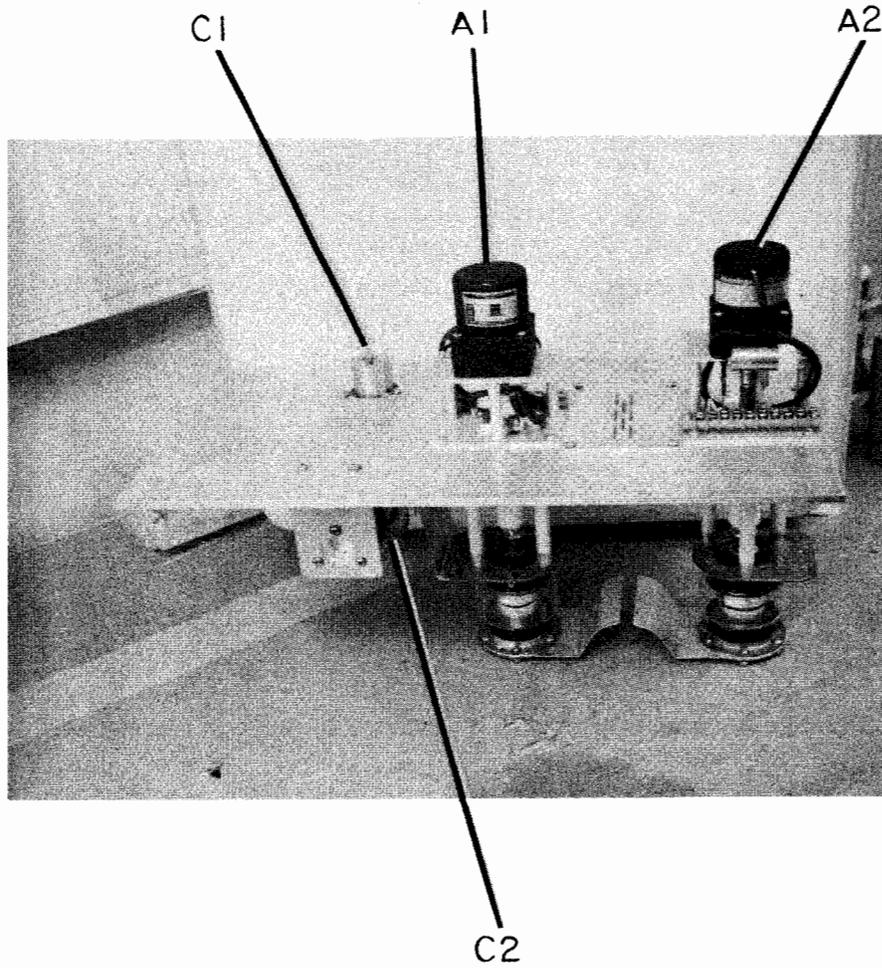


Figure 3-6. Component Location on A2 and A3 Mounting Plate Assembly.

- c. Place the PWR ON/OFF switch, in the control box, in the OFF position.
- d. Rotate the capacitor gear drive until the impedance value, which is equivalent to a VSWR of less than 2.0:1, is measured on the impedance bridge.
- e. Remove the hub-clamp assembly from the shaft.
- f. Adjust the number of dog-washers on the shaft until the correct number just causes the microswitch to be activated as described in step b.
- g. Replace the hub-clamp assembly on the shaft. Place a .012 feeler gauge, for correct tolerance, between the hub-clamp assembly and the top dog-washer. Tighten the hub-clamp assembly.
- h. Place the PWR ON/OFF switch, in the control box, in the ON position.
- i. Instruct the man at the control console to change channels. When the START lamp on the control panel goes out following channel selection, return to the previous frequency setting.
- j. Recheck the impedance. If further adjustment is necessary repeat steps b through i.

3-32. CHECK OF VSWR MONITOR AND RF ON/RF OFF CIRCUITRY.

3-33. After verifying that the complete control system is working normally, the VSWR monitor and the RF ON/RF OFF circuitry can be checked. The procedure for checking the VSWR monitor and RF ON/RF OFF circuitry is described in Section A of the Maintenance Standards Book.

3-34. NORMAL OPERATING PROCEDURE.

3-35. The following procedure is to be used when a change in the antenna configuration is desired:

- a. Set the CONTROL CONSOLE POWER/ON switch to the ON position.
- b. Place the AUXILIARY COMPRESSOR/MAIN COMPRESSOR switch, on the control panel, in the MAIN COMPRESSOR position. The MAIN COMPRESSOR IN-OPERATIVE indicator will be illuminated if the compressor has been inoperative for a long period of time prior to applying power. The indicator will remain lit until the pressure in the accumulator tank reaches a value in excess of 60 psig which should take a maximum of 40 minutes. If the indicator remains lit at the end of that time, set the AUXILIARY COMPRESSOR/MAIN COMPRESSOR switch to the AUXILIARY COMPRESSOR position. If the MAIN COMPRESSOR IN-OPERATIVE indicator still remains lit at the end of 40 minutes, refer to Section 4 of this manual for troubleshooting procedures.

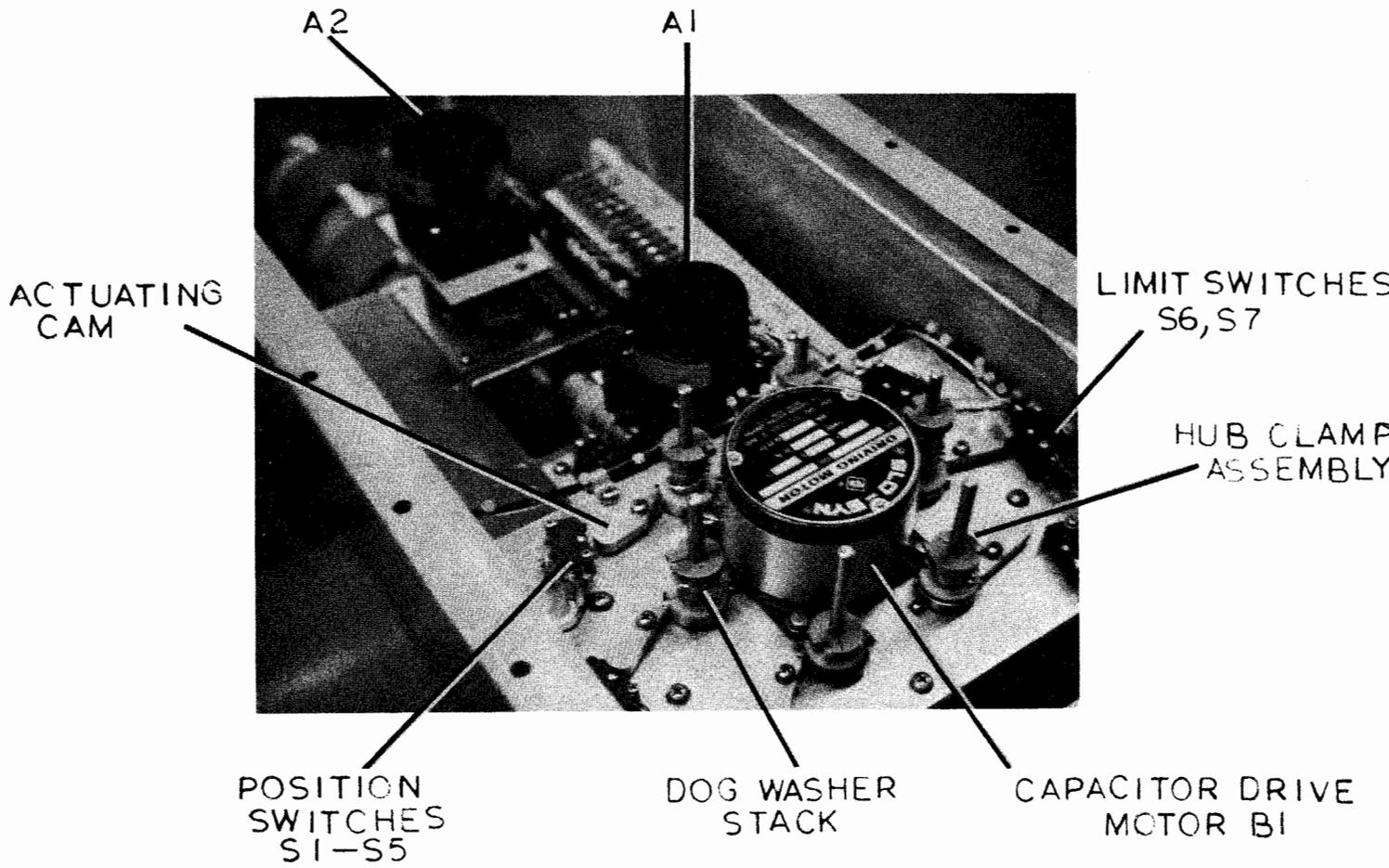


Figure 3-7. Component Location on A4 Mounting Plate Assembly.

- c. Place the EMERGENCY OVERRIDE/NORMAL switch in the NORMAL position and the ANTENNA CHANGE/TRANSMIT switch in the ANTENNA CHANGE position.
- d. Verify that the GATE OPEN indicator is not lit and that the CHANGE COMPLETED, CONTROLS ENABLED, and RF OFF indicators are lit.
- e. Select either the low or the high band antenna by depressing and holding in, until illuminated, the desired band pushbutton in the BAND-MHZ group on the FREQUENCY control assembly. The CHANGE COMPLETED indicator will go out and the SYSTEM CHANGING lamp will come on.
- f. Select the desired frequency channel by depressing and holding in, until illuminated, the appropriate CHANNEL MHZ pushbutton.
- g. Select the desired beamwidth (NARROW, WIDE, or OMNI) by depressing and holding in until illuminated, the appropriate indicator.
- h. Select the desired bearing by depressing and holding in, until illuminated, the appropriate indicator.
- i. Depress and release the START pushbutton on the DIRECTION control assembly. Both halves of the indicator (TUNE AND STEER) will light and will go out after period of two minutes (maximum). The SYSTEM CHANGING light goes out and the CHANGE COMPLETED indicator will come on.
- j. Place the ANTENNA CHANGE/TRANSMIT switch in the TRANSMIT position. The CONTROLS ENABLED light goes out and the TRANSMIT KEY ON indicator comes on.

#### NOTE

The transmitter is now ready to be energized. When the transmitter is operating at its rated power output, the RF OFF light on the STATUS AND CONTROL assembly, goes out and the RF ON lamp comes on.

#### 3-36. EMERGENCY OPERATING PROCEDURES.

3-37. An interlock circuit within the antenna set prevents unsafe operation of the system and provides a means of emergency operation during partial loss of electrical power. If a partial loss of electrical power should occur within any of the units, the interlock circuit is broken, thereby automatically turning off the transmitter.

3-38. If it is necessary to transmit during such an emergency, when the interlock circuit is not complete, the interlock may be bypassed by the EMERGENCY OVERRIDE/NORMAL key-operated switch on the control panel. Emergency transmission should be performed only in the omni mode. Should partial loss of electrical power occur, depress

the OMNI pushbutton to insure that the system will be in the omni mode if it has not done so automatically. If there is loss of air, the reflector system will automatically revert to the omni mode (all reflector switches open). The procedure for emergency operation during partial loss of electrical power is as follows:

#### WARNING

THE EMERGENCY INTERLOCK OVERRIDE KEY-OPERATED SWITCH ON THE CONTROL PANEL MUST BE USED ONLY IN CASE OF EXTREME EMERGENCY. THE OPERATOR MUST MAKE CERTAIN THAT THE RF CIRCUIT IS IN OPERATING CONDITION. SEVERE DAMAGE TO THE ANTENNA, TRANSMISSION LINE, OR TRANSMITTER MAY OCCUR FROM OPERATING IN A MISMATCHED CONDITION. FURTHERMORE, HIGH VOLTAGES FROM THE TRANSMITTER OR ARC PROTECTION CIRCUIT MAY BE PRESENT AND ARE EXTREMELY DANGEROUS TO PERSONNEL.

- a. Disable the transmitter so it cannot be turned on by unauthorized personnel.
- b. Observe the coaxial RF power transfer switch at the transmission line tee. Manually depress the pushbutton on the side of the switch nearest the antenna to be energized. Enter the compressor shed and exhaust the air from the compressor air tank by pulling on the pressure relief valve (see figure 16 in the Maintenance Standards Book).

#### CAUTION

DO NOT OVERRIDE THE INTERLOCK SYSTEM UNTIL IT IS DETERMINED THAT THE PROPER ANTENNA IS SELECTED AND THAT THE MATCHING UNIT TO THE SELECTED ANTENNA IS PROPERLY TUNED.

- c. Enter the fenced enclosure around the antenna to be used. Open the matching unit housings and inspect the appropriate vacuum switches for proper configuration. Refer to table 3-5 to determine which vacuum switches are to be connected in the circuit at a desired frequency for operation in the omni mode. For example, to transmit in the frequency of 5.9-6.7 or 14.7-17.6 MHz (depending upon which antenna is to be used), the vacuum switches, A2A1S1 and A2A2S1 must be closed and all other vacuum switches must be open. To close the vacuum switches, rotate the hexagonal shaft counterclockwise approximately seven turns. To open the other switches rotate the hexagonal shaft clockwise approximately seven turns. Observe whether the switches are opened or closed by looking into the glass bulb on the lower end of the vacuum switches.

#### CAUTION

CARE MUST BE EXERCISED DURING ROTATION OF THE SHAFTS AS EXCESS TORQUE WILL SNAP THE SHAFT COUPLING.

WARNING

ENSURE THAT THE FENCE GATES ARE CLOSED AND THERE IS NO PERSONNEL WITHIN THE FENCED ENCLOSURES PRIOR TO TURNING ON THE TRANSMITTER.

- d. When steps b and c have been satisfactorily accomplished, set the EMERGENCY OVERRIDE/NORMAL switch to EMERGENCY OVERRIDE position and the EMERGENCY OVERRIDE indicator will light. Transmitter power may now be turned on.

