OVERALL SYSTEM DESCRIPTION

TD-3 MICROWAVE RADIO

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1. GENERAL

1.01 The TD-3 Microwave Radio System is designed for long-haul transmission of multichannel telephony, television, carrier telegraph, data, or other wideband information. It operates in the 4-GHz common-carrier band, using low-index frequency modulation, and employs intermediate frequency (IF) heterodyne repeaters usually spaced at intervals of 25 to 30 miles.

1.02 This section is reissued to add information on the 713( ) radio frequency (RF) combiner, the 95A control unit, and the solid-state 660E and F integrated circuit (IC) (amplifier). Revision arrows are used to denote the changes.

1.03 Designed as a successor to TD-2, the TD-3 system employs solid-state technology to improve noise performance, increase reliability, and reduce maintenance effort. However, it shares the same frequency plan and can use the same building and tower arrangement. Table A is a brief list of selected data pertinent to the TD-3 system.

1.04 A full channel complement for TD-3 is twelve 2-way radio channels, each of which has a maximum capacity of 1800 message circuits or one video signal. One channel may be set aside as a protection channel for the remaining regular, or working, channels. The protection channel is automatically switched in place of a failed regular channel or one whose noise performance has become unacceptable. A protection channel can also be manually switched in place of a regular channel for maintenance or restoration purposes.

1.05 Each channel is assigned two 20-MHz portions of the common-carrier band, one for either direction of transmission. The center frequencies of these assignments along with their channel designations are listed in Table B. The channels, numbered

1 through 12, have A and B suffixes to denote, respectively, the lower and the upper of their two assignment frequencies. For any individual channel, these assignments differ by 40 MHz. Interleaving of the channels results in a 20-MHz separation between the center frequencies of adjacent assignments.

1.06 To prevent undesired feedback around the repeater, the transmitters for any individual channel at any one station operate on one frequency, and the receivers operate on the channel assignment 40 MHz away. Figure 1 shows a typical frequency plan used in the TD systems. In this plan, all receivers at a station receive on either the A or B assignments and all transmitters on the other assignments. This arrangement is reversed at the station next in line. Thus, the information in either direction of transmission on any channel alternates between its A and its B assignments at each successive station. This pattern may be modified at some installations to avoid interference with other local systems.

1.07 Figure 1 also shows the use of horizontal and vertical polarizations of the transmitted signals to reduce interference between adjacent channels. Polarization refers to the orientation of the electric field in a radiated wave. This technique makes use of the fact that if a microwave signal is transmitted with a particular polarization it will tend to be rejected by an antenna system which is oriented to receive the other polarization.

1.08 In TD-3, perpendicular polarizations of adjacent channels are accomplished by first combining the radio transmitter outputs of channels 1 through 6 into one group through the use of channel combining networks, and channels 7 through 12 similarly into another group. These two groups are then applied to systems combining networks which feed the antenna. The desired polarizations are achieved by proper orientation of the networks. For reception, this same process is applied in reverse; the networks in this case function as separation networks. Figure 30 illustrates this process.

1.09 The radio stations can be classified as either main or repeater stations. In general, repeater stations merely retransmit the received signals, whereas main stations perform the additional functions of dropping or picking up information and switching to the protection channel. Main stations comprise about 30 percent of the total number of stations in a typical route.

1.10 Two protection switching systems are available to achieve the service reliability objectives of the TD-3 system. The 100A or 400A system (Fig. 30) will maintain ***radio channel*** continuity from the input of a radio transmitter through a number of hops (1 to 10) to the output of a radio receiver. This portion of the signal path (radio line) is called a switching section. If a regular channel in the switching section should fail or develop excessive noise, the switching system will automatically substitute a protection channel. For 100A (1×11 system) used only with TD-3 systems, one of the twelve radio channels is set aside to protect the remaining eleven channels. A 400A (2×18 system) can be used to protect TD and TH channels jointly. In this case, two TH channels out of a total of twenty combined TD and TH channels are set aside to protect the remaining eighteen channels.

1.11 The 200A Protection Switching System is used in conjunction with channels carrying message circuits to maintain continuity from the output of the multiplex equipment to the output of the FM transmitter, or from the input of the FM receiver to the input of the multiplex equipment. Figure 30 shows only the transmitter portion of the 200A. One standby circuit is provided to protect twelve working circuits.

Space Diversity System

1.12 ♦TD-3 radio hops used for either message or data transmission may be equipped for space diversity operation by use of the 713( ) RF combiner and associated 95A control unit. This equipment, mounted as an assembly at the top of the radio bay, combines the RF signal from two receive antenna systems and provides the dynamic phase regulation necessary to permit the composite signal to be applied to the normal receive path.Details on the 713( ) RF combiner and the 95A control unit are in Section 422-500-501.♦

2. SYSTEM AND SIGNAL FLOW DESCRIPTION

2.01 The following is a brief description of the processes undergone by wideband information during its transmission through the TD-3 system and of the equipment accomplishing these processes. Except as indicated, the description will follow the signal flow outlined in Fig. 30 for one direction of transmission.

TABLE A

TD-3 SYSTEM SELECTED DATA

OVERALL	
Frequency band	3.7—4.2 GHz
System length	Transcontinental (designed to meet 4000-mile system objectives)
Station spacing	25—30 miles
Maximum number of broadband radio channels (2-way)	12 (one or two of these may be used for protection)
Capacity of each 2-way channel	1800 message circuits or 1 TV video signal
Frequency bandwidth of each half of a 2-way radio channel	20 MHz
Polarization	6 channels vertical; 6 channels horizontal (interleaved)
Worst circuit noise:	For 4000-mile system:
nonfaded	41 dBrnc0
faded	55 dBrnc0
IF frequency	70 MHz
MICROWAVE TRANSMITTER-RECEIVER	
Transmitter (RF)	+37 dBm (5 watts)
Transmitter input	—7 dBm, 70 MHz
Receiver output	—7 dBm, 70 MHz
Receiver input	—26 dBm (nominal)
Typical RF-RF amplitude response of T-R bay	±0.15 dB over ±8 MHz around center frequency
FM TRANSMITTER AND RECEIVER	
Normal peak frequency	±4 MHz
Transmitter output	+10 dBm, 70 MHz
Transmitter input (sine wave)	—12 dBm for ±4 MHz peak deviation
Baseband frequency response	6 Hz to 10 MHz (±0.1 dB)

TABLE A (Contd)

TD-3 SYSTEM SELECTED DATA

200A PROTECTION SWITCHING SYSTEM		
Maximum number of channels protected	12 (by one protection channel)	
Pilot tone frequency	64 kHz	
Type signal for switching-end coordination	Coded dc over wires	
Maximum length of switching section	8 miles	
Circuit interruption by switching operation	Less than 300 ms	
IF PROTECTION SWITCHING SYSTEM		
	100A	**400A**
Maximum number of channels protected	11 (by one protection channel)	18 (by two protection channels including 6-GHz channels)
Conditions for switch initiation:		
Noise increase equivalent to	41-dB fade (one hop)	41-dB fade (one hop)
Drop in carrier level (at receiver output) of	18 dB from normal	11 dB from normal
Other conditions for switch initiation:		
Presence of carrier resupply signal		
Manual initiation		
Circuit interruption by switching operation:	**100A**	**400A**
Manual switch	Less than 10 μs	Less than 1 μs
Carrier fade	Less than 10 μs	Less than 1 μs
Equipment failure	Less than 50 ms	Less than 50 ms
Type circuit for switching-end coordination	Voice-frequency lines	Voice-frequency lines
Maximum length of switching section	10 hops	10 hops
KS-15676 HORN-REFLECTOR ANTENNA (AT 4 GHz)		
Midband gain	39.6 dB (VERT)	39.4 dB (HOR)
Beam width (azimuth)	2.5° (VERT)	1.6° (HOR)
Beam width (elevation)	2.0° (VERT)	2.13° (HOR)

TABLE A (Contd)

TD-3 SYSTEM SELECTED DATA

WAVEGUIDE ATTENUATION PER 100 FT AT 4 GHz			
Rectangular copper WR229	0.84 dB		
Circular copper WC281	0.36 dB		
ALARM AND CONTROL SYSTEMS			
Maximum number of unattended stations	12(C1)	256(E1)	1024(E2
Maximum number of alarm indications	882(C1)	4096(E1)	4096(E2)
Maximum number of orders for control	490(C1)	4096(E1)	4096(E2)
POWER REQUIREMENTS			
Primary power	Commercial ac		
Standby power	Gasoline or diesel engine generator for sustained operation of battery plant to carry load over momentary or extended power failure		

TABLE B

TD-3 CHANNEL FREQUENCIES

CHANNEL NO.	CHANNEL CENTER FREQUENCY (MHz)	CHANNEL NO.	CHANNEL CENTER FREQUENCY (MHz)
1A	3730	7A	3710
1B	3770	7B	3750
2A	3810	8A	3790
2B	3850	8B	3830
3A	3890	9A	3870
3B	3930	9B	3910
4A	3970	10A	3950
4B	4010	10B	3990
5A	4050	11A	4030
5B	4090	11B	4070
6A	4130	12A	4110
6B	4170	12B	4150

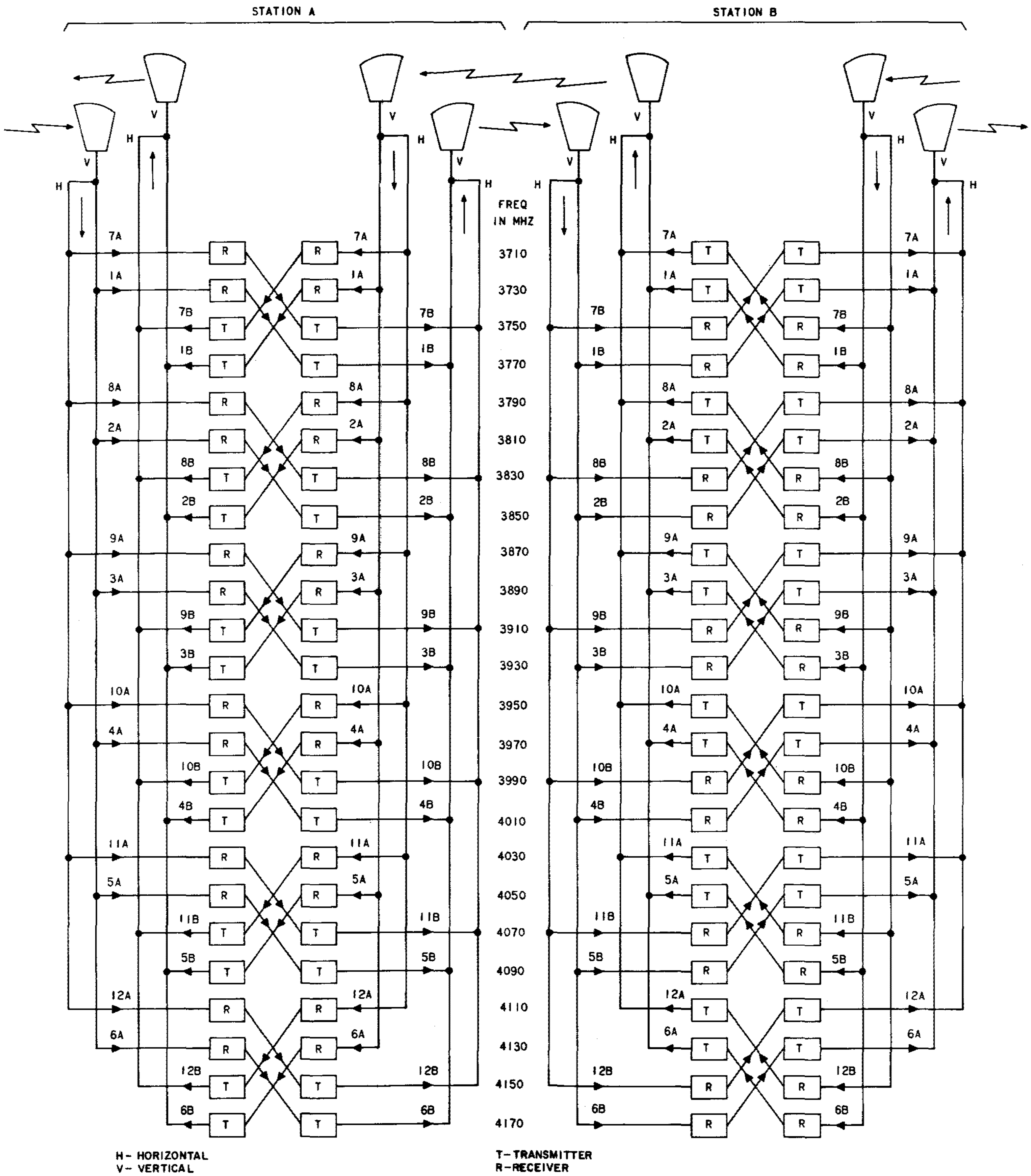


Fig. 1—TD Frequency Plan

2.02 For message transmission, mastergroup multiplex (MMX-2R) equipment is used to form a 2-mastergroup (1200 circuits) or 3-mastergroup (1800 circuit) baseband signal combination for application to the frequency modulation (FM) transmitter.