3-39. Another cause for invoking emergency operation procedures is the loss of air pressure to the reflectors. If, while transmitting in a directional mode and loss of air pressure to the reflectors occurs, the reflector switches become deactivated. With the loss of air pressure the MAIN COMPRESSOR INOPERATIVE lamp, on the control panel, lights. The deactivation of the switches places the reflectors in the omni mode but the matching units remain in the directional mode. The matching units must be reprogrammed to the OMNI mode to permit resumption of the transmission. See paragraph 3-38, step c, for procedure. The procedure for emergency operation during loss of air pressure is as follows:

- a. Place the AUXILIARY COMPRESSOR/MAIN COMPRESSOR switch, on the control panel, in the AUXILIARY COMPRESSOR position.

NOTE

The MAIN COMPRESSOR INOPERATIVE lamp will remain lit because enough pressure cannot build up in the compressor tank, during this emergency to cause the lamp to go out.

- b. Proceed with the normal operating procedures, as described in paragraph 3-34 of this section. If time does not permit troubleshooting of the pressure system, as noted in step b of the normal operating procedures, proceed with steps c through j.

NOTE

Depress the OMNI pushbutton to tune the matching units to the proper reflector mode.

SECTION 4  
TROUBLESHOOTING

4-1. GENERAL.

4-2. This section contains information for troubleshooting the antenna set. Included in this section are: simplified functional descriptions, detailed functional analysis, and troubleshooting procedures. The simplified functional descriptions define the operation of the system as a whole, showing functional interrelationship between the various units. The detailed functional analysis examines specific details of circuit implementation, describing signal flow and switching characteristics and sequences. A functional block diagram of the antenna set appears in figure 4-1. Troubleshooting procedures are based on methods outlined in NAVSHIPS 91828, Handbook of Test Methods and Practices.

4-3. SIMPLIFIED FUNCTIONAL DESCRIPTION.

4-4. The antenna set can be programmed to beam RF radiation in any of eight compass directions by activating or deactivating various groups of 16 reflectors that are arranged in a circular pattern around each monopole antenna as shown typically in figure 4-2. A group of activated reflectors on one side of the central monopole forms a reflecting screen which directs the energy in the opposite direction. For example, to direct radiation to the north at a given frequency, a predetermined number of reflectors (four, six, or eight), depending on beamwidth and frequency selected, are activated on the south side of the circle while the remaining reflectors are deactivated. The direction is set by depressing a single pushbutton on the DIRECTION control assembly on the control console. The beamwidth at a given frequency depends upon the number of active reflectors. Table 4-1 lists the number of reflectors activated versus the beamwidth selected. In the lower frequency range of each monopole antenna (low band channels; 4.0-6.9 MHz, high band channels; 11.0-17.6 MHz) four reflectors produce a wide beam and six reflectors produce a narrow beam. In the middle frequency range (low band channels; 6.9-10.0 MHz, high band channels; 17.6-26.8 MHz) four reflectors produce a wide beam and eight reflectors produce a narrow beam. In the highest frequency range (low band channels; 10.0-11.0 MHz, high band channels; 26.8-30.0 MHz) six reflectors produce a wide beam and eight reflectors produce a narrow beam. Selection of a wide or narrow beam is accomplished by depressing a single pushbutton on the DIRECTION control assembly. Omnidirectional radiation is achieved through deactivation of all reflectors by depressing a single pushbutton (OMNI) on the DIRECTION control assembly on the control panel. Concurrent with the reflector activation, the active antenna is matched to the transmission line for one of the ten channels within the band. Matching is accomplished by connecting a particular combination of reactive elements (inductors and capacitors), in the matching units, to the transmission line. Figures 4-3 through 4-8 illustrate various radiation patterns, directive gain, and front-to-back ratio of the antenna set.

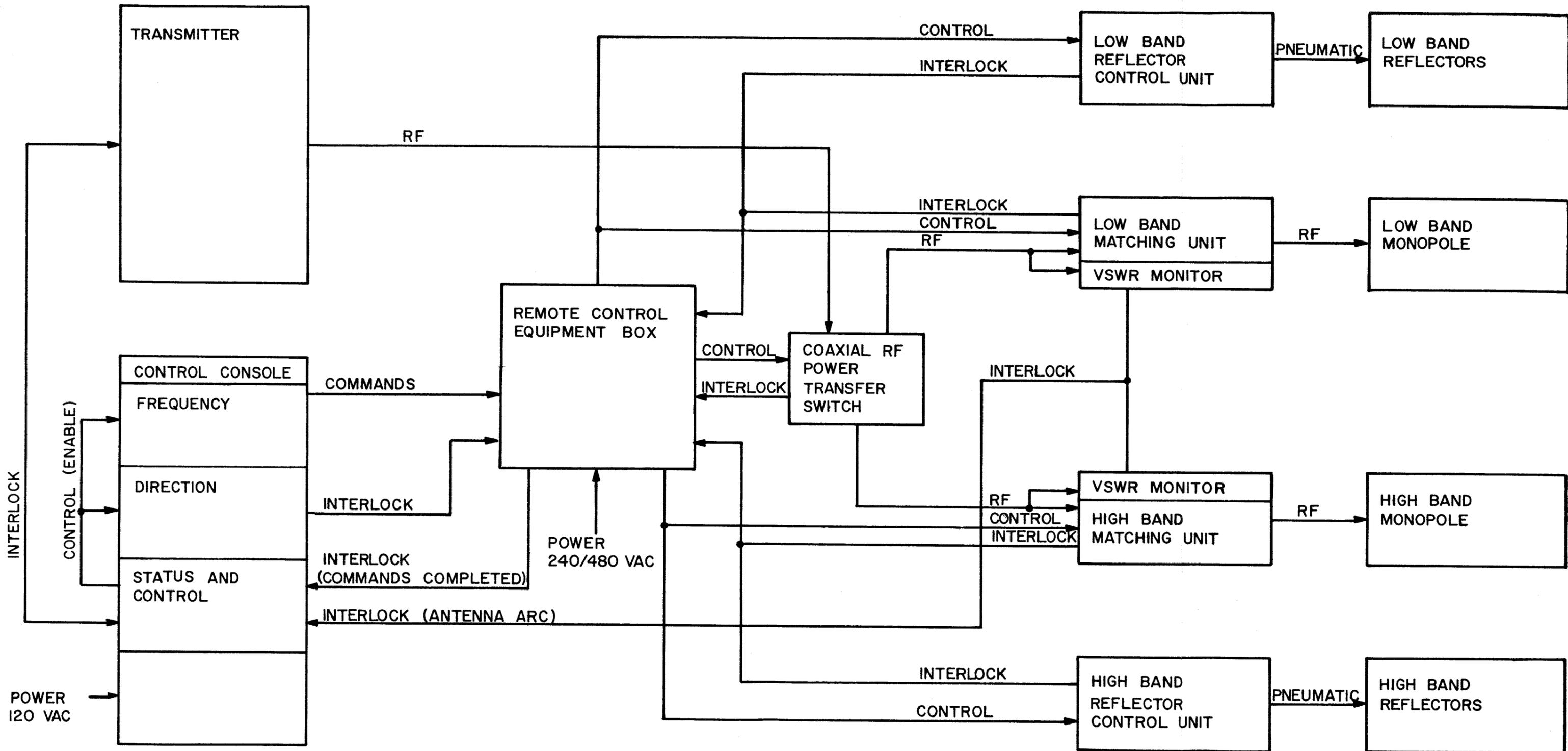


Figure 4-1. Antenna Set, AN/FRA-109 Functional Block Diagram.

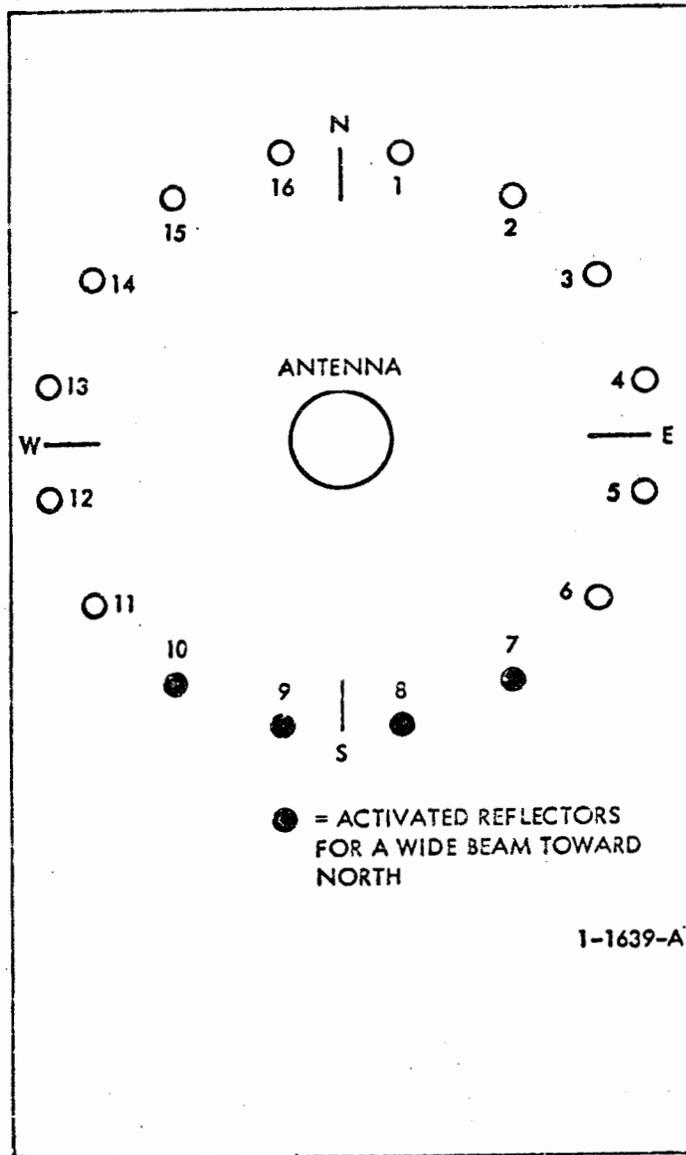


Figure 4-2. Reflector Arrangement and Typical Activation.

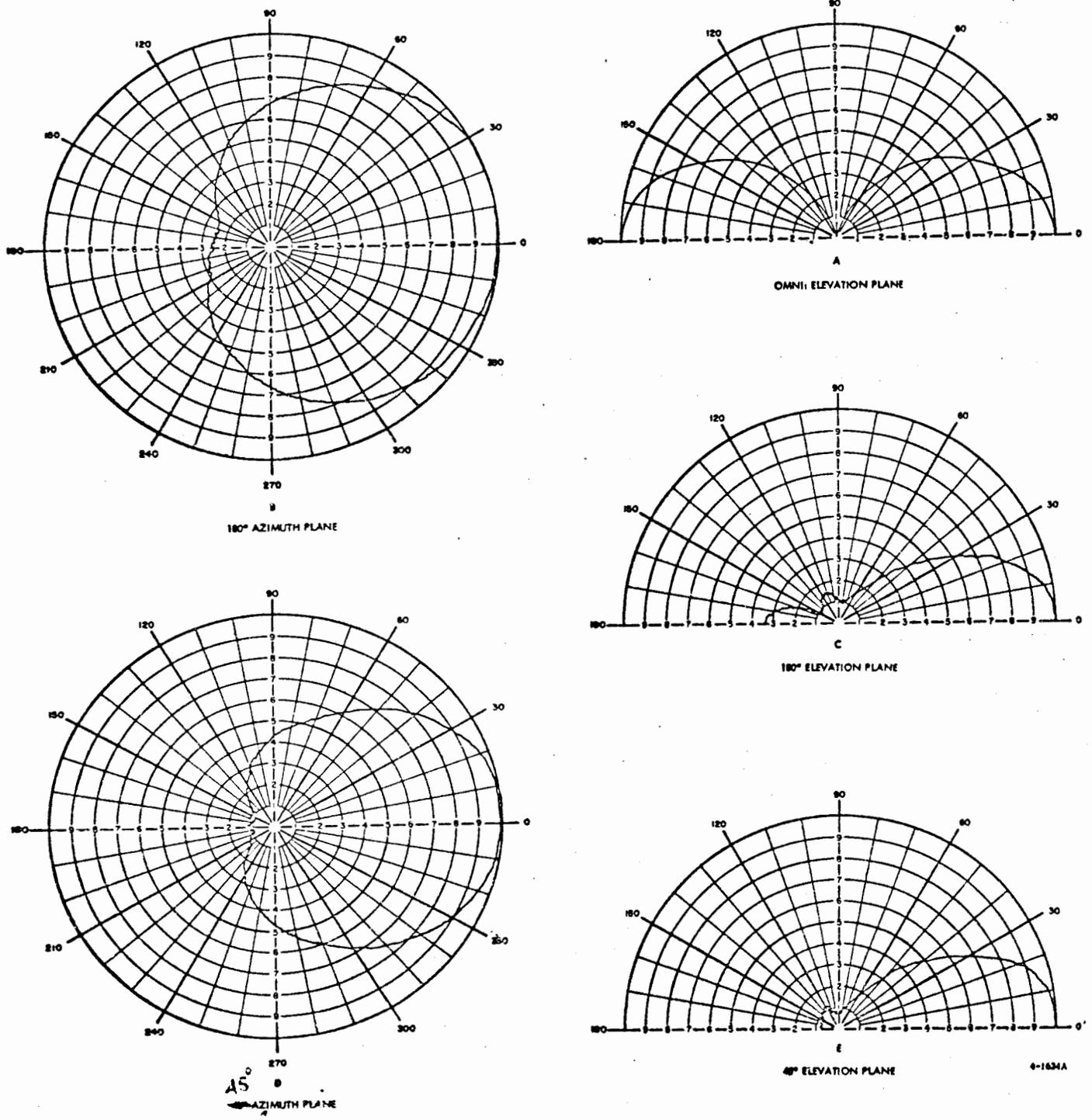


Figure 4-3. Radiation Patterns in Relative Field Strength Over Perfect Ground.

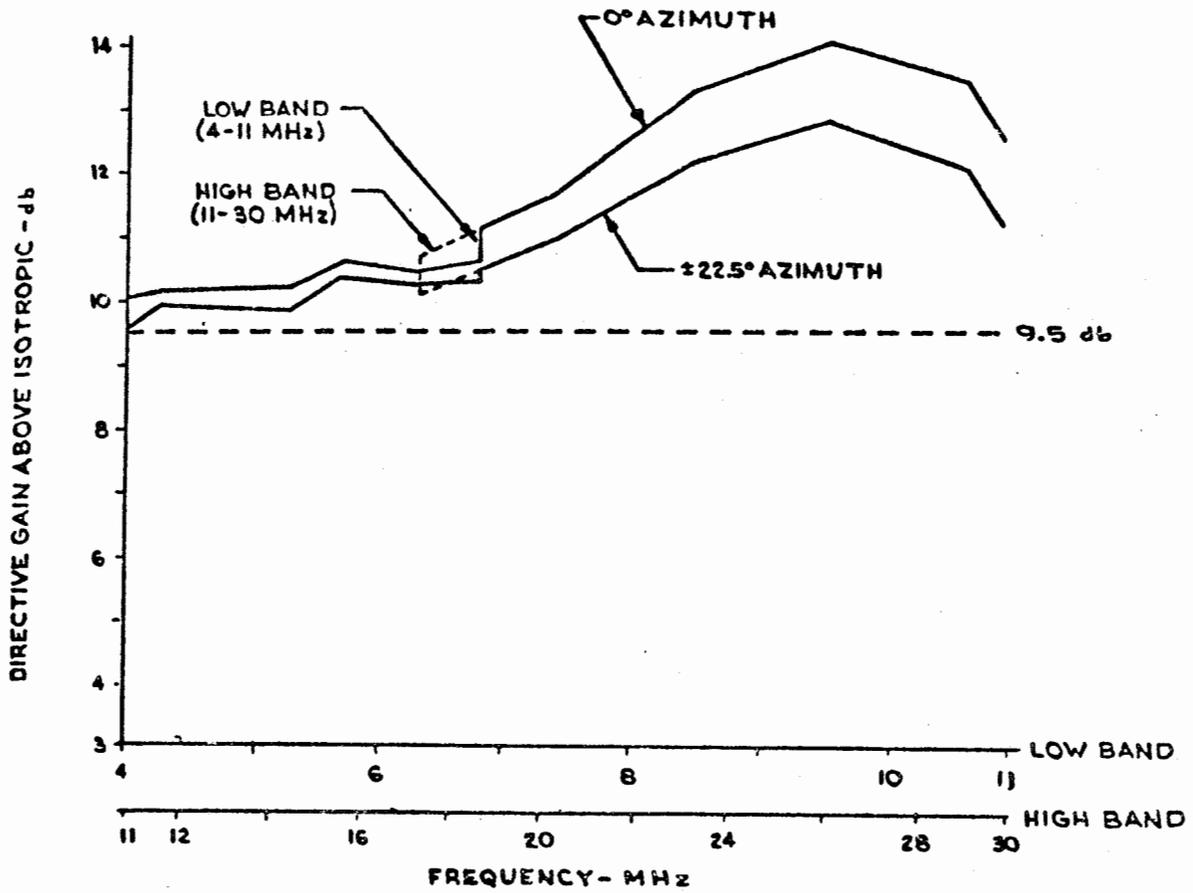


Figure 4-4. Directive Gain, Narrow Beam Mode.

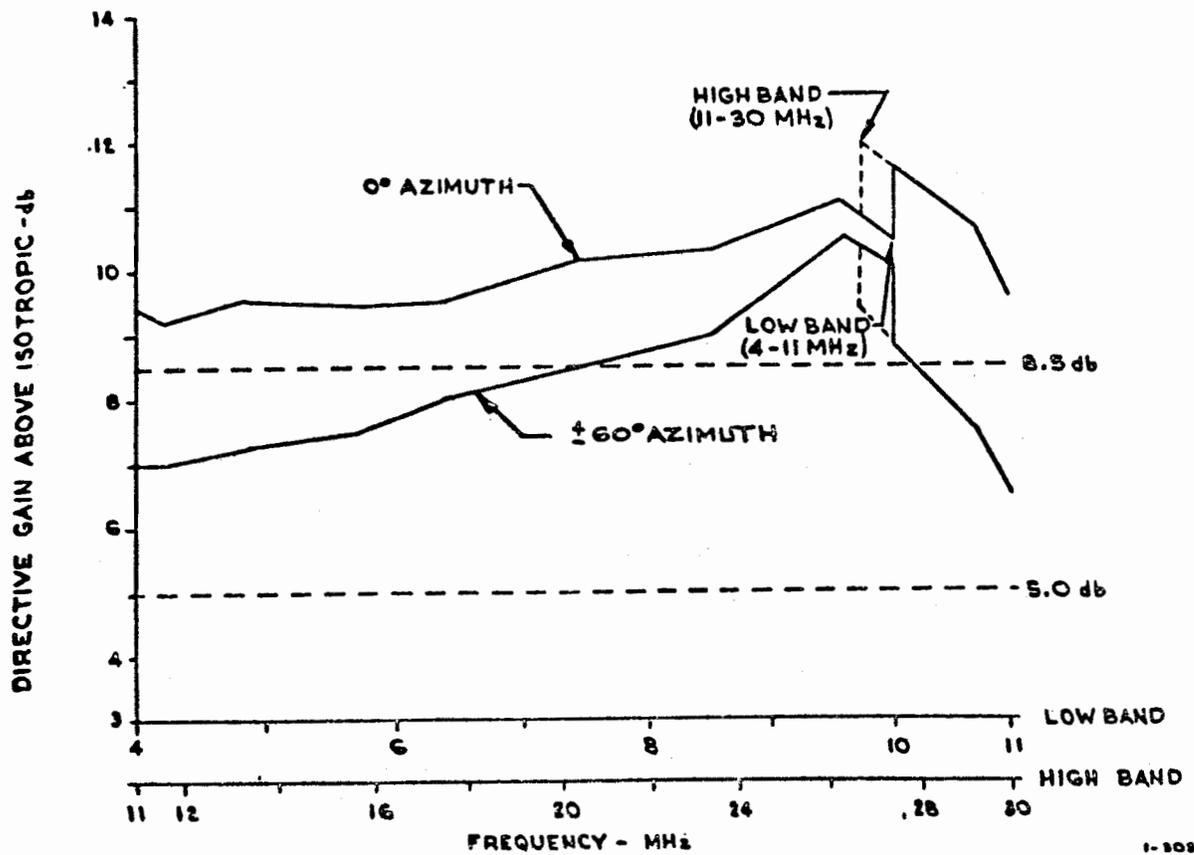
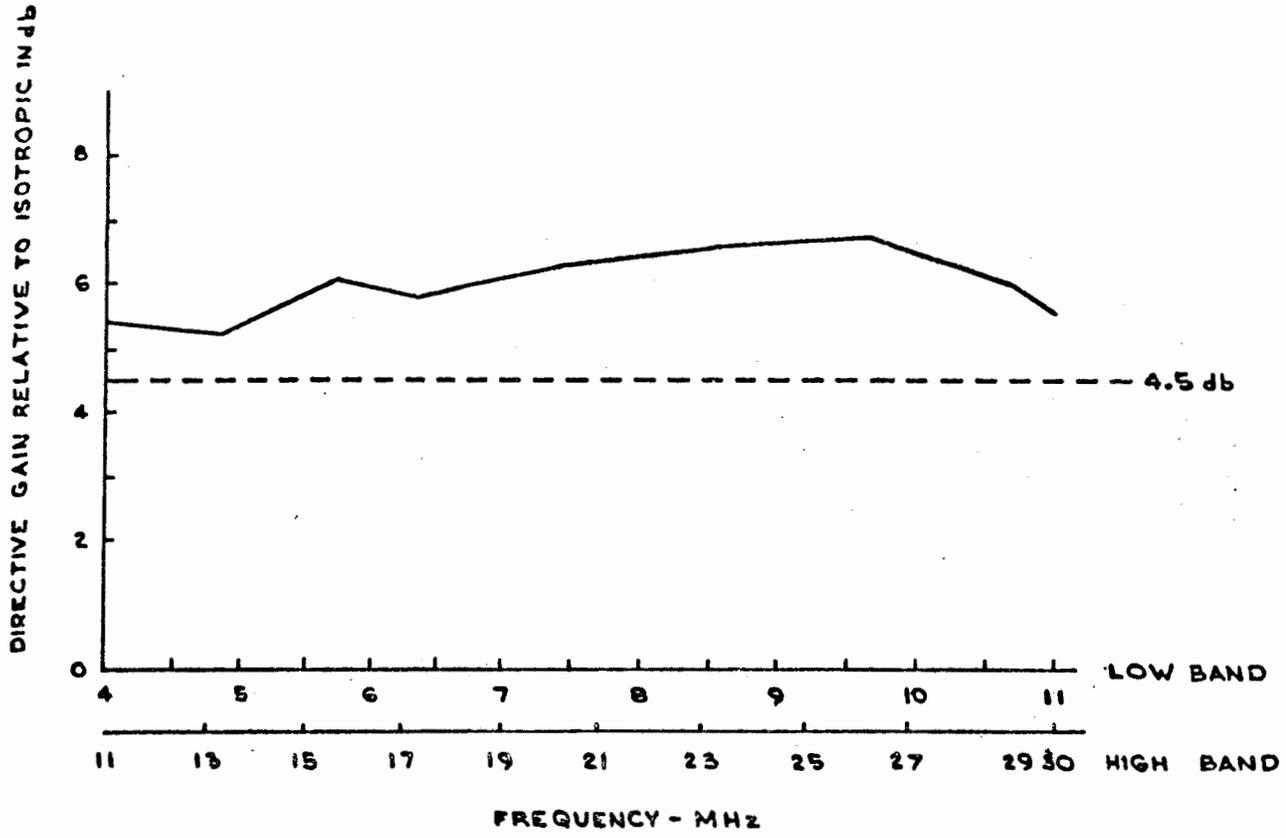


Figure 4-5. Directive Gain, Wide Beam Mode.



1-5080-A

Figure 4-6. Directive Gain, Omnidirectional Mode.

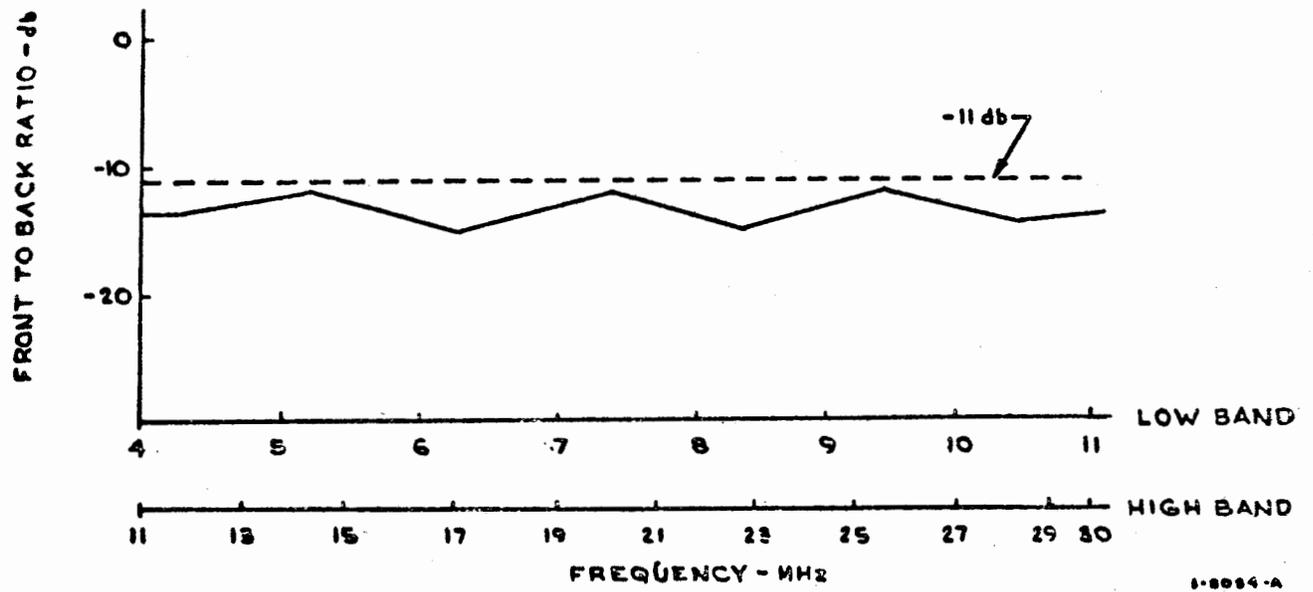


Figure 4-7. Front-to-Back Ratio Vs. Frequency, Narrow Beam Mode.