A. 3A Wire-Line Entrance Link

2.03 The transmission facility used to connect the output of the MMX-2R to the FM transmitter is the 3A wire-line entrance link (WLEL). It will equalize the losses in up to 8 miles of interconnecting cable and provide the proper input level to the FM transmitter. It includes a baseband pre-emphasis network which is used to increase the levels of the high frequency message circuits in the baseband signal. The FM systems inherently have higher noise at the higher baseband frequencies. The pre-emphasis network, by shaping the message circuit transmission levels in proportion to the system noise characteristic, helps to achieve similar signal-to-noise ratios in each of the message circuits in the baseband. At the receiving end of the system, a complementary de-emphasis network removes the shaping and re-establishes a flat transmission level across the message band. Refer to Sections 356-500-110 and 357-300-100 for more information on the MMX-2R and the 3A WLEL, respectively.

B. FM Transmitters and Receivers

2.04 The pre-emphasized baseband signal from the WLEL is converted by the FM transmitter to a low-index frequency-modulated 70-MHz IF carrier. An FM receiver (not shown in Fig. 30) performs the reverse operation at the receiving main station, and delivers baseband output to a WLEL or video connecting facility. Figures 2 and 3 show the type 3A FM transmitter and receiver, respectively. Section Section 411-200-100 describes the 3A transmitter, and Section 411-205-100 describes the receiver.

2.05 Designated 4A, a newer FM transmitter (Fig. 4) and FM receiver (Fig. 5) have been introduced which are less costly, physically smaller, and have lower power requirements. New design approaches have yielded improved performance for the transmitter-receiver pair. The 4A FM transmitter is described in Section 420-214-100 and the receiver in Section 420-215-100.

C. 200A Protection Switching System

2.06 The WLEL and FM transmitter continuity is protected by the 200A Protection Switching System using one WLEL-FM transmitter combination as a standby for any one of twelve regular combinations. To determine whether or not continuity has been interrupted, a 64-kHz pilot tone is inserted at the input to the WLEL and detected at the output of the FM transmitter. The loss of this tone at the FM transmitter output initiates the switching operation. A similar arrangement protects the FM receiver-WLEL combination at the receiving end (not shown in Fig. 30). The 200A system is depicted in Fig. 6 through 10. The system requires one each of the transmitting and receiving control bays, baseband equipment bays, and a transmitting and receiving IF switch bay to protect up to five working channels; for the full 12-channel capability, an additional control bay and equipment bay are needed. Refer to Section 420-630-100 for more details on the 200A system.

D. Video Connecting Facility

2.07 Video signals from the television operating center (TOC) enter TD-3 through a video connecting facility. This facility performs functions similar to the WLEL except that the frequency range and pre-emphasis requirements are different. The connecting facility and its associated FM transmitter are not protected by automatic equipment because they are almost always located at manned stations, and because 24-hour service is usually not required. For additional information on the video connecting facility, refer to Section 318-440-100.

2.08 The IF outputs of the FM transmitters, carrying the multiplexed message circuits and the video signals, together with the radio receiver IF outputs for circuits already enroute, are sent to their individual radio transmitters by way of the 100A or 400A Protection Switching System. (The 100A or 400A will be discussed later.) Included in these paths (but omitted for clarity at this point in Fig. 30) is a patch and access bay (also discussed later).

E. Microwave Transmitter

2.09 Each IF signal is conducted to an individual microwave transmitter (one for each channel). Here the signal is shifted to the proper transmitter channel frequency and amplified to an output power of about +37 dBm (5 watts). The outputs of the transmitters are combined into common rectangular waveguide runs by channel combining networks. As stated in Part 1, channels 1 through 6 are combined into one group and channels 7 through 12 are combined into another. Then the two groups are combined in the systems combining network, so that they

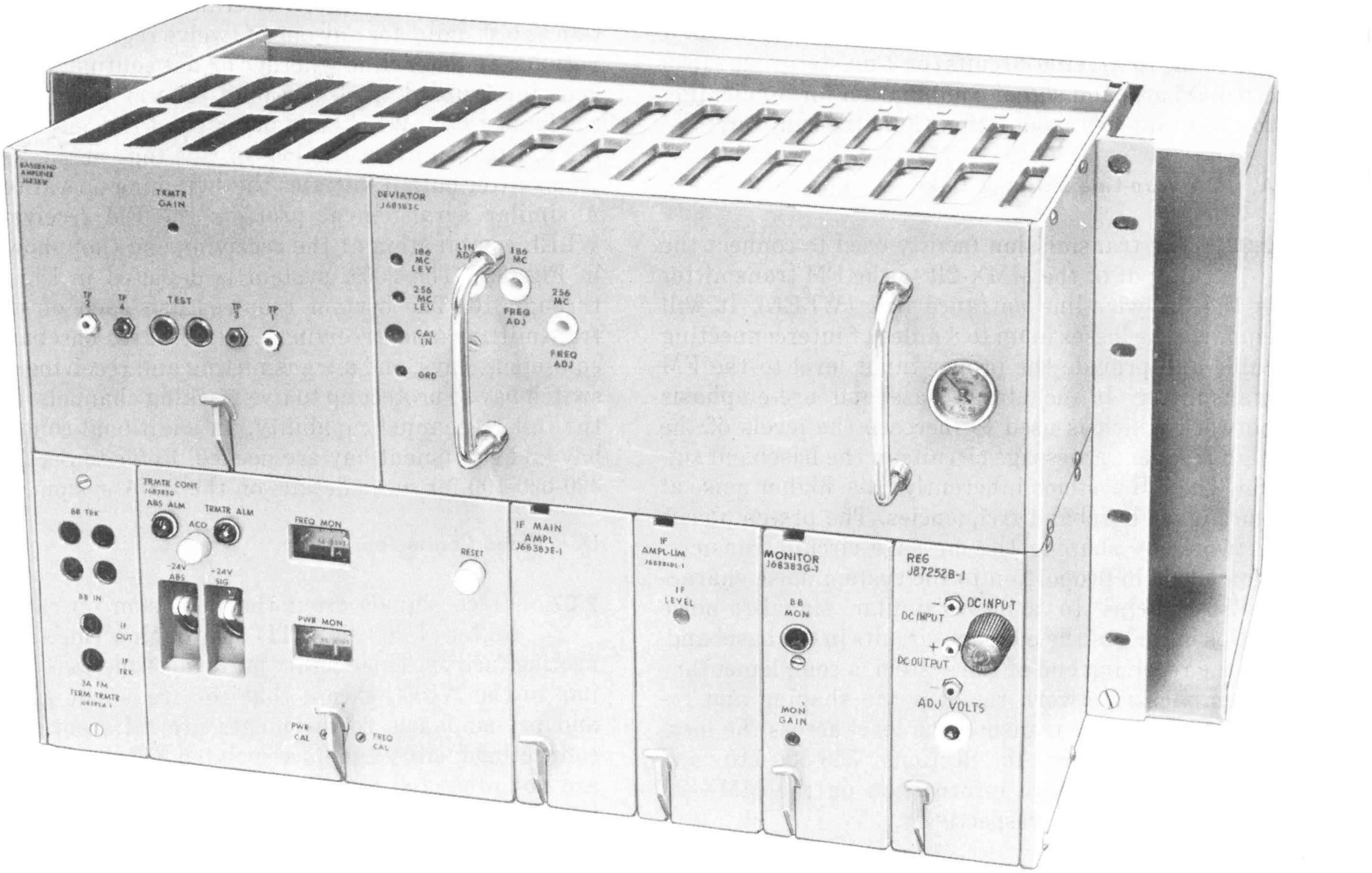


Fig. 2—3A FM Transmitter

have the proper polarizations for delivery to the antenna. Signals from microwave transmitters in other common-carrier bands may also be combined to use the same antenna.

2.10 The IF circuits of the radio transmitter include provision for supplying a carrier modulated by a 9-MHz tone if the input IF signal fails or falls below a certain level. Resupplying a carrier in this manner prevents the problem of adjacent channel noise spillover due to all subsequent receivers going to full gain upon loss of carrier. The 9-MHz tone also serves as a cue to the receiving end of the 100A or 400A switching section that the channel has failed.

F. KS-15676 Horn-Reflector Antenna System

2.11 The polarized outputs from the system combining networks are delivered to the transmitting antenna via circular waveguide. Circular waveguide is used here because it is capable of handling signals of both polarizations. The KS-15676 horn-reflector antenna (Fig. 11) is the most commonly used antenna in TD-3, both for transmitting and for receiving. Its broadband characteristics allow it to be used simultaneously for 4-, 6-, and 11-GHz band signals of both polarizations. High inter- and intra-station interference rejection is afforded by its good directional characteristics. Refer to Section 402-421-100 for a description of the KS-15676 horn-reflector antenna and waveguide assembly.

2.12 At the next station the same type of antenna, waveguide, and combining network assemblies are used to deliver the microwave signals to the appropriate radio receivers. The combining networks in this case, however, function as separating or dropping networks.

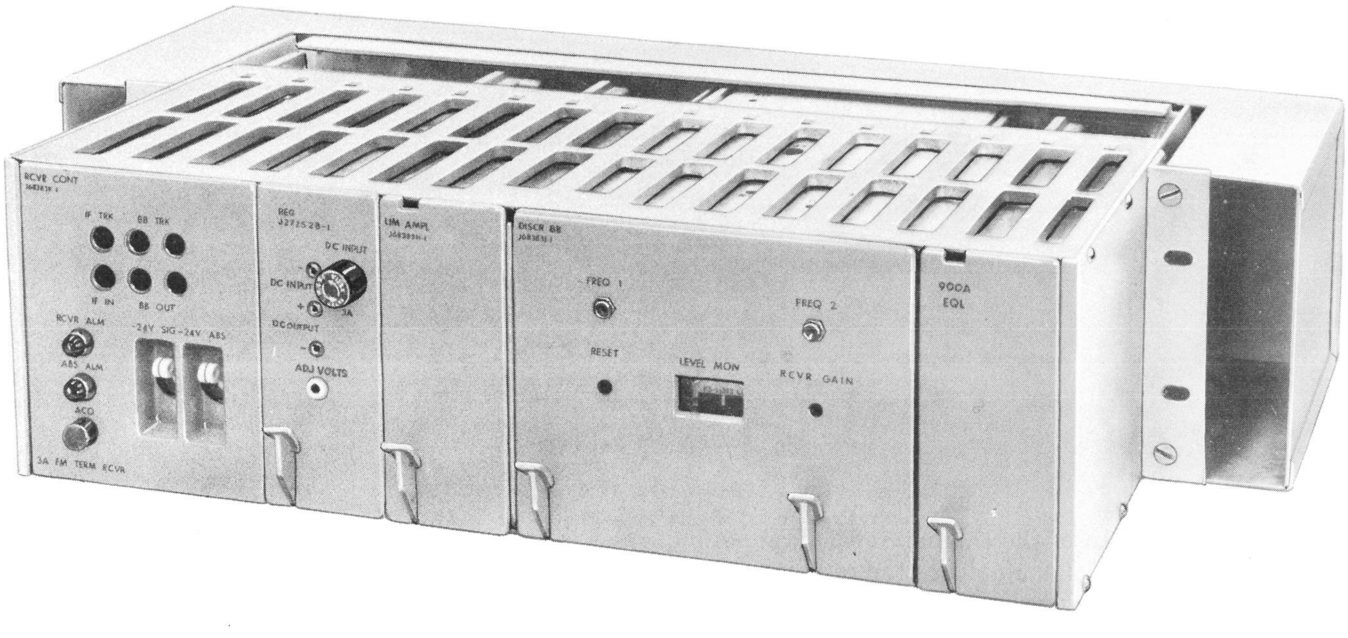


Fig. 3—3A FM Receiver

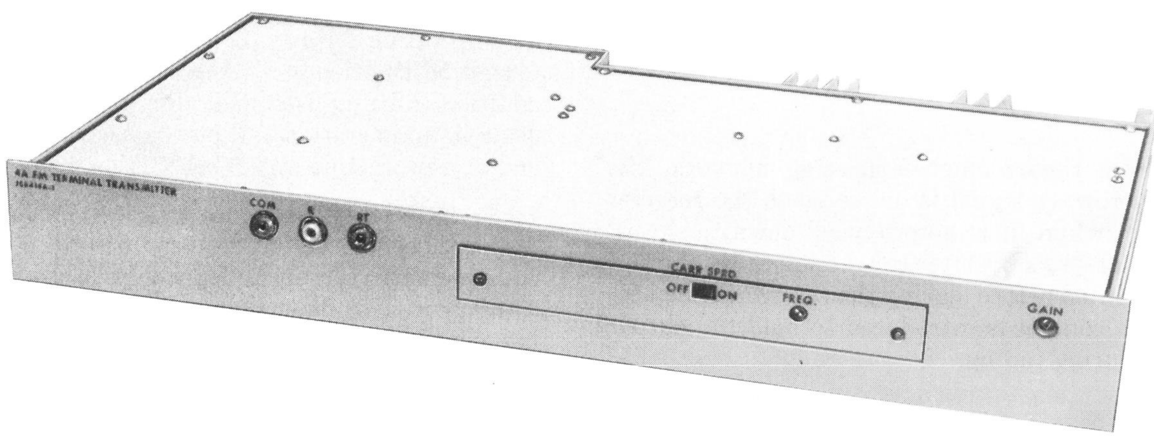


Fig. 4—4A FM Transmitter

G. 652A RF Preamplifier

2.13 A 652A integrated circuit RF preamplifier may be used in the common receiving waveguide run feeding the bay lineup. The application rules for applying the 652A are dependent on the message circuit loading on the radio channels and the normal received carrier power at the station. The 652A RF preamplifier is installed in the receiving