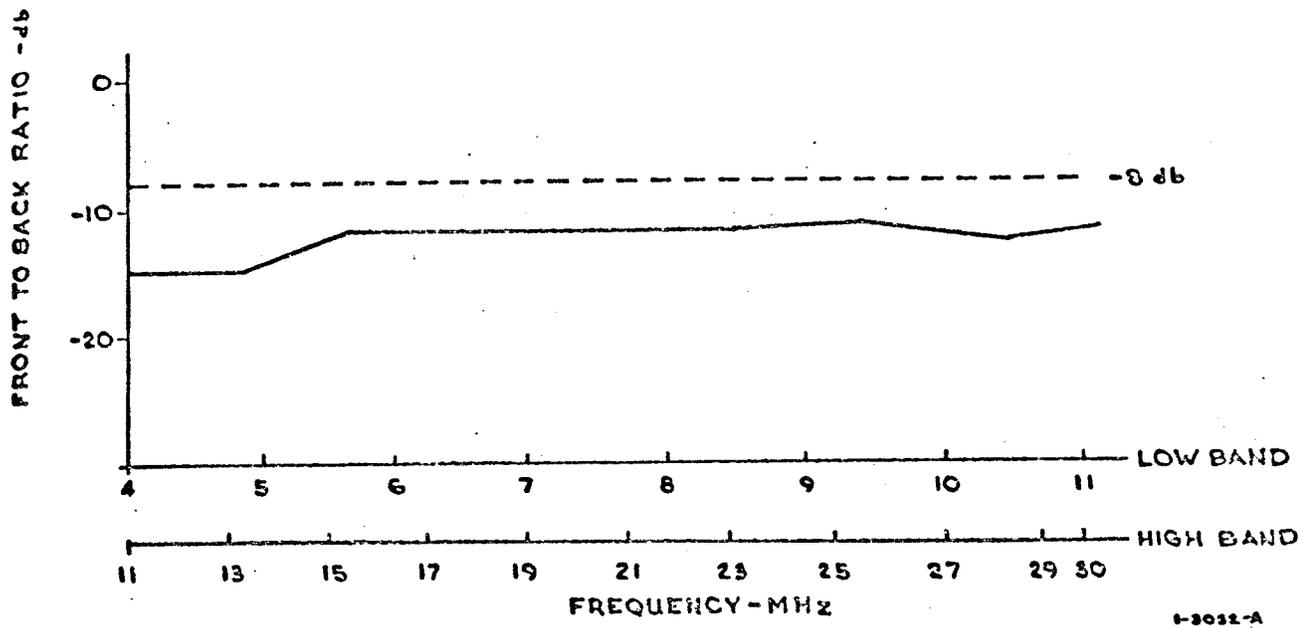


Figure 4-8. Front-to-Back Ratio Vs. Frequency, Wide Beam Mode.

Table 4-1. Reflector Activation vs Beamwidth.

Frequency Range	Band	Beamwidth	No. of Active Reflectors
Low	Low (4.0 - 6.9 MHz)	Wide	4
		Narrow	6
	High (11.0 - 17.6 MHz)	Wide	4
		Narrow	6
Mid	Low (6.9 - 10.0 MHz)	Wide	4
		Narrow	8
	High (17.6 - 26.8 MHz)	Wide	4
		Narrow	8
High	Low (10.0 - 11.0 MHz)	Wide	6
		Narrow	8
	High (26.8 - 30.0 MHz)	Wide	6
		Narrow	8

4-5. FUNCTIONAL DIVISIONS.

4-6. The antenna set is divided into three functional divisions: the control console, located in the transmitter building; the coaxial RF power transfer switch and remote control equipment box, located at the junction of the transmission lines, and the low and high band radiating groups. These functional divisions are interfaced as shown in the block diagram in figure 4-1 and described in the following paragraphs.

4-7. CONTROL CONSOLE.

4-8. The control console consists of a control panel which is made up of the FREQUENCY control assembly, the DIRECTION control assembly, and the STATUS AND CONTROL assembly. See figure 4-9 for a block diagram of the control console.

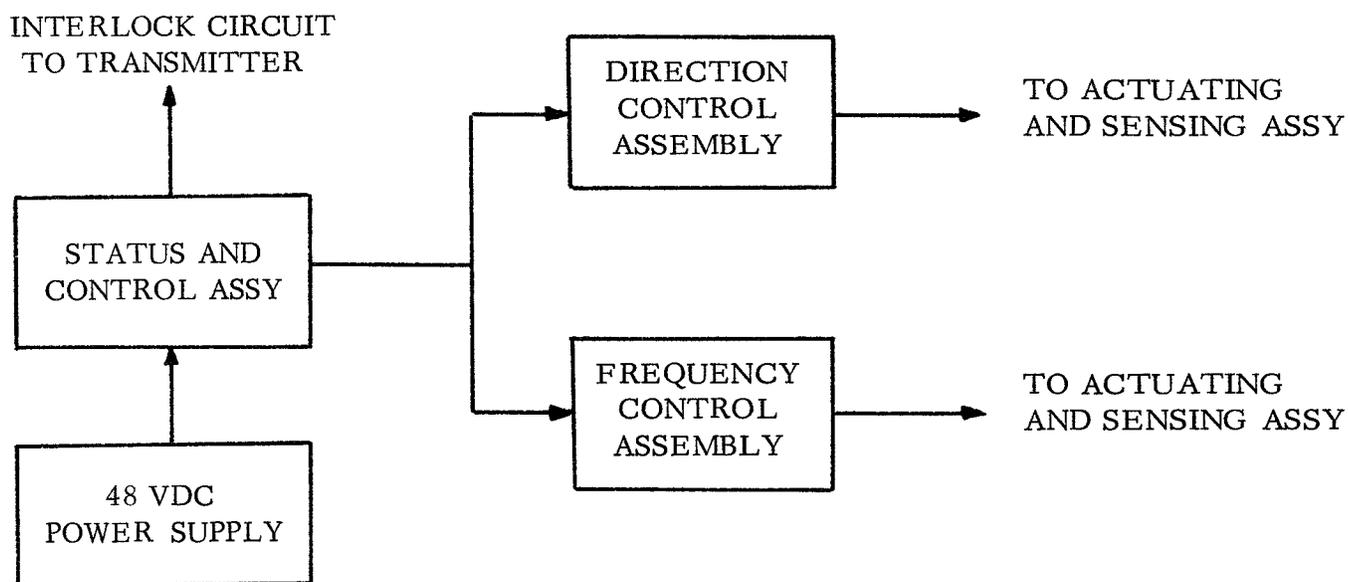


Figure 4-9. Control Console, Block Diagram.

4-9. FREQUENCY CONTROL ASSEMBLY. The frequency portion of the control panel has two groups of switches. One group is labeled BAND-MHz and consists of two pushbuttons: 4-11 LOW BAND and HIGH BAND 11-30. Actuation of either pushbutton selects the desired band of operating frequencies. The second group, consisting of ten switches labeled CHANNEL MHz, selects one of ten channels within either band. If the antenna can be safely changed, as indicated by illumination of the CONTROLS ENABLED lamp on the STATUS AND CONTROL assembly, actuation of either of the BAND-MHz switches results in the following: (1) activates circuits which connect the output of the RF switch to the desired antenna, (2) connects the frequency control switches to the matching unit of the selected antenna, and (3) connects the reflector control switches to the reflectors of the selected antenna. The ten frequency control pushbutton switches each have markings for two frequency channels. The upper half of the pushbutton is marked with a frequency channel (4.0 - 4.3 through 10.0 - 11.0) for the low band. The lower half of the pushbuttons is marked with a frequency channel (11.0 - 11.4 through 26.8 - 30.0) for the high band.

4-10. If the 4-11 LOW BAND pushbutton in the BAND-MHz group is pressed and a CHANNEL MHz frequency control pushbutton is pressed, the upper half of the frequency control pushbutton will be illuminated. This means that the low band matching unit and monopole will be tuned to the frequency channel indicated following actuation of the START pushbutton. If the HIGH BAND 11-30 pushbutton in the BAND-MHz is pressed, the lower half of the frequency control pushbutton in the CHANNEL MHz group will be illuminated. This means that the high band matching unit and monopole will be tuned to the frequency channel selected following actuation of the START pushbutton.

4-11. DIRECTION CONTROL ASSEMBLY. The DIRECTION portion of the control panel has three groups of pushbuttons. Actuation of these pushbuttons controls the beamwidth, the beam direction, and the start command to activate the required reflectors and matching unit to the desired configuration after the commands have been programmed.

4-12. The beamwidth pushbuttons, labeled WIDE, NARROW, and OMNI, determine the width of the transmitted beam. Pressing the WIDE or NARROW pushbutton initiates a sequence of operations which activate particular reflectors at the antenna. Depressing the OMNI pushbutton deactivates all reflectors to give full omnidirectional radiation of the transmitted beam.

4-13. A group of nine direction pushbuttons arranged in a square of three rows and three columns, controls the bearing in which the beam is directed. Eight of the pushbuttons are labeled with the eight main compass points while the center pushbutton is labeled OMNI. The eight directional pushbuttons control the direction in which the wide or narrow beam is to be aimed. The OMNI pushbutton programs the antenna to the omnidirectional mode.

4-14. The START pushbutton is a split screen indicator labeled TUNE and STEER which indicates that the desired commands are being programmed into the antenna system.

4-15. The FREQUENCY and DIRECTION commands can be given in any order, but they must be given in sequence and not simultaneously.

4-16. STATUS AND CONTROL ASSEMBLY. The STATUS AND CONTROL assembly prevents unsafe operation of the antenna set under normal operating conditions, provides a means for emergency operation when necessary, gives visual indication of the status of various operations of the system, and supplies 48 VDC relay power for use in the control console and elsewhere in the system. The STATUS AND CONTROL assembly also enables the FREQUENCY and DIRECTION control assemblies.

4-17. SEQUENCE OF FUNCTIONS.

4-18. When the first change command requiring a new antenna configuration is initiated, the SYSTEM CHANGING lamp on the STATUS AND CONTROL assembly will be illuminated. This shows that the condition indicated on the control panel no longer corresponds to the condition at the antenna site. No actual changes have taken place at the antenna itself, although the RF switch has been set to the programmed position, either high or low band. The operator at this time has an opportunity to review what will be the final configuration of the system, and to correct any errors without causing any unnecessary motions of the antenna mechanisms. After the START pushbutton is pressed, the operator will not be able to give further commands until the CHANGE COMPLETED lamp is illuminated. Closure of the START pushbutton completes the circuits from the control components in the actuating and sensing assembly to the mechanical tuning devices in the matching units and the pneumatic switches on the reflectors. The upper half of the START switch is marked TUNE; the lower half is marked STEER. One half or both halves will be illuminated to signify that the indicated change is taking place. The circuits (in the control panel), used for setting up frequency and direction commands, are disabled while the actual changes are taking place. Consequently, if an error is noticed while the antenna configuration is changing, the operator must wait until the command is executed (START lamp is extinguished, CHANGE COMPLETED lamp is illuminated) before a new command can be given.

4-19. As soon as the matching unit is tuned to the selected frequency, the TUNE lamp in the START switch will be extinguished, and as soon as the reflectors are activated or deactivated, the STEER lamp will be extinguished. Which ever lamp is extinguished first depends upon the previous setup and how much the various mechanisms have to adjust to satisfy the new command. When both the TUNE and STEER lamps are extinguished, the SYSTEM CHANGING lamp in the STATUS AND CONTROL assembly will be extinguished and the CHANGE COMPLETED lamp will light. When this condition is obtained, the command circuits are reactivated and new commands may be given, if required. Normally, however, the ANTENNA CHANGE/TRANSMIT switch would be turned to TRANSMIT and the transmitter output could then be applied to the antenna.

4-20. With the ANTENNA CHANGE/TRANSMIT switch in the TRANSMIT position, the control panel is deactivated and operation of pushbuttons have no effect. The lamps in the pushbuttons which were set up under the CONTROLS ENABLED condition will, however, remain illuminated. If the ANTENNA CHANGE/TRANSMIT switch is turned back to TRANSMIT while the antenna equipment is still changing, all changes will be halted and the equipment will be inoperative. The change can be completed by returning the ANTENNA CHANGE/TRANSMIT switch to ANTENNA CHANGE and pressing the START pushbutton.

4-21. COAXIAL RF POWER TRANSFER SWITCH.

4-22. The transmitter feeds RF energy, via a coaxial transmission line, to the coaxial RF power transfer switch. The RF switch, under command of the control console, connects the transmitter output to the high or low band matching unit upon command of signals from the actuating and sensing assembly. When a command is successfully executed, an interlock circuit in the RF switch is closed and an interlock signal is returned to the actuating and sensing assembly. A block diagram of the coaxial RF power transfer switch and remote control equipment box appears in figure 4-10.

4-23. ACTUATING AND SENSING ASSEMBLY. The actuating and sensing assembly, which is housed in the remote control equipment box, processes the frequency and direction commands in order to program the coaxial RF power transfer switch and the low or high band reflector control unit and matching units for a change in the antenna configuration. If, for example, the commands are for high band, wide beamwidth, north, channel 1 (11.0 - 11.4), the actuating and sensing assembly will initiate the following actions:

<u>Command</u>	<u>Action</u>
High Band	Transfer RF switch to high band radiating group.
Wide Beamwidth, North	Command high band radiating group to select and activate four reflectors on the south sector of the circle.
Channel 1 (11.0 - 11.4)	Command high band radiating group to match antenna for channel 1 frequency (11.0 - 11.4) MHz.

4-24. In addition, the actuating and sensing assembly commands the unused reflector control unit to deactivate its reflectors, the unused matching unit to go to the omni position, and returns a 'change completed' signal to the control console when all required changes have been successfully executed.