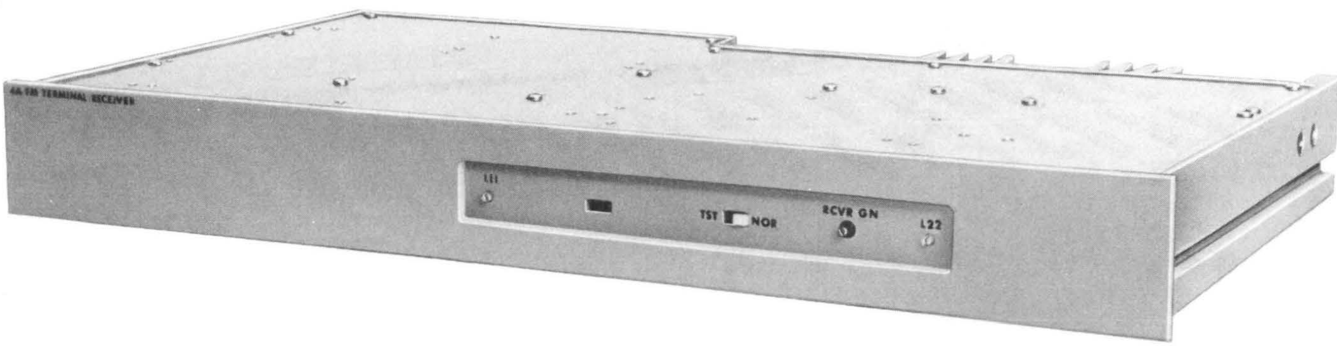


Fig. 5—4A FM Receiver

waveguide run ahead of the channel separating network (Fig. 30). The 652A amplifies the received carrier signals for all bays in the lineup on that receiving waveguide run. The preamplifier has a typical gain of 10 dB when powered and a maximum insertion loss of 13 dB when unpowered. The 652A RF preamplifier is not used when the normal received carrier power is equal to or greater than −27 dBm for loadings up to 1500 circuits or −23 dBm for loadings up to 1800 circuits. Refer to Section 420-802-100 for descriptive information and installation procedures.

H. Microwave Receiver

2.14 From the channel separating network, the microwave signal is delivered to the receiver modulator, where it is heterodyned down to the IF frequency of 70 MHz. After conversion to IF, the signal is amplified before leaving the receiver, and automatic gain control is introduced to hold the output constant during fading.

2.15 In repeater stations, the IF output of the radio receiver is connected directly to the IF input of the radio transmitter for retransmission. In main stations, however, the IF signal is sent through the 100A or 400A Protection Switching System and then through the IF patch and access bay, where it is either dropped or routed on for retransmission.

I. T-R Bays

2.16 A radio transmitter and a radio receiver are consolidated into one transmitter-receiver (T-R) bay (Fig. 12 and 13). However, there are differences between the T-R bays used at repeater stations and those used at main stations, and in their interconnections. These differences result from the fact that, whereas information received at a repeater station is merely retransmitted, information received on any one channel at a main station might be dropped and different information inserted for transmission. For these reasons, a repeater station T-R bay is arranged to serve one direction of a 2-way channel. A main station T-R bay, on the other hand, is arranged to serve opposite directions of a 2-way channel. Thus, a main station T-R bay normally will be carrying different information in its transmitter and receiver. In addition to being used where drops and pickups are desired, main station T-R bays also are used at each end of a protection switching section.

2.17 Reliability and maintenance considerations, therefore, dictate that main station receiving equipment be largely independent of transmitting equipment. This independence is obtained by providing main station T-R bays with individual microwave generators and voltage regulators for the transmitter and receiver. The microwave generators supply to the radio receiver and transmitter the signals necessary for conversion between IF and microwave frequencies. The voltage regulators regulate the voltage supplied to all T-R circuits except the traveling-wave tube (TWT).

2.18 Conversely, only one microwave generator and one regulator are used in repeater station bays since transmitted information is the same as that received. The microwave generator supplies both the transmitter and, in conjunction with a 40-MHz shift modulator, the receiver with the necessary signal for shifting the channel signal between the IF and microwave frequencies.