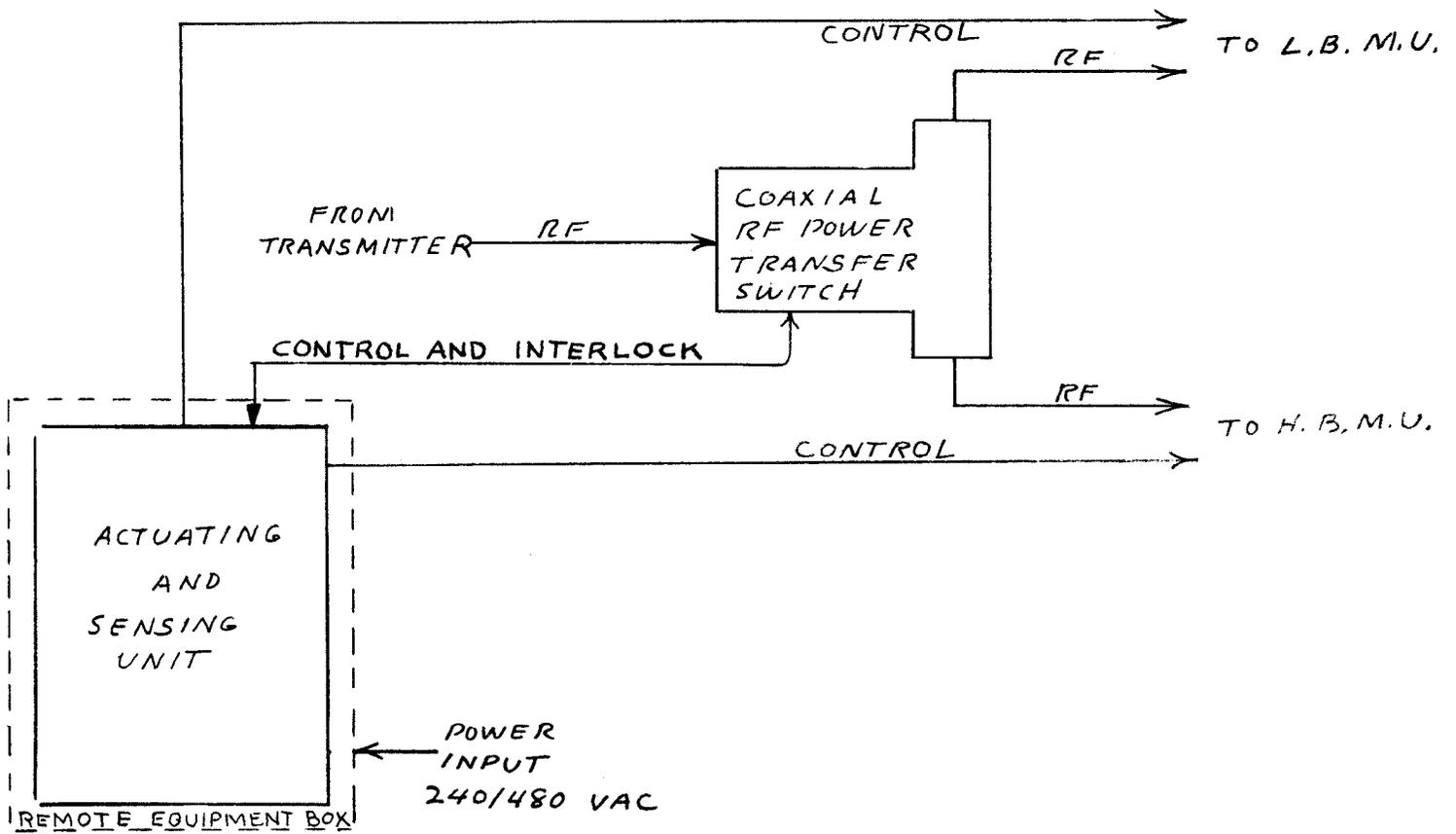


Figure 4-10. Coaxial RF Power Transfer Switch and Remote Equipment Box, Block Diagram.

4-25. LOW AND HIGH BAND RADIATING GROUPS.

4-26. The low and high band radiating groups are functionally similar, and each consists of a reflector control unit, 16 reflectors, a matching unit, and a monopole antenna. Figure 4-11 shows a block diagram of the low and high band radiating groups.

4-27. REFLECTOR CONTROL UNITS. The reflector control units have the circuits necessary to activate groups of reflectors upon command of signals from the actuating and sensing assembly. The command signals determine (1) beamwidth, by specifying whether four, six, or eight reflectors are to be activated, and (2) direction, by specifying the particular reflectors. To activate a given reflector, the reflector control unit opens a solenoid valve which applies pressurized air to the pneumatic switches on the reflector.

4-28. REFLECTORS. The reflectors consist of six lengths of copper tubing joined end-to-end by pneumatic switches. The reflectors are pressurized by the reflector control unit, with dry air from a compressor, and can be activated or deactivated through the solenoid valves in the reflector control unit. When pressure is applied to the pneumatic switches, the switches close and therefore connect the lengths of copper tubing to form a continuous conductor which reflects the RF energy emanating from the monopole antenna. When no pressure is applied to the pneumatic switches, the switches open and isolate the lengths of copper tubing so that for all intent and purposes the reflectors are transparent to the radiant energy.

4-29. MATCHING UNITS. An impedance matching unit is necessary to match the impedance of the antenna to the impedance of the transmission line. The units are adjustable because the impedance of the antenna varies with the changes in frequency, and beamwidth. Corresponding changes must be made accordingly. The matching unit essentially consists of a length of coaxial transmission line, shunt reactive elements, motor-driven vacuum switches, and a control assembly. A particular circuit arrangement required for a particular transmitting mode is set up by the control system. When this set-up is carried out, the matching unit transforms the antenna impedance to one having a VSWR below the specified maximum, at the input of the matching unit. For each frequency selection the appropriate tuning elements are connected across the transmission line by closing the associated vacuum switch. Refer to table 3-5. The other elements are disconnected by opening the other switches.

4-30. For example, directional operation in a certain frequency channel might require a specified inductor to be placed in shunt with the transmission line at an appropriate distance from the antenna in order to produce an acceptable VSWR. To obtain this condition the control circuits will cause the switch in series with this particular inductor to close and all other switches to open.

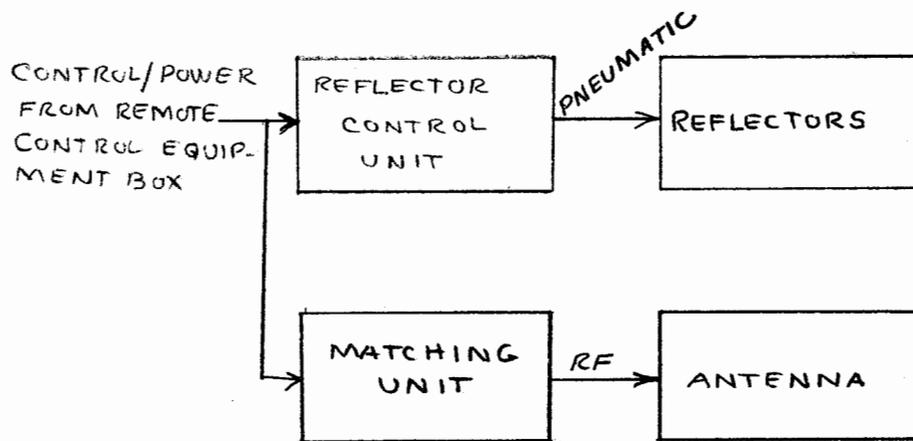


Figure 4-11. Low and High Band Radiating Group, Typical, Block Diagram.

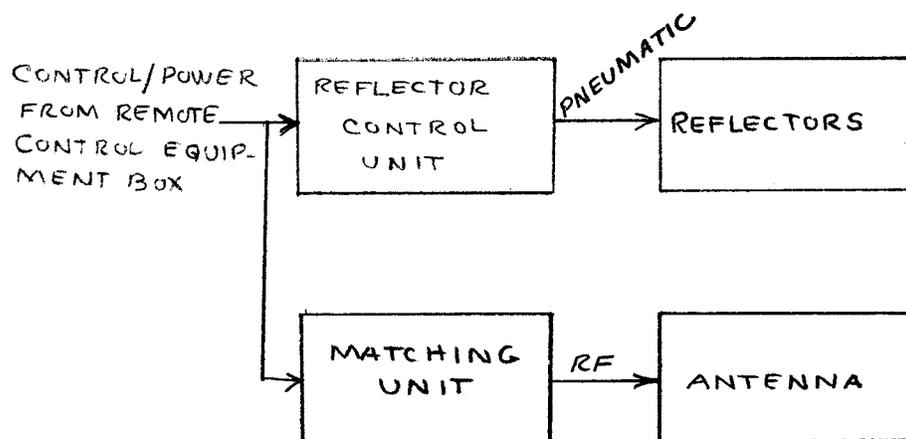


Figure 4-11. Low and High Band Radiating Group, Typical, Block Diagram.

4-31. A VSWR monitor is located in the control assembly of each of the matching units. The function of the VSWR monitor is to monitor the ratio of forward and reflected power present at the input of the matching unit at the gas barrier. As long as the VSWR remains below the ratio of 2:1, signifying the absence of arcs or malfunctions, no antenna arc signal is applied to the STATUS AND CONTROL assembly. If the VSWR rises above the ratio of 2:1 due to an arc or malfunction, an antenna arc signal is applied to the STATUS AND CONTROL assembly, which then disables the transmitter by opening the interlock circuit.

4-32. MONOPOLE ANTENNAS. The monopole antennas are vertically polarized radiators that are 1/4-wave length long at the lowest frequency within the band. The bases of the antennas are located at the center of a ground screen which consists of 120 radial wires spaced at 3-degree intervals and terminated at the outer ends by ground rods and a peripheral wire.

#### 4-33. DETAILED FUNCTIONAL ANALYSIS.

4-34. The following paragraphs present a detailed functional analysis of the STATUS AND CONTROL assembly, the FREQUENCY and DIRECTION assemblies, and the actuating and sensing assembly. These assemblies are depicted schematically in figure 4-12, sheets 1 through 3 and figure 4-13. Functional behavior is examined by observing the responses to commands in terms of signal flow, time sequence, and activity of specific circuit components.

#### 4-35. STATUS AND CONTROL ASSEMBLY.

4-36. The principal functions of the STATUS AND CONTROL assembly are arc protection, transmitter interlock, and control enabling. Additional functions include air compressor and RF signal status. See figure 4-12, sheet 1 of 3.

4-37. ARC PROTECTION. The arc protection circuit consists of the ANTENNA ARC lamp, latching relay K2, relay K3, momentary-contact ARC ALARM RESET switch S3, and the alarm bell DS1. An antenna arc or malfunction in the RF circuits will place a +48 VDC antenna arc signal on terminal 8 of TB3 (magnetic latching relay). The antenna arc signal latches K2 via the closed contacts 6-7 of relay K3. Contacts 14-9 of K2 close, applying 120 VAC to the alarm bell, contacts 13-6 of K2 close, applying +48 VDC to the ANTENNA ARC lamp, contacts 5-12 of K2 open, disabling the transmitter by breaking the transmitter interlock circuit; contacts 10-11 close, applying +48 VDC to relay K3. Contacts 6-7 of K3 open, breaking the 48 VDC return to K2 so that K2 will not continue to draw current and possibly overheat. The conditions just described prevail until K2 is unlatched or reset by +48 VDC applied to the reset winding via the manually operated momentary-contact ARC ALARM RESET switch, S3.

#### NOTE

A false antenna arc signal can be generated when one or more reflectors fail to open or close upon command. Failure to open or close will result

in a higher-than-normal VSWR as seen by the VSWR monitor. If the VSWR exceeds a preset threshold, the VSWR monitor will apply a +48 VDC antenna arc signal, initiating the sequence described above.

4-38. TRANSMITTER INTERLOCK. The transmitter interlock circuit is routed through the STATUS AND CONTROL assembly as follows: TB3-3, contacts 6-5 of normally energized relay K4, the EMERGENCY OVERRIDE/NORMAL switch S2 (in NORMAL position), contacts 5-12 of latching relay K2, the ANTENNA CHANGE/TRANSMIT switch S4 (in TRANSMIT position), contacts 6-5 of the normally energized relay K1, and terminals 9 and 10 of TB3. The interlock will be broken, causing the transmitter to shut down, under any of the following conditions:

- a. Relay K4 is deenergized by loss of 48 VDC gate interlock signal (GATE OPEN indicator illuminated); however, if the gate is being deliberately overridden, K5 will be energized, and will in turn keep K4 energized.
- b. Latching relay K2 is latched by a +48 VDC antenna arc signal.
- c. ANTENNA CHANGE/TRANSMIT switch S4 is set to ANTENNA CHANGE.

4-39. In addition, the transmitter interlock circuit will be held open if the interlock complete signal is not present on TB3-13, an indication that the reflector control or matching unit has not successfully completed its assigned program.

4-40. In emergency situations the EMERGENCY OVERRIDE/NORMAL switch can be set to EMERGENCY OVERRIDE to bypass K2, S4, and K1. The gate interlock and override circuits, however, are still included within the interlock loop.

4-41. CONTROL ENABLING. The EMERGENCY OVERRIDE/NORMAL switch S2 and ANTENNA CHANGE/TRANSMIT switch S4 together constitute a control enabling circuit which must be closed before the antenna configuration can be changed. With EMERGENCY OVERRIDE/NORMAL switch set to NORMAL, and the ANTENNA CHANGE/TRANSMIT switch set to ANTENNA CHANGE, the CONTROLS ENABLED lamp is illuminated by the +48 VDC applied via S2 and S4. The +48 VDC control enabling circuit is completed via TB3-17, of the STATUS AND CONTROL assembly, and TB3-17 of the DIRECTION control assembly, to "go" relay K10 and START switch A25 in the DIRECTION control assembly.

4-42. MISCELLANEOUS FUNCTIONS. Remaining circuits in the STATUS AND CONTROL assembly indicate the RF and compressor status. When the antenna system is satisfactorily radiating RF signals, a +48 VDC signal from the VSWR monitor is present at terminal TB3-14 and 48 VDC common is available at terminal TB3-15. The +48 VDC signal energizes relay K6, which in turn connects +48 VDC to the RF ON indicator lamp, A32. If the output of the main compressor drops below 40 psi, a pressure switch connected to the compressor output applies a +48 VDC main compressor inoperative signal to TB3-16. This signal energizes

relay K7, which in turn connects +48 VDC to the MAIN COMPRESSOR INOPERATIVE lamp, A33. When the main compressor is inoperative, the AUXILIARY COMPRESSOR/MAIN COMPRESSOR switch S5 is set to AUXILIARY COMPRESSOR, by the operator, connecting +48 VDC to the starting relay on the auxiliary compressor.