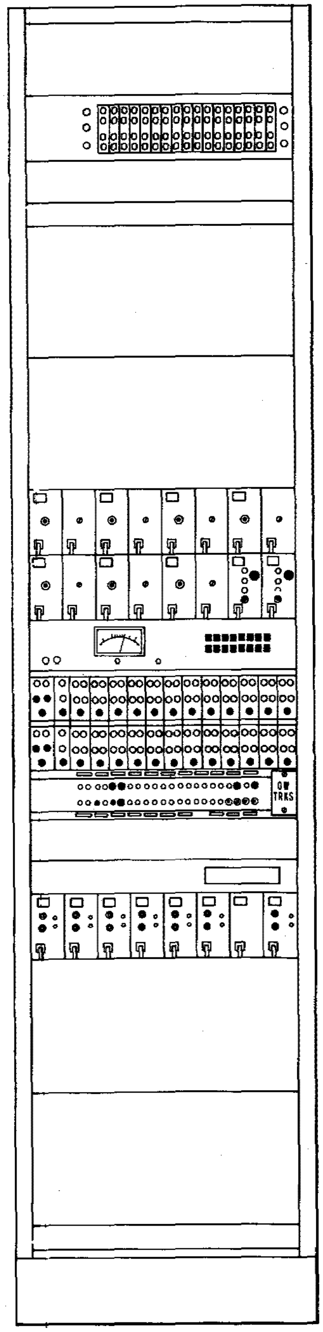


Fig. 6—J68398A (200A) Transmitting and Receiving Control Bay

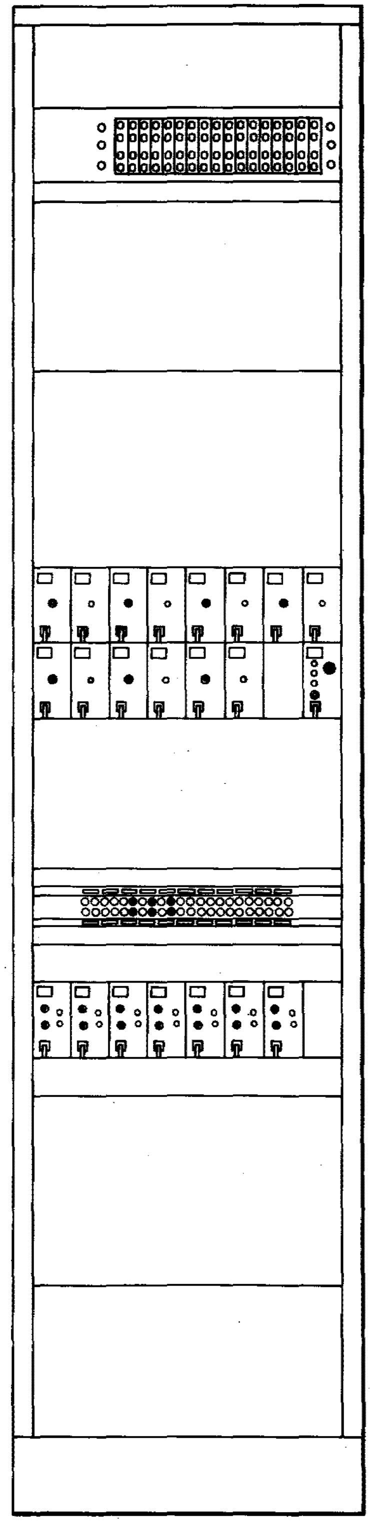


Fig. 7—J68398B (200A) Transmitting and Receiving Control Bay

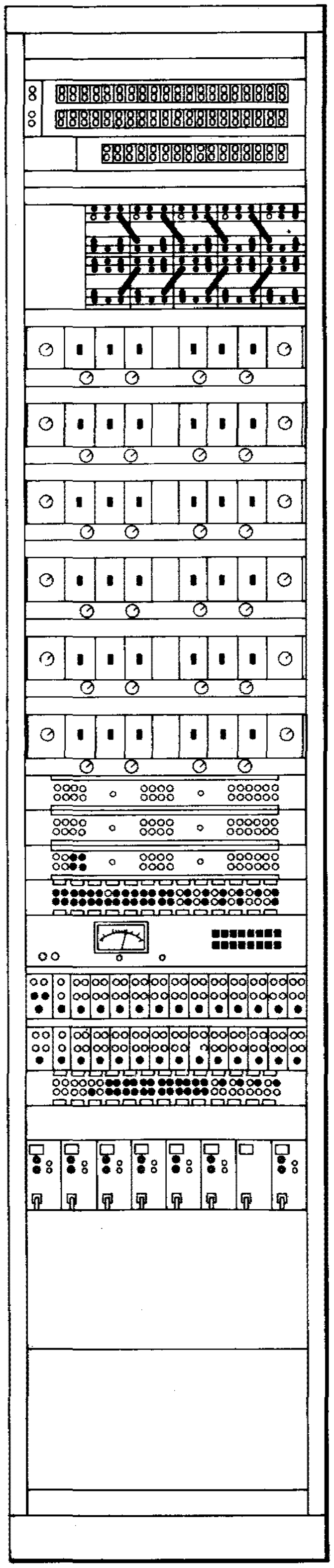


Fig. 8—J68398C (200A) Baseband Equipment Bay

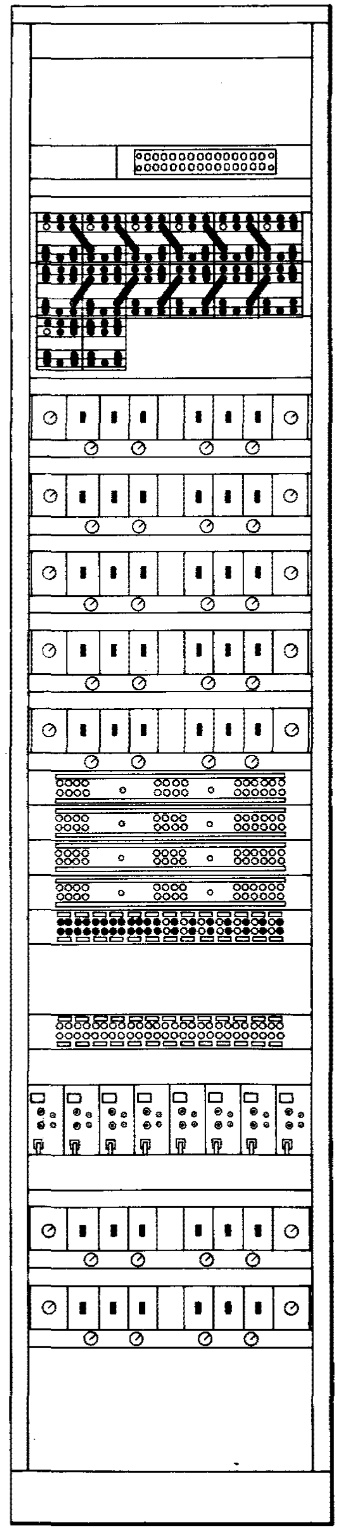


Fig. 9—J68398D (200A) Baseband Equipment Bay

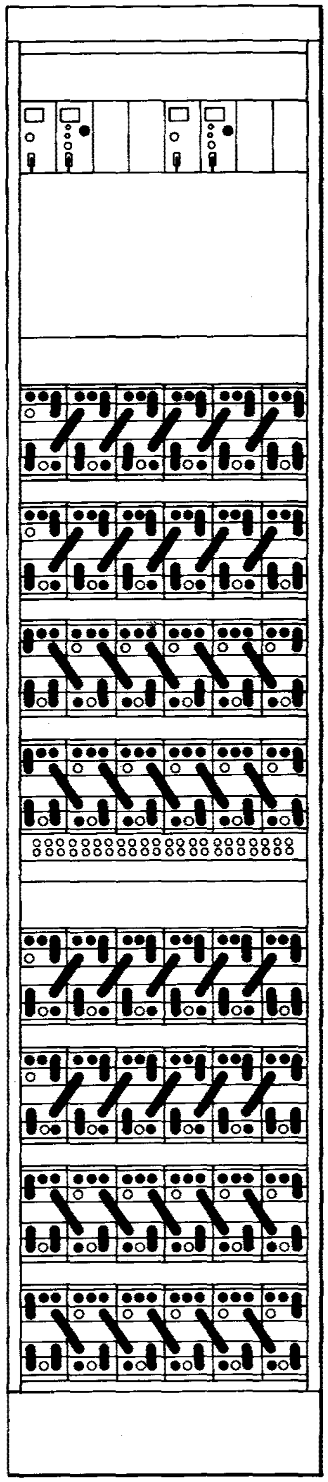


Fig. 10—J68398T (200A) Transmitting and Receiving IF Switch Bay

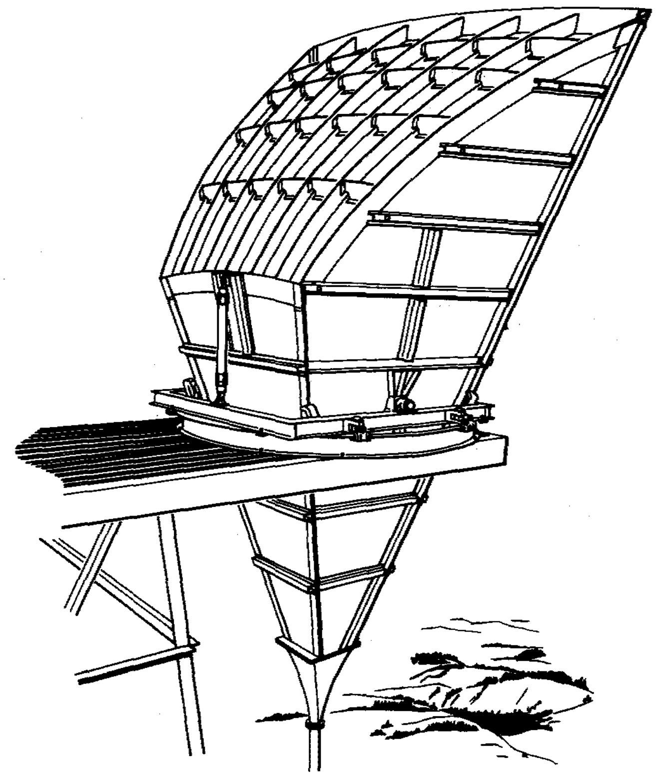


Fig. 11—KS-15676 Horn-Reflector Antenna

2.19 Figure 12 shows the J68386A (repeater station) or J68386B (main station) bay. A detailed description of these bays may be found in Section 411-400-100. Two newer T-R bays, pictured in Fig. 13, were introduced in 1971. They are designated J68386G and J68386H for the repeater station and main station bays, respectively, and are described in Section 411-500-100. ➧A 5-watt solid-state amplifier, coded 660E and F integrated circuit (amplifier) [660( ) IC], was made available in 1982 to be used as a replacement for the 461A TWT amplifier.➧

2.20 At both main and repeater stations, as many as six T-R bays are arranged side by side into one lineup with their respective channel combining and separating networks interconnected. Two such lineups allow channels 1 through 6 and channels 7 through 12 to be combined into two separate groups. These groups, one with vertical and the other with horizontal polarization, are fed to the antenna to be radiated. However, in repeater stations, one pair of lineups serves to relay information in one direction of transmission and another pair serves the return direction. Main station lineups serve both the receiving and transmitting functions in one compass direction from the station, and other lineups serve other compass directions. These two arrangements are shown in simplified form for one 2-way channel in Fig. 14.

J. 100A Protection Switching System

2.21 At the receiving end of a radio switching section, the IF outputs of the radio receivers are sent to the 100A Protection Switching System. The 100A monitors the IF output of each radio receiver for carrier level and for noise level. If the carrier level falls below a predetermined value, a switch to an available protection channel is initiated. Similarly, a switch will be initiated if the noise in a narrowband slot centered at 9 MHz is too high, or if the 9-MHz tone from the carrier resupply of a preceding transmitter is present. The 100A coordinates the switch at both ends of a switching section using coded voice-frequency signals sent over a land line or auxiliary radio circuit. Service interruptions are less than 10 microseconds for fade or maintenance-initiated switches, and less than 50 milliseconds for equipment failure-initiated switches. The 100A is equipped with an automatic exerciser which periodically performs operational checks on the system. Figures 15 through 18 show the various bays containing 100A equipment. Refer to Section 420-610-100 for more details on the 100A system.

K. 400A Protection Switching System

2.22 The 400A is a newer switching system with similar performance to the 100A system, but can be used to protect TD and TH channels combined. It monitors the IF output of each radio receiver and initiates a switch if the carrier level falls or if the 9-MHz noise increases. Coordination of the switches at each end of the switching section is accomplished by using coded voice-frequency signals sent over a land line or auxiliary radio circuit. Service interruptions are less than 50 milliseconds for equipment failure-initiated switches. Like 100A, the 400A is equipped with an automatic exerciser to perform operational checks on the system. Figure 19 shows the 400A equipment bays. Refer to Section 420-620-100 for more details on the 400A Switching System.

L. IF Patch and Access Bay

2.23 At main stations, the IF patch and access bay (Fig. 20) is the central point for all IF interconnections. It provides jack fields for manually terminating or interconnecting the inputs and/or outputs of the receivers, transmitters, FM terminal equipment, monitoring equipment, restoration circuits, protection equipment, etc, for maintenance, testing, and regular and temporary operation. Directional couplers and reed-type coaxial switches may also be provided for automatic restoration service. Figure 21 shows the relationship of the patch and access bay to other main station equipment.

3. MISCELLANEOUS

3.01 This part discusses auxiliary and test equipment, physical facilities, and other features of the TD-3 system not covered in the preceding two parts.

A. System Power

3.02 The normal basic voltage required by a TD-3 station is −24 volts dc. The system will perform satisfactorily, however, with voltages ranging from −22 to −28 volts. Where voltages other than −24 volts are required, they are furnished by power supplies powered from the −24 volt source. These power supplies are discussed in the sections covering the equipment with which they are associated.

3.03 The dc distribution circuits used with the original J68386A and J68386B T-R bays are divided into three groups to isolate the signal path circuits from the noisy circuits connected to the common −24 volt battery plant. The signal (quiet) group feeds the −19 volt regulators, and ➧the 660( ) RF power amplifier.➧ The noisy group feeds the TWT converter-type power supplies and an undesignated group supplies the bay alarm circuits. The newer J68386G and J68386H T-R bays have sufficient filtering built into the TWT power supply to permit connecting the supply to the signal group, thereby eliminating the need for a separate noisy group for these bays.

3.04 The input power to the station equipment is usually obtained from a −24 volt rectifier plant operating from commercial alternating current having a standard −24 volt battery plant floating on its output. The rectifier output voltage is adjusted to a value that will provide a small charging current to the battery cells in addition to the requirements of the station. An engine alternator will automatically supply input power in case of commercial power failure. If the engine alternator fails to operate, the battery capacity that typically is provided will furnish at least 8 hours of operation.