4-43. FREQUENCY AND DIRECTION CONTROL ASSEMBLIES AND ACTUATING AND SENSING ASSEMBLY.

4-44. The FREQUENCY and DIRECTION control assemblies, of the control panel, figure 4-12, sheets 2 and 3, respectively and the actuating and sensing control assembly, of the coaxial RF switch remote control equipment box, figure 4-13, are discussed together in order to maintain continuity of signal flow. Circuit behavior is examined by observing the response to the following programming commands: band selection, channel selection, bearing selection and start.

4-45. BAND SELECTION. Band selection is effected by the BAND-MHz switches in the FREQUENCY control assembly, operating in conjunction with band memory relay K4 "change-high-to-low" relay K10, and "change-low-to-high" relay K11 in the actuating and sensing assembly.

4-46. Low Band (4-11 MHz). Actuation of the 4-11 LOW BAND switch applies a +48 VDC to contact 16 of the band memory relay K4 via TB1-12 in the actuating and sensing assembly. The +48 VDC routing to K4 is via normally closed contacts of the directional and beamwidth switches in the DIRECTION control assembly, and normally closed contacts of the CHANNEL MHz switches in the FREQUENCY control assembly.

4-47. With +48 VDC available at contact 16 of K4, the circuit action depends upon whether K4 is in the high or low band condition. If K4 is in the high condition, +48 VDC is applied via contacts 16-15 to "change-high-to-low" relay K10-1. Contacts 2-3 of K10 close, applying a -145 VDC "change-high-to-low" command to the RF switch. This command is applied via TB13-3, TB13-2 to TB14-3 in the actuating and sensing assembly. The RF switch transfers the RF output of the transmitter from the high band antenna to the low band antenna. Upon successful completion of the transfer, the RF switch interlock circuit applies +48 VDC to contact 13-14 of K4. This voltage is applied via interrupter contacts 21-22 to the solenoid of K4, causing K4 to transfer to the low condition.

4-48. If K4 is already in the low condition, the "change-low-to-high" relay K11 is disabled because 48 VDC common is not present on TB1-9, which is connected to the common side of K11. With K4 in the low position, +48 VDC is routed via contacts 19-20 to low band relay K8 in the FREQUENCY control assembly. Contacts 5-6 of relay K8 applies +48 VDC to the 4-11 BAND MHz indicator lamp, and completes the 48 VDC common return path via K8 contacts 3-4 for the ten low band CHANNEL MHz indicator lamps. Remaining contacts of K4 are not used until the start command is given.

4-49. High Band (11-30 MHz). Actuation of the HIGH BAND 11-30 switch applies a +48 VDC to contact 16 of K4, as described previously. Again, circuit action depends upon whether K4 is in the low or high condition. If K4 is in the low condition, the "change-low-to-high" relay K11 is energized and the RF switch transfers the output of the transmitter from the low band antenna to the high band antenna. Upon successful completion of the transfer, the RF switch interlock circuit applies +48 VDC to contact 12 of K4, and K4 transfers to the high condition. If K4 is already in the high condition, the "change-high-to-low" relay K10 is disabled by the absence of 48 VDC common on TB1-10. With K4 in the high condition, +48 VDC is routed via contacts 19-18 of K4 to the high band relay K9 in the FREQUENCY control assembly. Contacts 5-6 of relay K9 applies +48 VDC to the 11-30 BAND MHZ indicator lamp, and completes the 48 VDC common return path via K9 contacts 3-4 for the ten high band CHANNEL MHZ indicator lamps. Remaining contacts of K4 are not used until the start command is given.

4-50. CHANNEL SELECTION. Channel selection is under control of the ten CHANNEL MHZ switches on the FREQUENCY control assembly, operating in conjunction with channel selection stepping switch K2 in the actuating and sensing assembly. The following discussion, describing the circuit action for selection of channel 5 (high or low band), is applicable to selection of any channel if the appropriate CHANNEL MHZ switch is substituted.

4-51. When the channel 5 (5.9-6.7/14.7-17.6 MHz) switch is actuated, the 48 VDC common return normally present on deck 1 (homing) contact 5 of the channel selection stepping relay K2 in the actuating and sensing assembly, is broken. The OMNI, 4-11 LOW BAND and HIGH BAND 11-30 switches are disabled and a +48 VDC is applied to terminal 8 of auxiliary relay K7 in the actuating and sensing assembly. With +48 VDC available on terminal 8 of auxiliary relay K7, circuit action depends upon the position of K2. If K2 is already in position 5, corresponding to channel 5 (5.9-6.7/14.7-17.6) the 48 VDC common return path for K7 is broken by open contacts of K2. If K2 is at any position other than 5 (5.9-6.7/14.7-17.6) the 48 VDC common return path for K7 is completed via closed interrupter contacts of K2, channel switches in the FREQUENCY control assembly, and the NARROW, WIDE, and the eight direction control switches in the DIRECTION control assembly. With K7 energized, +48 VDC is applied to K2. K2 steps until the arm of deck 1 (homing) reaches position 5, corresponding to the channel selected, at which time K2 stops because the 48 VDC common return path for K7 is broken by open contacts K2. Depending upon whether low band relay, K8 or high band relay, K9, in the FREQUENCY control assembly, is energized, either the high band channel 5 (14.7-17.6) lamp or the low band channel 5 (5.9-6.7) lamp in the FREQUENCY control assembly is energized by +48 VDC applied via deck 2 of stepping switch K2 in the actuating and sensing assembly. Decks 3 through 8 route commands to one of the matching units with the exact routing depending upon band memory relay K4, beam memory relay K5 and omni memory relay K3 all in the actuating and sensing assembly.

4-52. BEAMWIDTH. Beamwidth is selected by means of the WIDE, NARROW, and OMNI switches in the DIRECTION control assembly, operating in conjunction with omni memory relay K3 and beam memory relay K5 in the actuating and sensing assembly.

4-53. Wide Beam. Actuation of the WIDE switch completes a +48 VDC path to the beam memory auxiliary relay K9, in the actuating and sensing assembly, through the omni memory relay K3 contacts 16 and 17.

4-54. The sequence of events at this point depends upon whether the beam memory relay K5, in the actuating and sensing assembly, is in the wide or narrow condition. If K5 is in the narrow condition, the 48 VDC common return path for K9 is completed via normally closed interrupter contacts 14-13 and closed contacts 6-7 of K5, normally closed contacts of the channel 10 (10.0-11.0/26.8-30.0) and HIGH BAND 11-30 BAND-MHz switches in the FREQUENCY control assembly, and normally closed contacts of the NARROW switch in the DIRECTION control assembly. Under these conditions relay K9 is energized and connects +48 VDC to the solenoid of beam memory relay K5. Relay K5 transfers to the wide condition, interrupter contacts 14-13 of K5 open and break the 48 VDC common return circuit of K9. Relay K9 deenergizes K5.

#### NOTE

Beam memory relay K5 is a cam-operated mechanical latching relay that transfers and holds each time the solenoid is deenergized. When the solenoid is energized, interrupter contacts open but the remaining contacts remain as they are. When the solenoid is deenergized, the interrupter contacts close and a cam-ratchet linkage transfers the remaining contacts. Thus, when the solenoid is first energized and then deenergized, as described above, the contacts transfer to the wide condition and remain there until the solenoid is again energized and deenergized at some later time.

4-55. If K5 is already in the wide condition, the 48 VDC common return path for K9 is open. The 48 VDC common return routing in this case is via 7-8 of K5 and the normally closed contacts of the channel 9 (9.5-10.0/24.8-26.8) and 4-11 LOW BAND switches in the FREQUENCY control assembly and open contacts of the WIDE switch in the DIRECTION control assembly.

#### NOTE

The preceding discussion assumed that omni memory relay was in the directional condition. This assumption is valid because omni memory relay K3 would have transferred automatically to the directional condition if it had been in the omni condition. Relay K3 is a cam-operated latching relay that operates in a manner identical to K5.

4-56. If K3 is initially in the omni condition, contacts 12-13 are closed, applying +48 VDC to the solenoid of K8. Relay K8 connects +48 VDC to K3. Interrupter contacts of K3 open, deenergizing K8. K8 in turn deenergizes K3, and the cam-ratchet linkage of K3 transfers K3 to the directional condition. If K3 is in the directional condition, and K5 in the wide condition, as described above, +48 VDC is routed via contacts 7-8 of K3 and 4-5 of K5 to the WIDE indicator lamp in the DIRECTION control assembly. The lamp is now illuminated to indicate the WIDE condition.

4-57. Narrow Beam. When the NARROW switch is actuated, the circuit sequencing is similar to that described for the wide beam, except that K5 transfers to, or remains in, the narrow condition.

4-58. Omni Beam. The omni mode can be initiated by either of the two OMNI switches, both of which produce the same end result. Actuation of either OMNI switch applies a +48 VDC to contact 19 of the omni memory relay K3 in the actuating and sensing assembly.

4-59. If K3 is already in the omni condition, the +48 VDC signal will dead-end at contact 19 of K3. If K3 is in the directional condition, +48 VDC is applied via contacts 19-20 to auxiliary relay K8. K8 connects +48 VDC to the coil of K3 which actuates and then deenergizes K8. Relay K8, in turn, disconnects +48 VDC from K3, and the cam-ratchet linkage of K3 transfers K3 to the omni condition. With K3 in the omni condition, +48 VDC is applied via contacts 6-7 to the OMNI lamp on the DIRECTION control assembly. The OMNI lamp is now illuminated to indicate the omni condition.

4-60. BEARING SELECTION. The eight direction control switches (N, NE, E, etc) in the DIRECTION control assembly are used to activate various combinations of reflectors so that the transmitted beam will be directed toward one of eight compass bearings. The DIRECTION control switches operate in conjunction with bearing selection stepping relay K1 in the actuating and sensing assembly. The following discussion, describing the circuit action for selection of a south (S) bearing, is applicable to any bearing selection if the appropriate direction control switch is substituted.

4-61. The south (S) direction control switch in the DIRECTION control assembly is actuated to select a south bearing.

4-62. With +48 VDC available at terminal 8 of auxiliary relay K6, circuit action at this point depends upon the position of K1. If K1 is already in position 5, corresponding to a south bearing, the 48 VDC common return path for K6 is broken by the open contacts of the S switch. If K1 is at any position other than 5, the 48 VDC common return path for K6 is completed via the closed interrupter contacts of K1, closed contacts of the CHANNEL MHz switches in the FREQUENCY control assembly, and closed contacts of the other direction control switches in the DIRECTION control assembly. With K6 energized, a

+48 VDC is applied to the solenoid of K1. K1 steps until the arm reaches position 5 of deck 1, at which time the 48 VDC common return for K6 is broken and K1 stops. The S indicator lamp, on the DIRECTION control assembly, is energized by +48 VDC applied via contact 5 of deck 2, closed interrupter contacts of K1, contacts 9-10 of K3 and through terminals 13-14 of TB3. The remaining decks of relay K1 route command signals to the reflector control units. Utilization of these control signals depends upon the position of omni memory relay K3, beam memory K5, and channel selection stepping switch K2 all in the actuating and sensing assembly.

4-63. START COMMAND. The START command is given subsequent to the programming commands discussed above. When the START switch, A25, in the DIRECTION control assembly is actuated, the programmed commands are executed by the applicable reflector control unit and matching unit. During the time the commands are being executed, the TUNE and STEER lamps are illuminated to indicate that tuning and steering are in progress. The reflector control unit and the matching units of the unactive antenna are returned to the omni configuration.

4-64. Closure of the START switch applies +48 VDC to "go" relay K10 which in turn applies the same +48 VDC to the STEER and TUNE lamps. The direction and frequency programming switches are disabled and K10 is latched via the closed contacts 3-2 of "steer complete" relay K11 and "tune complete" relay K12 in the DIRECTION control assembly. A +48 VDC is also applied to the "go initiate" signal to "go" relay K12 in the actuating and sensing assembly. Relay K12 connects a +48 VDC control signal to K13 (MCU control power), K14 (RCU control power), K15 (go reflector), and K16 (go tune) and +48 VDC "step" signals to the stepping switches in the high and low band reflector control and matching units. Relay K13 connects +48 VDC and 48 VDC common signals to the matching units. Relay K14 connects a +48 VDC and 48 VDC common signals to the reflector control unit. With these signals available, the low or high band (depending upon the condition of band memory relay K4) reflector control and matching units perform their programmed functions.

4-65. When low band reflector activation is completed, or is not required, +48 VDC is available at TB5-15 of the actuating and sensing assembly. The voltage is routed via the "go reflector" relay K15 to terminal 3 of "reflector complete" relay K18 in the actuating and sensing assembly. When high band reflector activation is completed, or is not required, +48 VDC is available at terminal 15 of TB7 of the actuating and sensing assembly. This voltage energizes "reflector complete" relay K18, which in turn connects +48 VDC to terminal 8 of "steer complete" relay K11 in the DIRECTION control assembly. K11 is energized, and the +48 VDC is removed from the STEER lamp, indicating that steering is complete. Contacts 3-2 break one of the two latching paths to "go" relay K10.

4-66. When the high band matching operation is complete, or is not required, 48 VDC is available at terminal 17 of TB10 and +48 VDC is available at TB17-16 in the actuating and sensing assembly. This voltage energizes "tune complete" relay K17 in the same assembly. When the low band matching operation is complete, or is not required, 48 VDC common is available at terminal 17 of TB8. This voltage is routed via contacts of "tune complete" relay K17 to terminal 1 of "tune complete" relay K12 in the DIRECTION control assembly. K12 is energized, and contacts 6-7 and 3-2 open. Contacts 6-7 remove +48 VDC from the TUNE lamp, indicating that tuning is complete. Contacts 3-2 break the remaining latching path to "go" relay K10. K10 then disables the "go initiate" signal and reenables the direction and frequency programming switches.

#### 4-67. REFLECTOR CONTROL UNIT.

4-68. The reflector control unit performs two functions. First, it activates and deactivates various reflectors in accordance with commands from the actuating and sensing assembly. Second, it completes interlock circuits to indicate that activation or deactivation of the desired reflectors has been successfully accomplished. Figure 4-14 is a schematic of the reflector control unit. Principal components consist of 14-deck 25-position stepping relay K1, solenoid-actuated air-control valves L1 through L16, and pneumatically actuated DPDT interlock switches S1 through S16. Decks 13 and 14 of stepping relay K1 are used to carry out the homing operation. Decks 1 through 8 connect 120 VAC to solenoid valves V1 through V16. Decks 9, 10, 11, and 12 connect or disconnect pneumatic interlock switches S1 through S16 as required for different antenna configurations.

4-69. Assume that the configuration command is N-8, requiring that eight reflectors be activated to direct the beam north. For this particular command, reflectors 5, 6, 7, 8, 9, 10, 11, and 12 are activated, as shown in table 4-2. The following paragraphs describe how these particular reflectors are activated and how the interlock circuit is closed.

4-70. A 48 VDC step reflector control unit signal from the actuating and sensing assembly is applied to terminals 10-11 and 12-13 of terminal board TB2 in the reflector control unit. A 48 VDC N-8 configuration command from the actuating and sensing assembly is applied via TB1-3 to deck 13 of K1; all the other inputs to deck 13 are floating.

4-71. With a 48 VDC N-8 signal applied, stepping auxiliary relay K2 is energized via TB1-3 and the normally closed interrupter contacts of K1. Contacts 3-2 of stepping auxiliary relay K2 close, applying +48 VDC to the solenoid of K1. K1 begins stepping, and continues stepping until it reaches position 3. In this position, the insulator between the NC (normally closed) contacts 13 and 14 disconnects the 48 VDC N-8 command signal from deck 13 of K1, K2 deenergizes K1, and K1 stops at position 3. In this position the remaining decks of K1 make the connections necessary to activate the required reflectors and complete the interlock circuit, after the time delay relay has dropped out (approximately 5-sec).

Table 4-2. Reflector Program.

+48 VDC Signal Input		K1 Homes to Position	Reflectors Actuated															
Direction	Applied to		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
N-4	TB1-1	1							X	X	X	X						
-6	-2	2						X	X	X	X	X						
-8	-3	3					X	X	X	X	X	X	X					
NE-4	-4	4								X	X	X	X					
-6	-5	5							X	X	X	X	X	X				
-8	-6	6						X	X	X	X	X	X	X	X			
E-4	-7	7										X	X	X	X			
-6	-8	8									X	X	X	X	X	X		
-8	-9	9								X	X	X	X	X	X	X	X	X
SE-4	-10	10												X	X	X	X	X
-6	-11	11	X											X	X	X	X	X
-8	-12	12	X	X									X	X	X	X	X	X
S-4	-13	13	X	X													X	X
-6	-14	14	X	X	X										X	X	X	X
-8	-15	15	X	X	X	X								X	X	X	X	X
SW-4	-16	16	X	X	X	X												
-6	-17	17	X	X	X	X	X											X
-8	-18	18	X	X	X	X	X	X									X	X
W-4	-19	19			X	X	X	X										
-6	-20	20		X	X	X	X	X	X									
-8	TB2-1	21	X	X	X	X	X	X	X	X								
NW-4	-2	22						X	X	X	X							
-6	-3	23				X	X	X	X	X	X	X						
-8	-4	24			X	X	X	X	X	X	X	X						
OMNI	-5	25																

ORIGINAL

4-72. When the commands from the actuating and sensing assembly are applied between terminals 6 and 7 of TB2, of the reflector control unit, relay K4 is energized via the closed contacts 5-7 of the five-second time delay relay K3. The contacts of K4 open, disconnecting 120 VAC from TB7. Five seconds after application of the "go rcu" signals, time delay relay K3 operates and breaks the 48 VDC circuit to K4. The contacts of K4 close, applying 120 VAC via TB7 to decks 1 through 8 of K1. With K1 in position 3, as described above, solenoid-actuated pressure switches S5, S6, S7, S8, S9, S10, S11 and S12 are energized. These switches activate (close) the corresponding reflectors by opening the air supply lines to the pneumatic switches located between the reflector segments.

#### NOTE

The purpose of the five-second delay is to prevent reflectors from being falsely activated while K1 is stepping and to prevent arcing at the contacts of K1.

4-73. In addition, when the air lines are pressurized, the pneumatically actuated interlock switches that are located in the reflector control unit, and connected to the pressurized lines, are actuated. Each switch has a DPDT contact arrangement. One set designated L1-M1, is closed when the applied pressure becomes greater than a predetermined amount. The other set, L2-M2 is closed when the pressure becomes less than the predetermined amount. These switches are connected to decks 9, 10, 11, and 12 of stepping relay K1 in an interlock arrangement that forms a closed circuit only when the programmed reflector configuration is successfully established. In the typical configuration under discussion, with K1 in position 3, the interlock circuit is routed as follows: deck 9 position 3 of K1/TB4-5/pressure-closed contacts L1 and M1 of S5 through S12/TB4-13/deck 10, position 4 of K1/deck 10 position 1 of K1/deck 11 position 1 of K1/deck 11 position 4 of K1/TB5-13/ then to the open pressure switches S13 through S4, out to deck 12 position 4/deck 12 position 1/TB2-15/ thereby completing the interlock circuit. It will be noted that the pressure-closed contacts are associated with the activated reflectors, and the pressure-released contacts with the deactivated reflectors.

4-74. MATCHING UNIT.

4-75. The matching unit matches the impedance of the rf transmission line to that of the antenna in order to maintain VSWR lower than 2:1 for any frequency or beamwidth. Impedance matching is accomplished by connecting various combinations of reactive elements to the rf transmission line at three points along the line. Matching is performed for the wide, narrow, or omni beamwidth for each of the ten channels. Figure 4-15 shows the schematic of the low and high band matching units.

4-76. Operation of the matching unit will be explained by analyzing the switching sequence for a typical command; analysis of switching sequences for other commands are similar. It is assumed that a +48 VDC "step matching unit" signal is available at TB2-5, "go" signals are available between terminals 1 and 2 of TB2, and +48 VDC channel 5 WIDE/NARROW signal is applied to TB1-5. The channel 5 WIDE/NARROW matching requirements are as follows:

A2A1S1L1	Connected
A2A2S1C1	Disconnected
A3A1S1L1	Disconnected
A3A2S1C1	Disconnected
A4A1S1L1	Disconnected
A4A2S1C1	Disconnected

The following paragraphs describe the operations that take place in bringing about the above conditions.

4-77. The +48 VDC channel 5 WIDE signal is routed to position 5 of deck 8 through deck 7 of stepping relay K1. If K1 is already in position 5 the insulator will break the circuit between deck 8 position 5 and deck 7 position 5, preventing +48 VDC from reaching the interrupter contacts of K1. If, however, K1 is not in position 5, auxiliary relay K2 is energized by +48 VDC applied via K1-F-6, and interrupter contacts of K1. Contacts 2 and 3 of K2 close, applying +48 VDC to K1. K1 steps until the arm of deck 8 reaches position 5, in which position the insulator breaks the +48 VDC circuit to K2. K2 deenergizes K1, and K1 remains in position 5. While K1 is stepping to position 5, +48 VDC is applied via CR1 to relay K3, contacts 2 and 3 of K3 open, breaking the return path for relays K5 through K18 to prevent any tuning action from taking place during stepping.

4-78. With deck 1 in position 5, +48 VDC is applied via K1-F-6 through deck 7 of K1 to the arm of switch A2A1S3. If vacuum switch A2A1S1 is already closed, the arm of A2A1S3 will be in the position opposite that shown on the schematic, connecting +48 VDC to deck 2 of stepping switch K1. If vacuum switch A2A1S1 is open, however, the arm of switch A2A1S3 will be in the position shown on the schematic connecting +48 VDC to K6 and, via CR3, to K4. Contacts 5-6 and 3-4 of K6 close, applying 120 VAC to the windings of motor A2A1B1. Motor A2A1B1 closes vacuum switch A2A1S1, and transfers switch A2A1S3 to the position opposite that shown in the figure. Vacuum switch A2A1S1 connects inductor L1 to the transmission line, while A2A1S3 connects +48 VDC to deck 2 of stepping switch K1.

4-79. Deck 2 of stepping relay K1 connects +48 VDC via position 5 to the arm of switch A2A2S2. If vacuum switch A2A2S1 is already open, the arm of A2A2S2 will be in the position shown in the figure, connecting +48 VDC to deck 3 of stepping relay K1. If vacuum switch A2A2S1 is closed, however, the arm of A2A2S2 will be in the position opposite that shown in the figure, connecting +48 VDC to K7 and, via CR4 to K4. K7 applies 120 VAC to the windings of motor A2A2B1. Motor A2A2B1 opens vacuum switch A2A2S1 disconnecting A2C1 and A2C2 from the transmission line, and transfers switch A2A2S2 to the position shown in the figure, connecting +48 VDC to deck 3 of K1.

4-80. Deck 3 of K1 connects +48 VDC via position 5 to the arm of switch A3A1S2. If vacuum switch A3A1S1 is already open, the arm of A3A1S2 will be in the position shown in the figure, connecting +48 VDC to deck 4 of stepping relay K1. If vacuum switch A3A1S1 is closed, however, the arm of A3A1S2 will be in the position opposite that shown in the figure, connecting +48 VDC to K9 and, via CR6, to K4. K9 applies 120 VAC to the windings of motor A3A1B1. Motor A3A1B1 opens vacuum switch A3A1S1, disconnecting L1 from the transmission line, and transfers A3A1S2 to the position shown in the figure, connecting +48 VDC to deck 4 of K1.

4-81. Deck 4 of K1 applies +48 VDC via position 5 to the arm of switch A3A2S2. If vacuum switch A3A2S1 is already open, switch A3A2S2 will be in the position shown in the figure, connecting +48 VDC to deck 5 of stepping relay K1. If vacuum switch A3A2S1 is closed, however, the arm of A3A2S2 will be in the position opposite that shown in the figure, connecting +48 VDC to relay K11 and, via CR8 to K4. K11 applies 120 VAC to the windings of motor A3A2B1. Motor A3A2B1 opens vacuum switch A3A2S1, disconnecting A3C1 and A3C2 from the transmission line, and transfers A3A2S2 to the position shown in the figure, connecting +48 VDC to deck 5 of K1.

4-82. Deck 5 of K1 applies +48 VDC via position 5 to the arm of switch A4A1S2. If vacuum switch A4A1S1 is already open, the arm of A4A1S2 will be in the position shown in the figure, connecting +48 VDC to deck 6 of stepping relay K1. If vacuum switch A4A1S1 is closed, however, the arm of A4A1S2 will be in the position opposite that shown in the figure, applying +48 VDC to relay K1 and, via CR10, to K4. K13 connects 120 VAC to the windings of motor A4A1B1. Motor A4A1B1 opens vacuum switch A4A1S1 disconnecting L1 from the transmission line, and transfers the arm of A4A1S2 to the position shown in the figure, connecting +48 VDC to deck 6 of K1.

4-83. Deck 6 applies +48 VDC via position 5 and normally closed contacts of cam-operated switch A4A3S3 to maximum limit switch A4A3S6, relay K18, and, via CR15, to K4. The circuit action at this point depends upon the setting of capacitor A4C1.

4-84. If A4C1 is at its minimum limit, switch A4A3S6 and A4A3S7 are opened, K17 is de-energized K18 is energized, and 120 VAC is applied to the windings of motor A4A3B1; motor A4A3B1 turns A4C1 in the direction of increasing capacitance until, at a preset position determined by factory adjustment, cam-actuated switch A4A3S3 is tripped. When A4A3S3 is tripped, +48 VDC is disconnected from K18 and motor A4A3B1 is stopped, while simultaneously +48 VDC is applied via contacts of A4A3S3 to the arm of switch A4A2S3. If vacuum switch A4A2S1 is already closed, A4A2S3 will be in the position opposite that shown in the figure, and a +48 VDC interlock signal will be routed via contacts 10-11 of relay K4 to TB1-16. If vacuum switch A4A2S1 is open, however, the arm of A4A2S3 will be in the position shown in the figure, applying +48 VDC to K16 and, via CR13, to K4. K16 connects 120 vac to the windings of motor A4A2B1. Motor A4A2B1 closes vacuum switch A4A2S1 connecting A4C1 to the transmission line, and transfers A4A2S3 to the position opposite that shown in the figure, and thus the interlock complete signal goes to TB1-16.