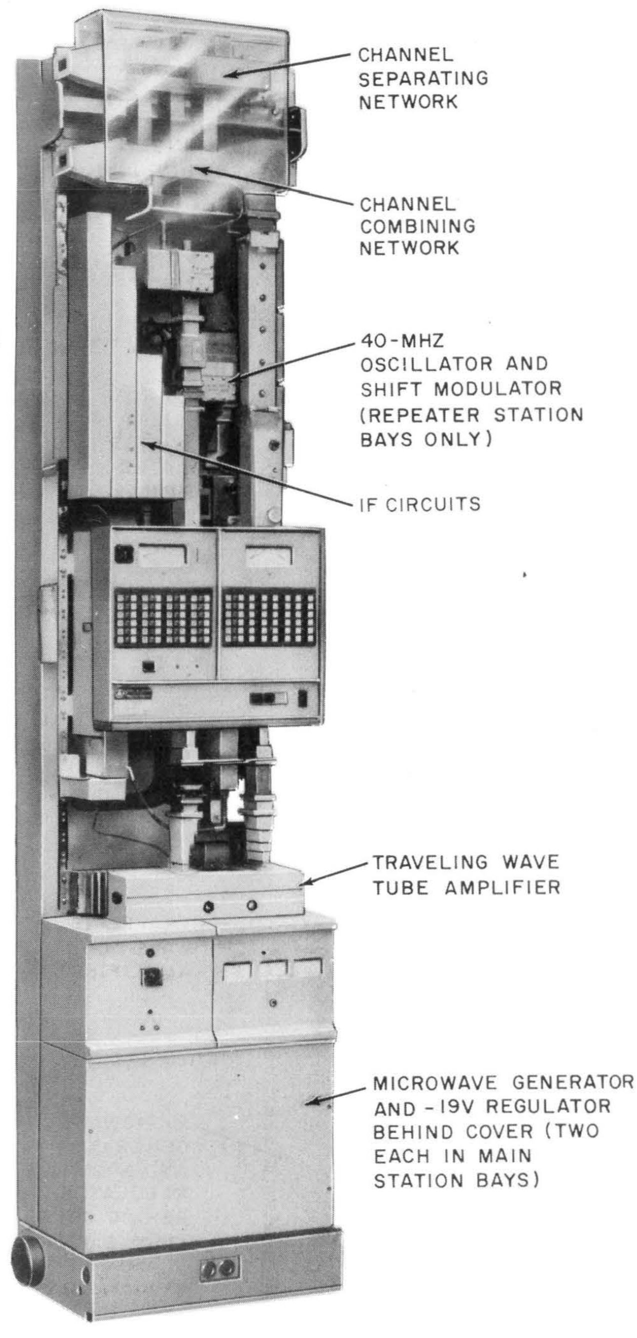


Fig. 12—J68386A or J68386B Transmitter-Receiver Bay

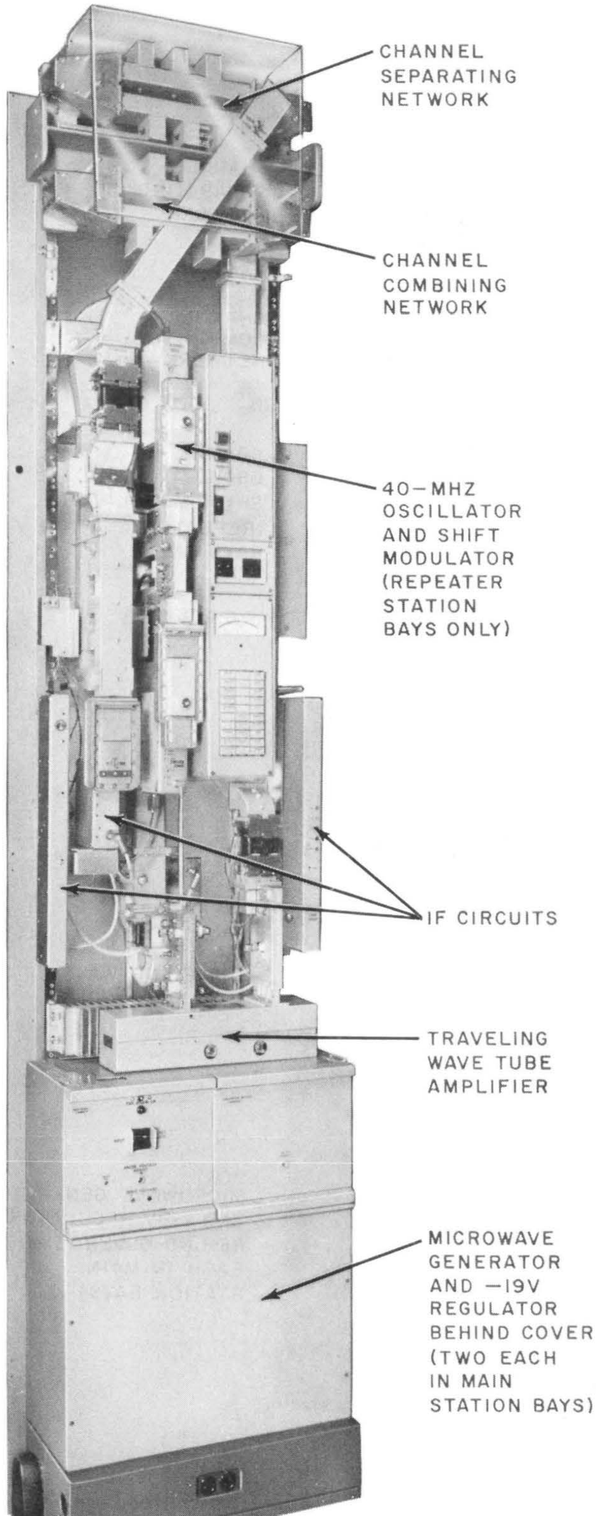
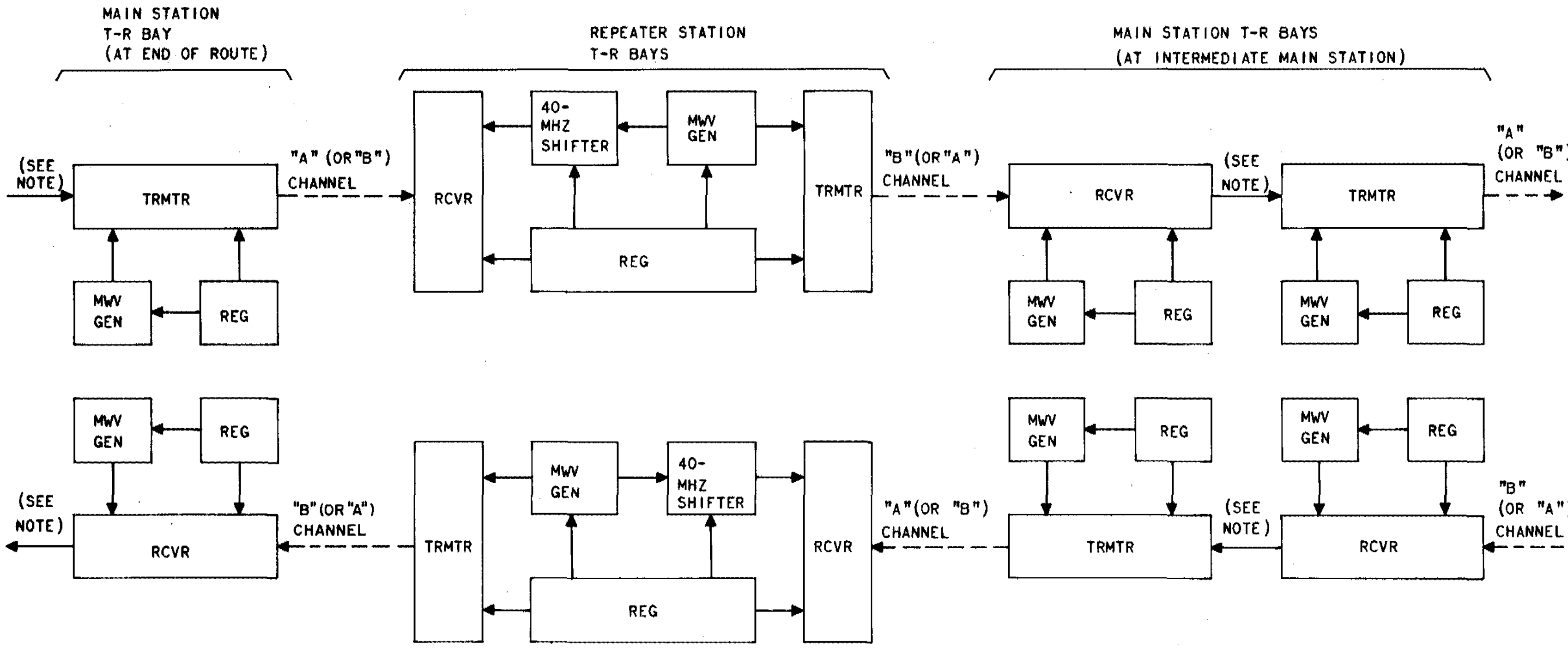


Fig. 13—J68386G or J68386H Transmitter-Receiver Bay



NOTE:
MAIN STATION T-R BAY INTERCONNECTIONS ARE MADE VIA IF PATCH AND ACCESS BAYS, FM TERMINALS, PROTECTION SWITCHING, ETC. (REFER TO FIG. 21 FOR THESE DETAILS).

Fig. 14—Transmitter-Receiver Bay Configurations for One 2-Way Channel

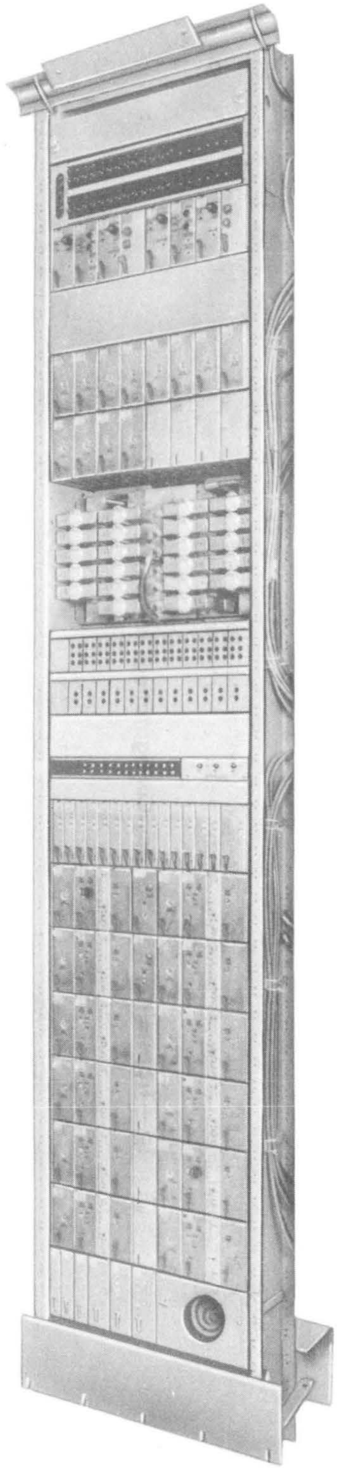


Fig. 15—J68381B (100A) Receiving IF Switch Bay

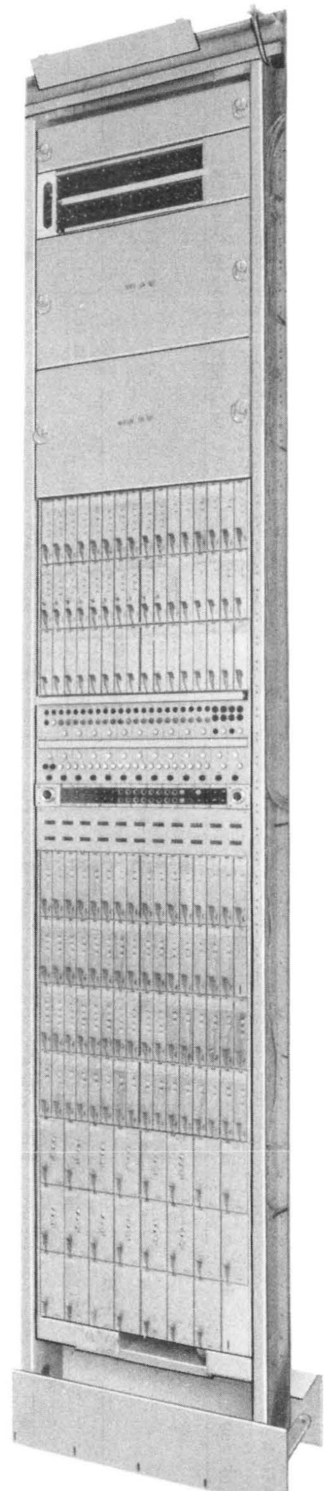


Fig. 16—J68381C (100A) Receiving Control Bay

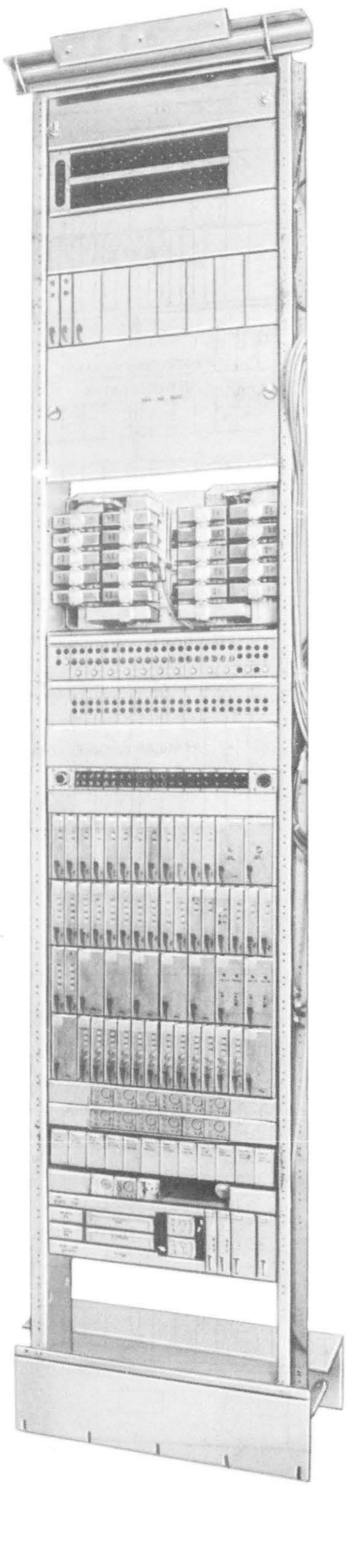


Fig. 17—J68381A (100A) Transmitting IF Switch and Control Bay

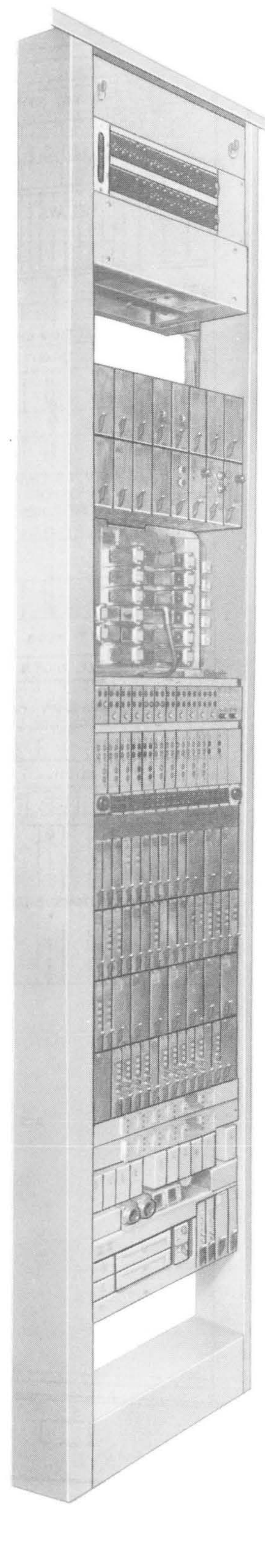


Fig. 18—J68381D (100A) Auxiliary Station IF Switch and Control Bay

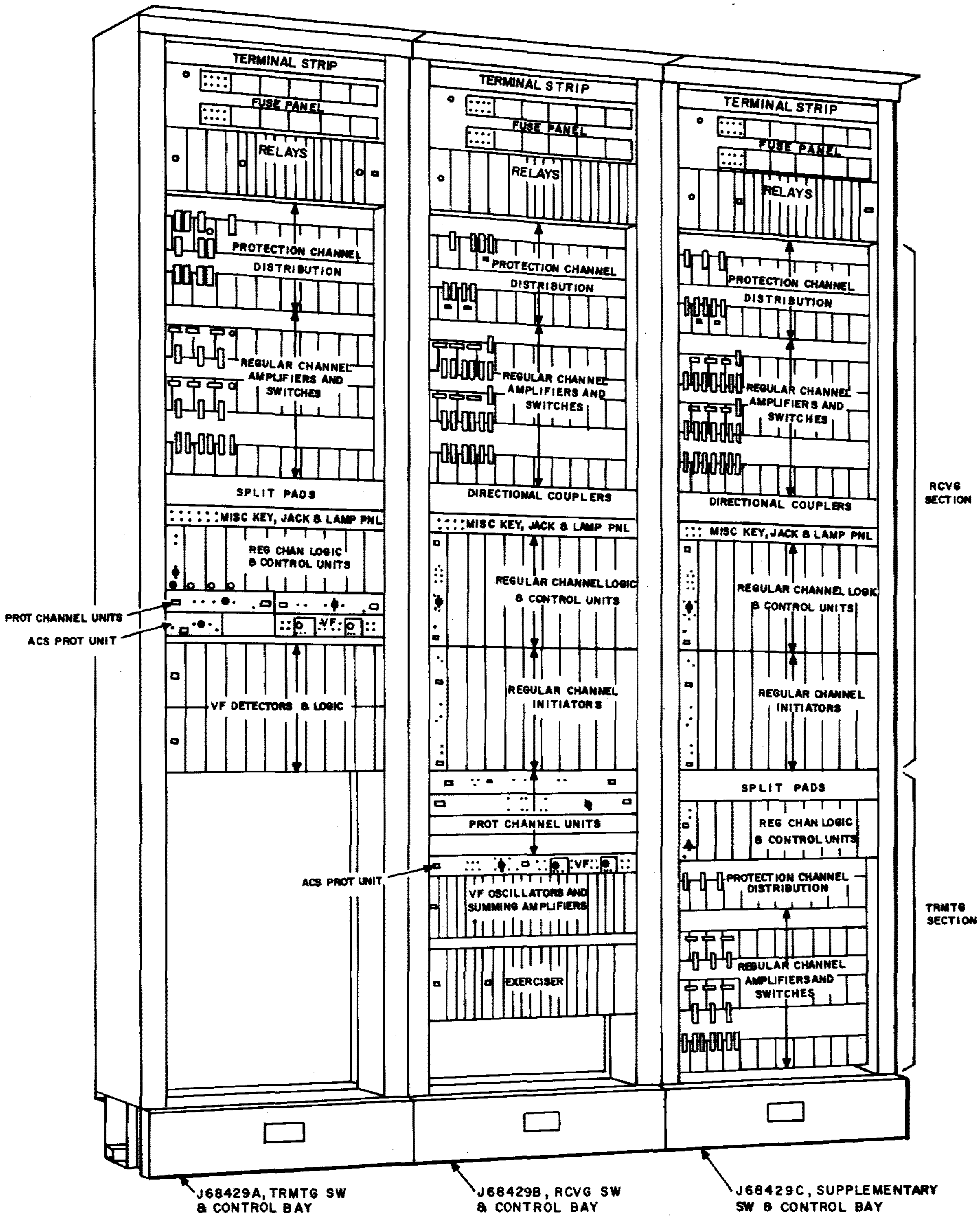


Fig. 19—400A Bays—Basic System

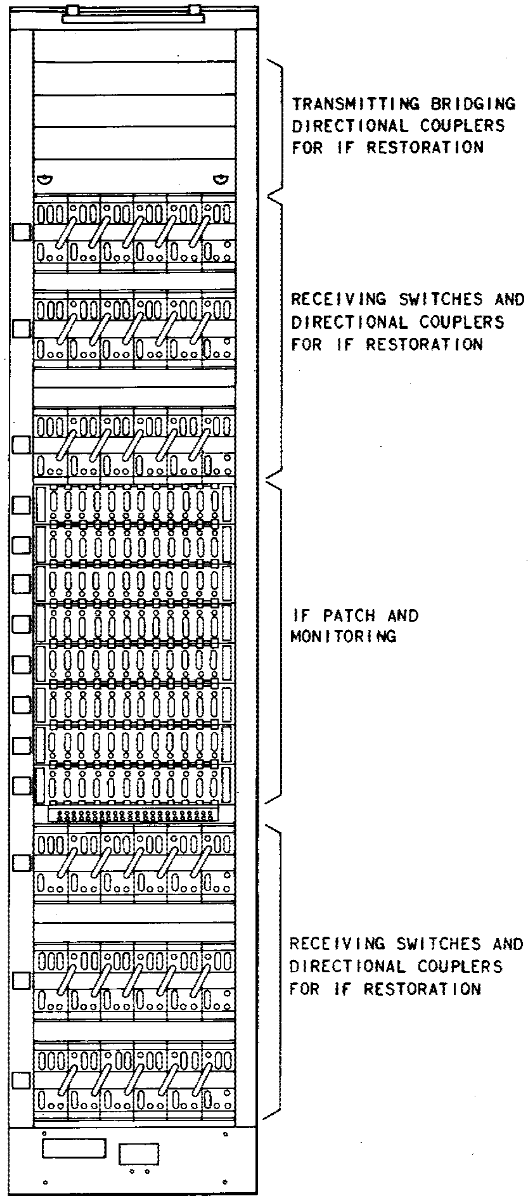


Fig. 20—IF Patch and Access Bay

B. Alarm and Remote Control Facilities

3.05 Two types of alarm and remote control systems are in use in TD-3. They are the C1 Alarm and Control System and a newer, more versatile solid-state system, the E-Type Status Reporting and Control System. Their functions are to relay detailed information on station alarms from unattended repeater stations to the responsible alarm centers, and to relay remote control order signals from the alarm centers to the unattended stations. Status reports and/or control of such conditions as room or equipment temperature deviations, tower light, power, engine starting, and engine or fuse failures, and open doors are relayed by these systems. Both systems operate over standard voice-frequency land lines or auxiliary radio lines. Section 201-631-101 describes the C1 system, and Sections 201-639-101 and 201-644-100 describe the E1 and E2 systems, respectively.

C. Test Equipment

3.06 Four major pieces of test equipment are necessary to maintain the component parts of the TD-3 system. They are described in the following four paragraphs.

3.07 The J68392A transmitter-receiver test set (Fig. 22) is used to measure amplitude response, power level, and return loss in the T-R bays at both IF and RF frequencies. It is also used for measuring the noise figure of the microwave receiver and the basic oscillator frequency of the microwave generator and the 40-MHz shift oscillator. Most of the measurements performed with this test set use sweep-frequency techniques. See Section 104-415-000 for a description of and operating instructions for this test set. A new test set (Fig. 23), coded J68428A, is available to perform the same measurements as the J68392A test set. See Section 104-417-000 for a description of this test set.

3.08 The J68396A test bench (Fig. 24) is used at maintenance centers in conjunction with the transmitter-receiver test set for troubleshooting, repairing, and testing the component units of the T-R bay and the FM terminal transmitter and receiver. The test bench provides power supplies and component units which are used either in conjunction with or as substitutes for the units under test. Also provided is a working surface for repair and storage space for miscellaneous auxiliary equipment and reference material. Section 104-382-100 covers the test bench in more detail.

3.09 The J68337H FM terminal test set (Fig. 25) or the newer KS-20548 distortion test set are used to test and align the 3A FM transmitters and

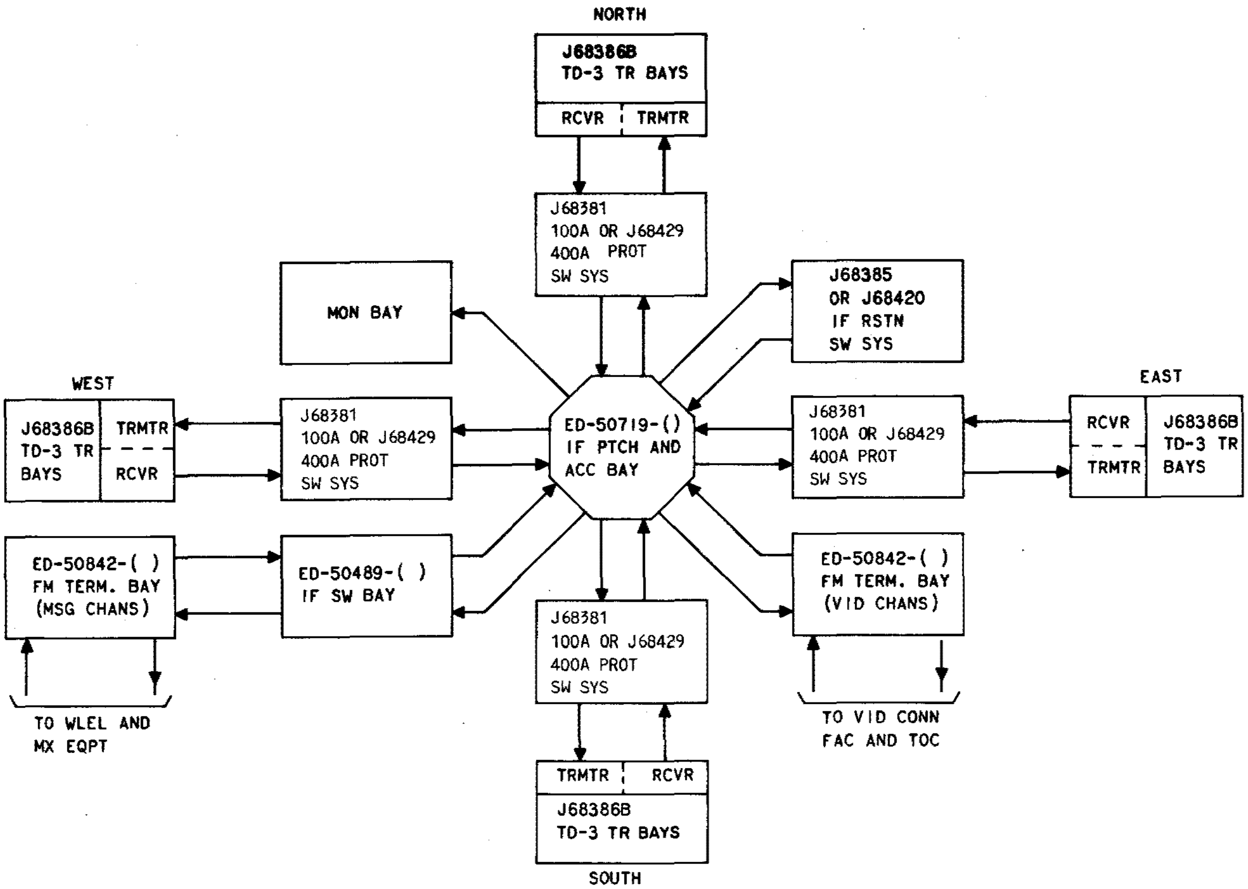


Fig. 21—Block Diagram of a Typical TD-3 Main Station

receivers. Measurement and/or alignment of the FM transmitter and receiver deviation sensitivity and other important characteristics can be made using this test equipment. Refer to Section 104-303-100 for greater detail on the FM terminal test set or to the manufacturer's instruction manual for more information on the distortion test set.

3.10 The J68381T protection switching test set (Fig. 26) is provided at stations having 100A protection equipment. It is capable of making all the required tests on the 100A system, including a complete checkout of the transmitting and receiving bay logic; and of checking the frequency, level, and gain of the 100A IF circuits. Additional coverage of this test set may be found in Section 104-331-100.

3.11 In addition to the above, overall system test equipment is needed for making envelope delay distortion, noise loading, baseband response and similar type measurements on the radio channels. Refer to drawing ED-51731-10 for a listing of the test equipment that may be used for this purpose.

D. Building and Tower

3.12 Housing for TD-3 stations is typically in poured, reinforced concrete buildings. A typical example is shown in Fig. 27. The buildings are designed in accordance with Bell System plans for continuity of communication in the event of nuclear attack. Heating and air-conditioning are provided to maintain the temperature in the radio equipment space between 55° and 95°F. Exterior wall panels are designed to be removable to facilitate station expansion.

3.13 Equipment layout plans for typical main and repeater stations are shown in Fig. 28 and 29, respectively. The layout plans of actual installations may differ considerably from these basic plans, but important considerations observed are minimization of IF cable and indoor waveguide run lengths. Because main stations are usually attended at least on a part-time basis, they have additional facilities for hygiene, relaxation, and study.

3.14 Towers for the horn antennas are available in various styles of construction in heights from 50 to 400 feet. The type of structure selected depends on such factors as the number of antennas to be supported (including provision for growth), and whether or not guying is to be used. All structures are designed to withstand winds in excess of 100 miles per hour, and their twist and deflection limits are customarily specified for 100-mph winds. The tower pictured in Fig. 27 is about 100 feet in height and supports an additional pair of parabolic antennas used for an auxiliary channel for order and alarm circuits.

E. Dehydrator

3.15 Dehydrators are usually provided to furnish dry air at a slight positive pressure to the waveguide system. Dry air is necessary to prevent water accumulation in the outdoor waveguide through condensation or leakage, and to charge the humidity-sensitive T-R bay waveguide filters. The dehydrators operate on a combined refrigeration and desiccation principle. One dehydrator normally will meet the needs of a typical repeater station, but more than one may be required to provide the dry air capacity needed at larger stations.