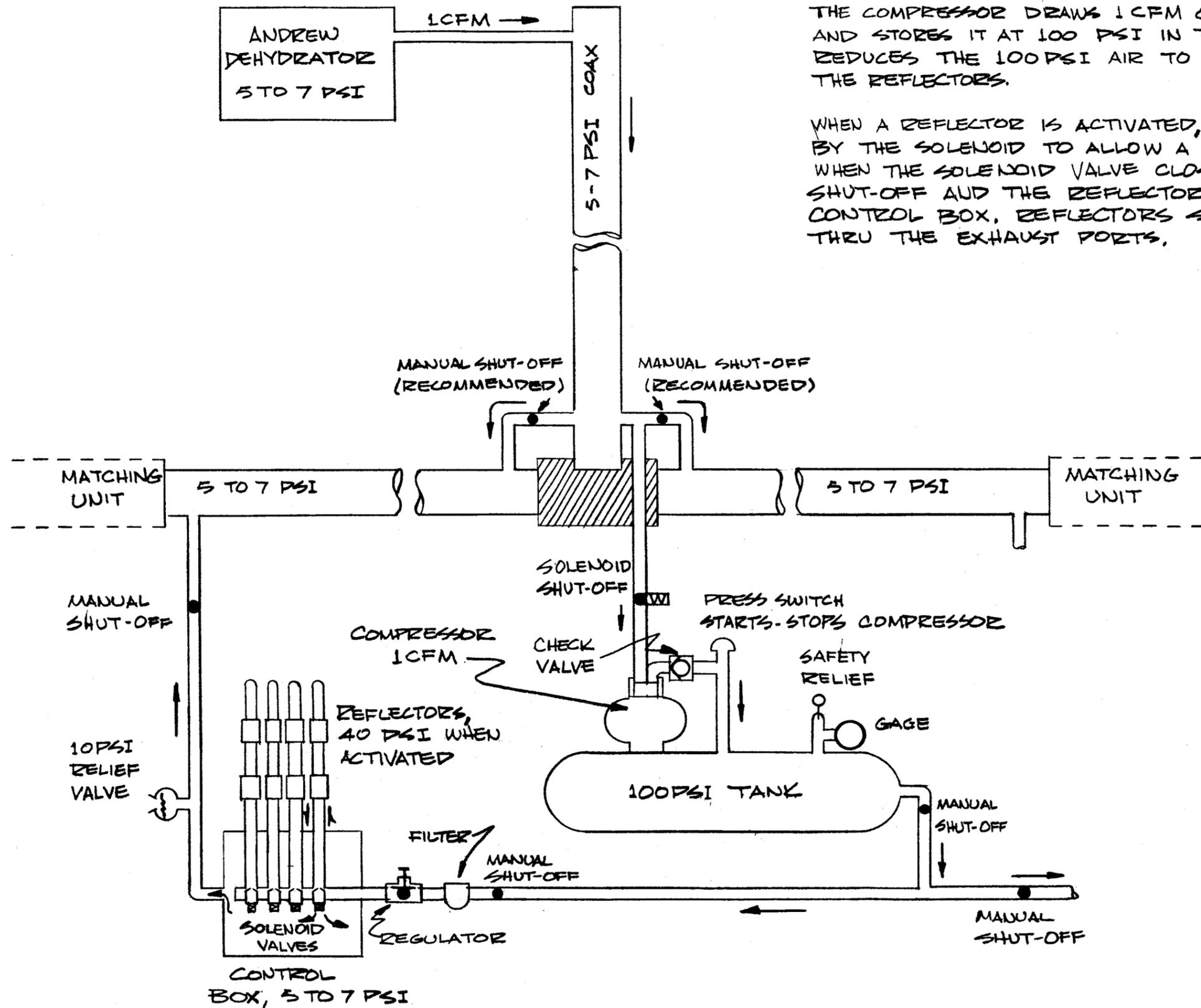
4-85. If A4C1 is not at its minimum limit, switch A4A3S6 and A4A3S7 is open, K17 is deenergized, and K18 is energized. K18 connects 120 vac to the windings of motor A4A3B1. Motor A4A3B1 turns A4C1 in the direction of increasing capacitance. At this point, two sequences can occur, depending upon whether the required capacitance of A4C1 is greater or less than the initial setting required by switch A4A3S3. If the required capacitance is greater than the initial setting, motor A4A3B1 turns A4C1 until cam-actuated switch A4A3S3 is tripped, as described previously. If the required capacitance is less than the initial setting, A4A3S3 will not be tripped before A4C1 reaches its maximum limit. A4C1 will reach its maximum limit, switch A4A3S6 will be tripped, and K17 will be energized, and K18 is deenergized connecting 120 vac to the windings of motor A4A3B1. A4A3B1 will now turn A4C1 in the direction of decreasing capacitance, until A4A3S6 is again tripped by the minimum capacitance setting at this point. K18 is energized and K17 is deenergized and the motor reverses and A4C1 increases until A4A3S3 is deactivated.

#### 4-86. PRESSURE SYSTEM.

4-87. The following paragraphs describe the theory of operation of the pressure system of the antenna set. See figure 4-16 for a pressure system flow diagram.

4-88. The antenna set requires a high pressure and a low pressure air system. The low pressure system supplies dry air to the coaxial transmission line and is housed in the transmitter building. The air is forced into the transmission line at a constant pressure and is separated at the RF switch with air going to both low and high band transmission lines and also to the high pressure air system. When the air reaches the end of the high and low band transmission line it is routed to the reflector control units and is used to pressurize the units. Therefore, all three sections of the coaxial transmission line are under low pressure while the RF switch is vacuum sealed. A gas barrier at the input of the matching units seals the pressurized transmission line from the oil-filled matching unit. The transmission line is tapped just before it reaches the gas barrier. A pipe, with a shut-off valve, carries the low pressure dry air to the reflector control unit.

4-89. The high pressure system, is installed near the RF switch and furnishes high pressure dry air for the operation of the reflector assemblies. The high pressure system draws dry air from the main transmission line and provides 8 cubic feet reserve of dry air at 60 to 100 psi. This pressure is piped to the solenoid-operated air valves in the reflector control unit. When the air valves are actuated, regulated 40 psi air is applied to the reflector switches. When deactivated, the reflector switches exhaust to the reflector control unit. The dehydrator/compressor, located in the transmitter building, provides dry air for the coaxial line and to the high pressure air system. The air compressor for the high pressure system draws air from the coaxial line and stores it in an accumulator at a pressure of approximately 100 PSIG. Filling the accumulator tank requires approximately 40 minutes and takes about 62 cubic feet of air at atmospheric pressure. When air is drawn from the coaxial line, the line pressure will be reduced because the volume of this line is limited. Table 4-3 shows pressure changes for various coaxial line lengths.



THE COMPRESSOR DRAWS 1 CFM OF DRY AIR FROM COAX AND STORES IT AT 100 PSI IN THE TANK. THE REGULATOR REDUCES THE 100 PSI AIR TO 40 PSI FOR USE BY THE REFLECTORS.

WHEN A REFLECTOR IS ACTIVATED, THE VALVE IS HELD OPEN BY THE SOLENOID TO ALLOW A FREE SUPPLY OF AIR. WHEN THE SOLENOID VALVE CLOSES, THE 40 PSI AIR IS SHUT-OFF AND THE REFLECTOR EXHAUSTS INTO THE CONTROL BOX. REFLECTORS STAY AT COAX PRESSURE THRU THE EXHAUST PORTS.

Figure 4-16. Pressure System Flow Diagram.

Table 4-3. Coaxial Line Length vs. Pressure Changes.

Length of Coaxial Line	Fill to 100 psig from 0	Recharge from 60 to 100 psig
Pressure reduction in 1000 feet of coaxial line	7.8 psig	2.7 psig
Pressure reduction in 1500 feet of coaxial line	5.2 psig	1.8 psig
Pressure reduction in 2000 feet of coaxial line	3.9 psig	1.4 psig

4-90. The above table also presumes a closed line with no makeup air being supplied. It is desirable to permit the dehydration equipment to makeup air as it is withdrawn and thereby avoid any possibility of causing a vacuum on the coaxial line.

NOTE

If the compressor should inadvertently cause a vacuum in the coaxial line, no structural damage, to the line or the pump, will result.

4-91. When the high pressure system tank reaches 100 psig the compressor motor automatically stops. If the pressure decreases to approximately 60 psig the compressor restarts.

4-92. If the main compressor motor does not restart and the tank pressure decreases to approximately 45 psig, the WARNING pressure switch activates the MAIN COMPRESSOR INOPERATIVE lamp circuit on the control console. The auxiliary compressor motor can only be started by placing the MAIN COMPRESSOR/AUXILIARY COMPRESSOR switch in the AUXILIARY COMPRESSOR position.

4-93. TROUBLESHOOTING.

4-94. If it is suspected that the antenna set is not operating properly and the cause of the improper functioning is unknown, troubleshooting procedures should be utilized.

4-95. ISOLATING A MALFUNCTION TO A FUNCTIONAL DIVISION.

4-96. The first visual indication of improper performance will usually be failure of the selected control pushbutton on the FREQUENCY or DIRECTION control assemblies or the READY TO TRANSMIT lamp on the STATUS AND CONTROL assembly to become illuminated when a command is given. Check first to verify that the operating procedures are being followed correctly. Refer to Section 3 of this manual for operating procedures.

4-97. For troubleshooting purposes, the antenna set may be regarded in terms of the functional divisions previously described. The troubleshooting procedures defined in table 4-4 will, in most cases, isolate a malfunction to a functional division (i.e. control panel, actuating and sensing assembly, RF switch, reflector control unit, or matching unit).

Table 4-4. Troubleshooting Procedure (Part 1 of 4).

Control Settings: CONTROL CONSOLE POWER switch to ON  
EMERGENCY OVERRIDE/NORMAL switch to NORMAL  
ANTENNA CHANGE/TRANSMIT switch to ANTENNA CHANGE

Step	Trouble Symptom	Probable Cause	Checks and Corrective Action *
1	Alarm bell does not ring and indicator lamps in status and control portion of control panel (Unit 1) do not glow when LAMP AND ALARM TEST switch is activated.	a. 120 VAC supply  b. Defective lamp(s)	a. Check for 120 VAC between terminals 1 and 2 of 1A1A2TB1 on control chassis. If present, check 1A1A1F1 and 1A1A2T1. If absent, check cable W22 and source of primary power in transmitter building.  b. Check and replace, if necessary.
2	Alarm bell rings but indicator lamps in the status and control portion do not glow when LAMP AND ALARM TEST switch is activated.	a. Failure of 48 VDC supply in control console.	a. Check 1A1A2CR58 and A1A1A2T1 on control console chassis assembly.
3	One or more indicator lamps in the status and control portion fail to glow when LAMP AND ALARM TEST switch is activated.	a. Defective lamp(s)  b. Defective diodes.	a. Replace lamps.  b. Check diode associated with unlit lamp.
4	None of the indicator lamps in the direction control portion or frequency control portion of the control panel glow when LAMP TEST switch is activated.	a. Failure of 48 VDC supply in control console  b. Defective diodes	a. Check power supply components on chassis (see step 2 above).  b. Check diodes associated with lamps.

\* Hold command button depressed while making measurements

Table 4-4. Troubleshooting Procedure (Part 2 of 4).

Control Settings: CONTROL CONSOLE POWER switch to ON  
EMERGENCY OVERRIDE/NORMAL switch to NORMAL  
ANTENNA CHANGE/TRANSMIT switch to ANTENNA CHANGE

Step	Trouble Symptom	Probable Cause	Checks and Corrective Action*
5	None of the indicator lamps in the direction control portion or frequency control of the control panel glow to indicate that a direction command has been initiated	Enabling voltage absent	Check for 48 VDC enabling voltage between terminals 17 and 2 of 1A1A2TB3 on control console chassis. If absent, check EMERGENCY OVERRIDE/NORMAL switch S2, ANTENNA CHANGE/TRANSMIT switch S4.
6	Operator programs the antenna set for a desired configuration but the lamps on the control panel indicate a different configuration.	<p>a. Proper commands are not being delivered by control panel.</p> <p>b. Commands are not being programmed by actuating and sensing assembly in remove control box (Unit 2).</p>	<p>a. Check 48 VDC command voltages at 1A1A2TB4 and 1A1A2TB6, on the control console chassis. If incorrect, check switches and associated components on each portion of control panel.</p> <p>Check input commands from control console (see figure 4-13): if proper +48 VDC signals present, check actuating and sensing assy 48 volt supply. If absent, check cables W20 and W21.</p>

\*Hold command button depressed while making measurements

Table 4-4. Troubleshooting Procedure (Part 3 of 4).

Control Settings: CONTROL CONSOLE POWER switch to ON  
EMERGENCY OVERRIDE/NORMAL switch to NORMAL  
ANTENNA CHANGE/TRANSMIT switch to ANTENNA CHANGE

Step	Trouble Symptom	Probable Cause	Checks and Corrective Action*
7	TUNE or STEER lamps in START pushbutton remain lighted, as well as SYSTEM CHANGING lamps; CHANGE COMPLETED lamp does not come on.	<p>c. Programmed commands not being executed by matching unit or reflector control unit.</p> <p>Open interlock circuit in reflector control units, matching units, or actuating and sensing assembly.</p>	<p>Check (1) command versus position if K1 (Refl. control) referring to table 4-2. Check (2) command versus position of K1 (matching unit) referring to table 3-5 and schematic (figure 4-15). If positions are incorrect, check components in actuating and sensing assembly. Also check cables from actuating and sensing assembly to reflector control units and matching units.</p> <p>Check interlock circuit in each unit (refer to schematic diagrams, fig. 4-12 thru 4-15). Also check pressure switches in reflector control unit. If switches are not closing increase setting of air tank pressure regulator (located at compressor, Unit 9) to between 41 and 42 PSI.</p>

\*Hold command button depressed while making measurements

Table 4-4. Troubleshooting Procedure (Part 4 of 4).

Control Settings: CONTROL CONSOLE POWER switch to ON  
EMERGENCY OVERRIDE/NORMAL switch to NORMAL  
ANTENNA CHANGE/TRANSMIT switch to ANTENNA CHANGE

Step	Trouble Symptom	Probable Cause	Checks and Corrective Action*
8	RF ON indicator does not come on when transmitter is activated. All direction and frequency commands completed properly.	Defective VSWR monitor circuit in matching unit (Units 3 and 4)	Program system for other band and change transmitter frequency. If proper operation is obtained replace VSWR assembly (A1A1) in matching unit.
9	MAIN COMPRESSOR IN-OPERATIVE lamp illuminated; main compressor motor not working.	<p>a. No primary power to motor.</p> <p>b. Motor starting switch defective.</p> <p>c. Pressure switch defective.</p>	<p>a. If auxiliary compressor is operative, check switch 1A1A1S5 on control panel (control console). If neither is working, check circuit breakers 2A1A1A2CB1 and 2A1A1A2CB2 in actuating and sensing assembly. Also check cabling to compressor unit (Unit 9).</p> <p>b. Replace motor starting switch, located in motor junction box.</p> <p>c. Check for actuation of pressure switch 9S1 (located near main compressor motor 9B2) when tank pressure falls below 60 PSI. If switch does not actuate at this point, replace switch.</p>

\*Hold command button depressed while making measurements