Fig. 22—J68392A Transmitter-Receiver Test Set

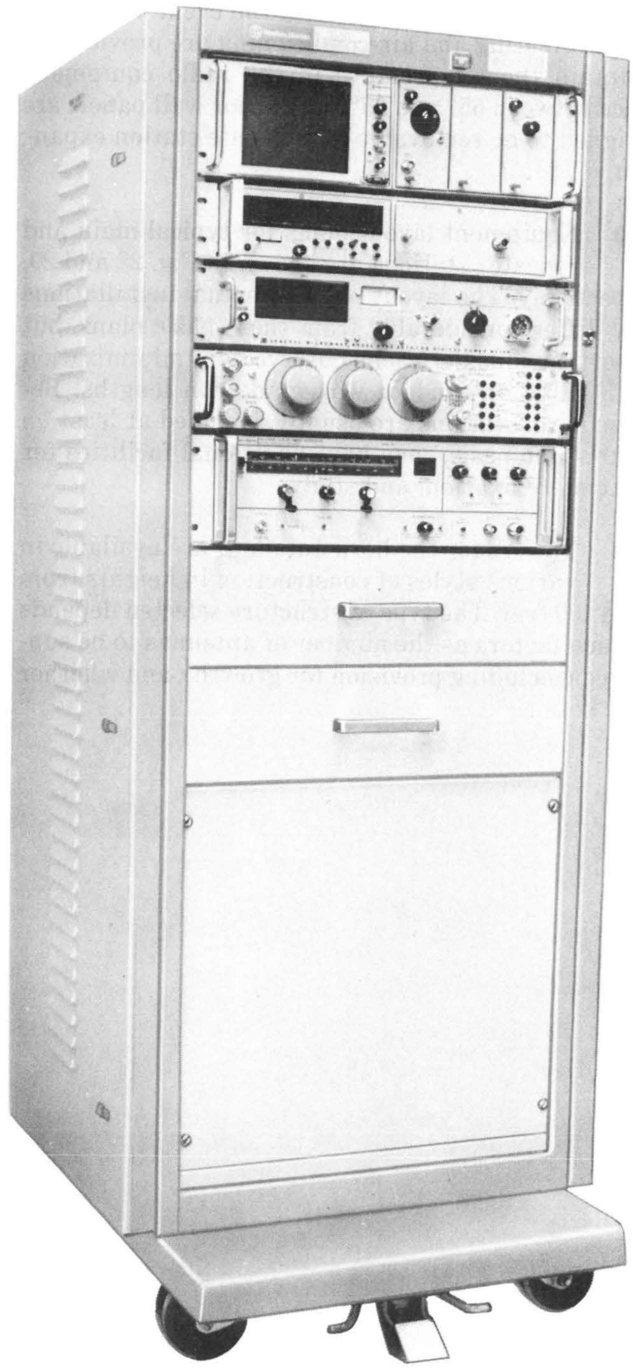


Fig. 23—J68428A Transmitter-Receiver Test Set

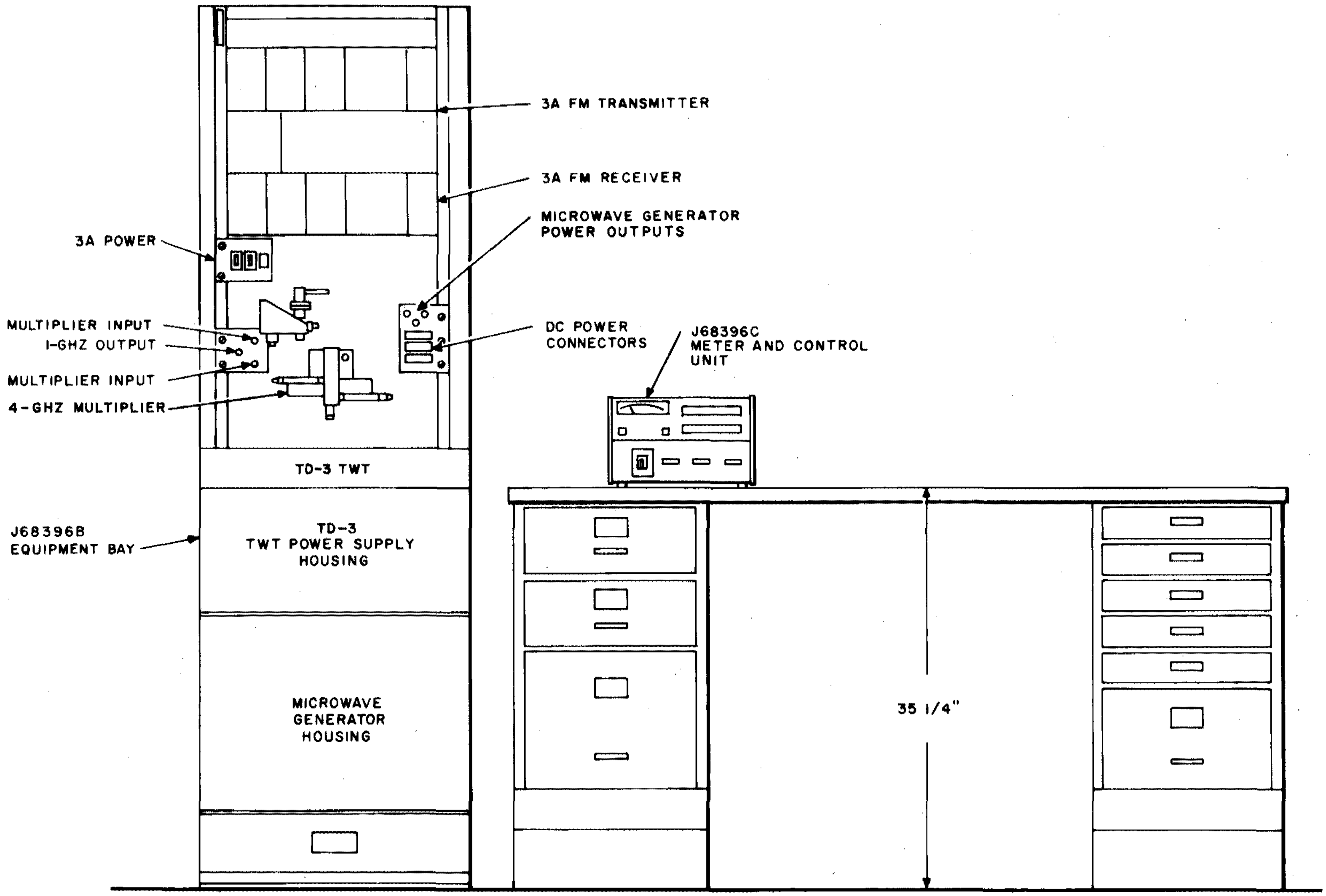


Fig. 24—J68396A Test Bench

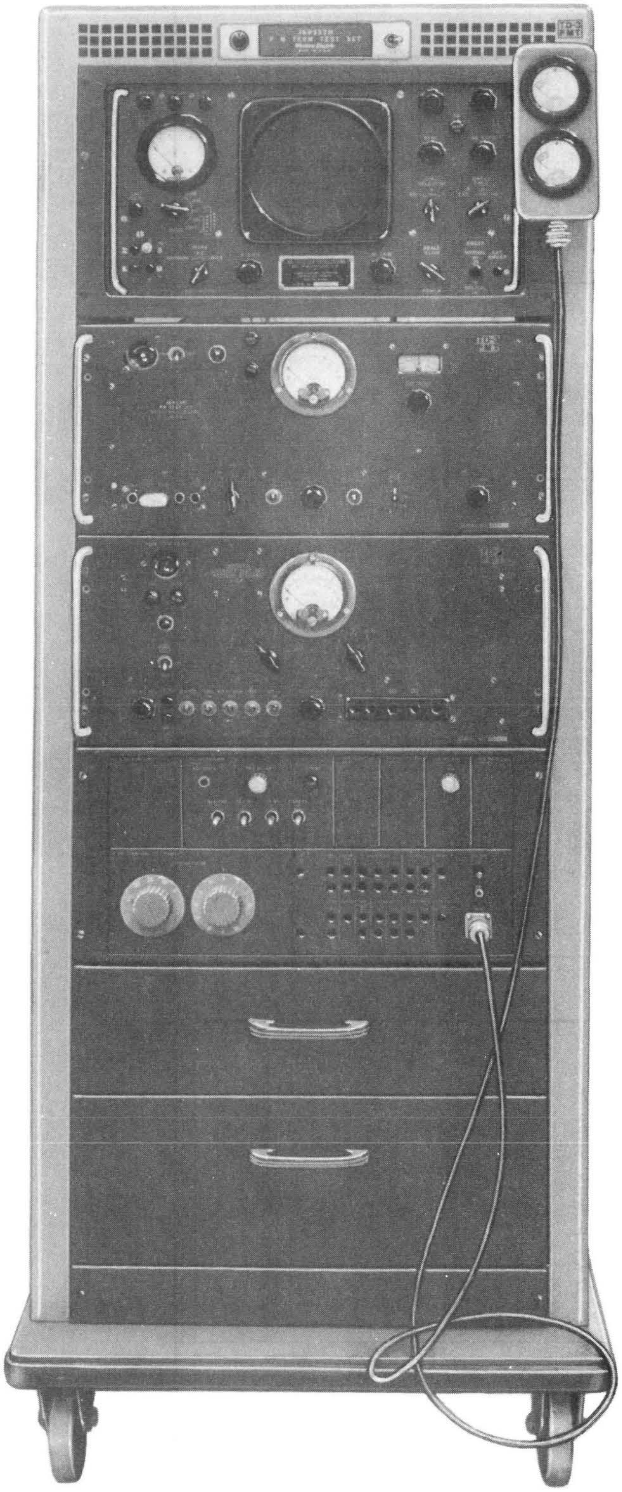


Fig. 25—J68337H FM Terminal Test Set

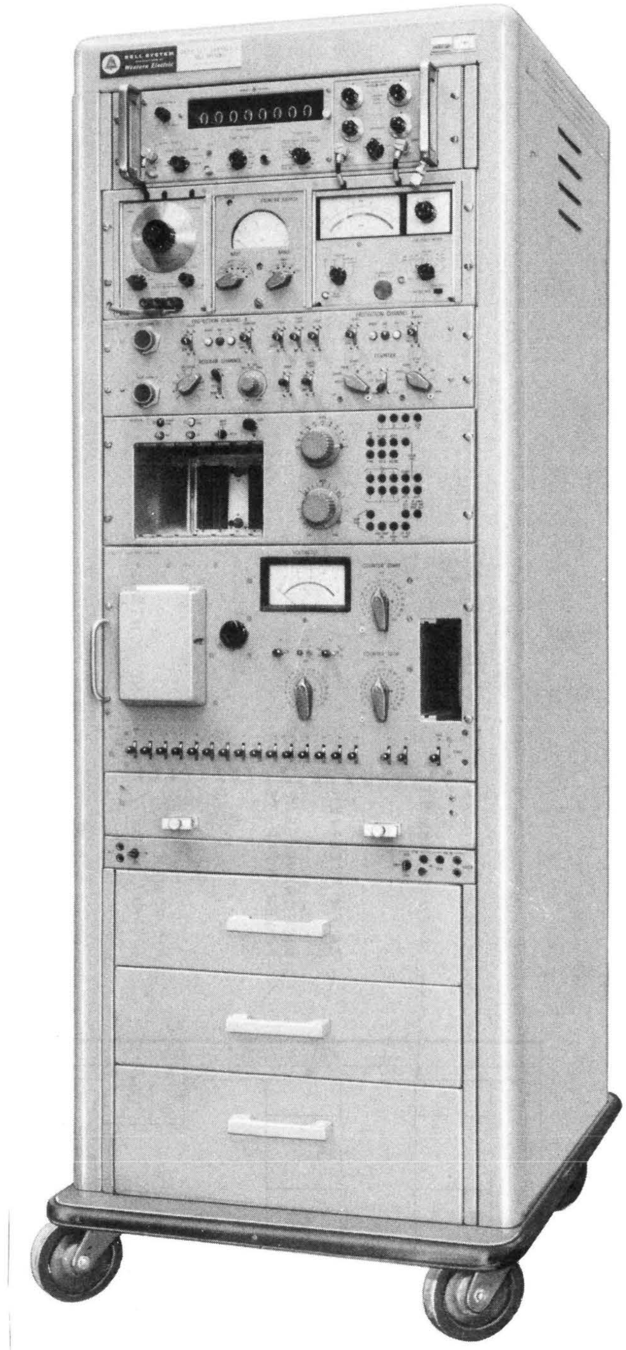


Fig. 26—J68381T 100A Protection Switching Test Set

Fig. 27—A Typical TD-3 Repeater Station

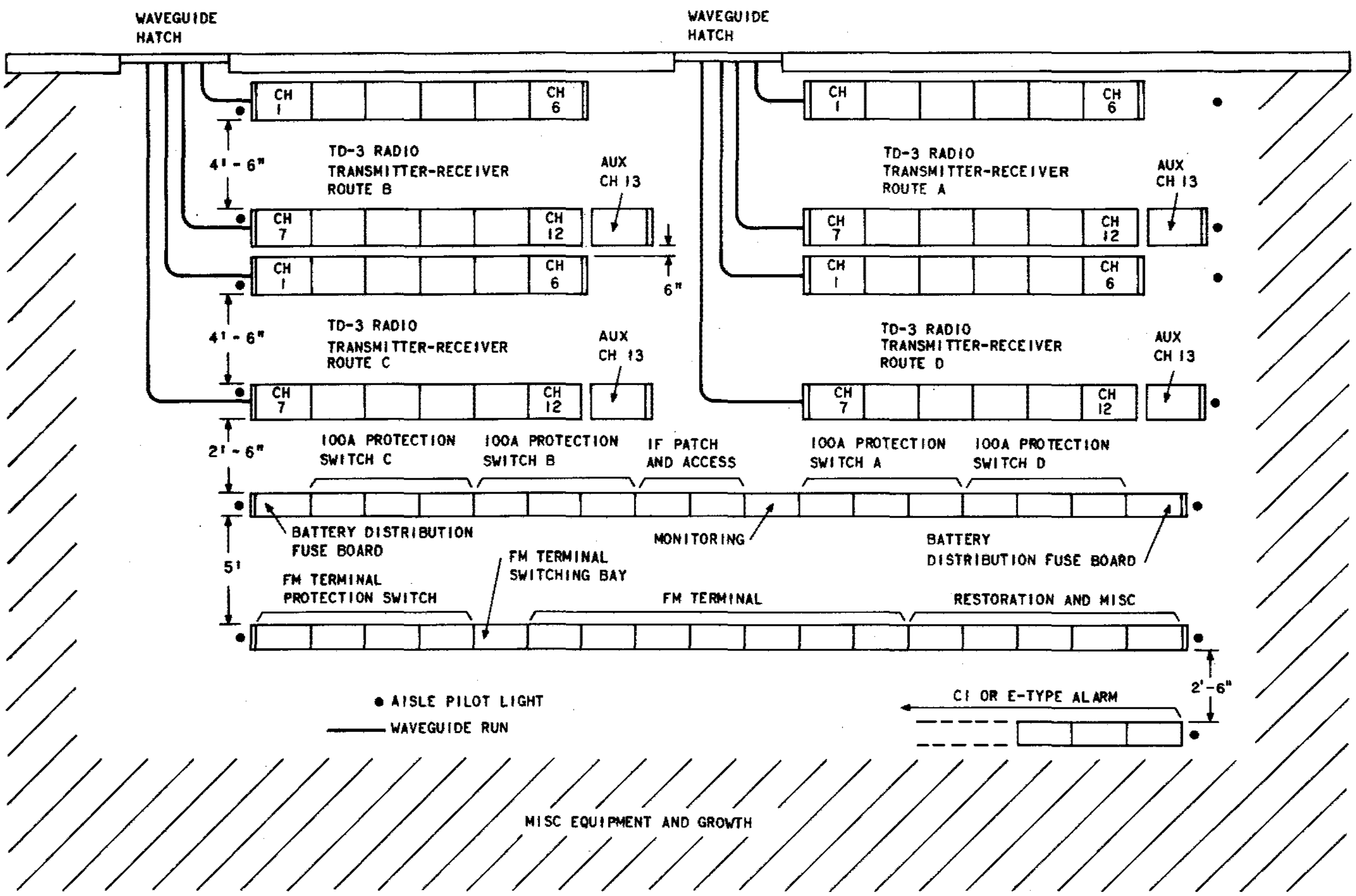


Fig. 28—Typical Main Station Equipment Layout Plan

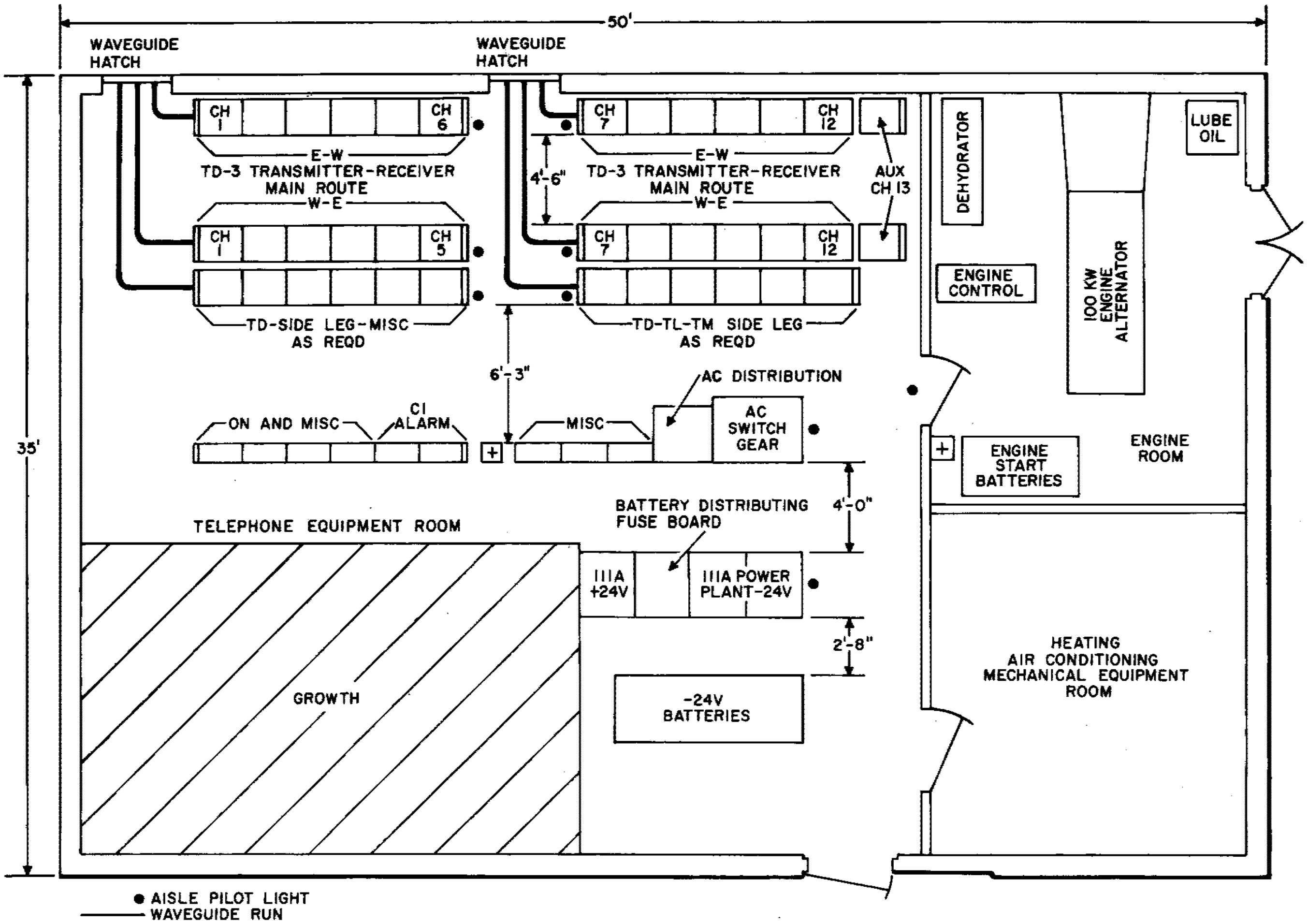
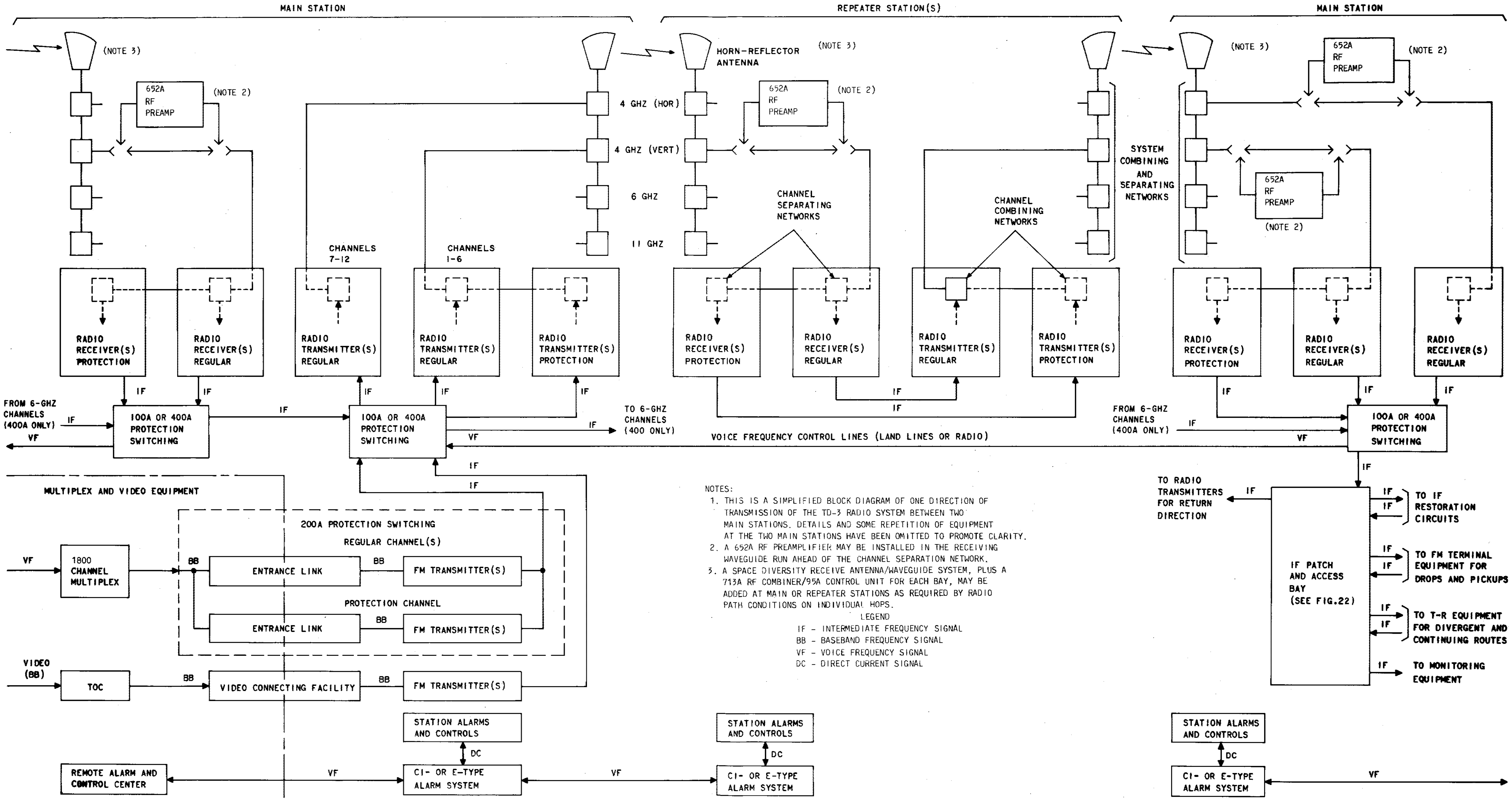


Fig. 29—Typical Repeater Station Equipment Layout Plan



NOTES:

1. THIS IS A SIMPLIFIED BLOCK DIAGRAM OF ONE DIRECTION OF TRANSMISSION OF THE TD-3 RADIO SYSTEM BETWEEN TWO MAIN STATIONS. DETAILS AND SOME REPETITION OF EQUIPMENT AT THE TWO MAIN STATIONS HAVE BEEN OMITTED TO PROMOTE CLARITY.
2. A 652A RF PREAMPLIFIER MAY BE INSTALLED IN THE RECEIVING WAVEGUIDE RUN AHEAD OF THE CHANNEL SEPARATION NETWORK.
3. A SPACE DIVERSITY RECEIVE ANTENNA/WAVEGUIDE SYSTEM, PLUS A 713A RF COMBINER/95A CONTROL UNIT FOR EACH BAY, MAY BE ADDED AT MAIN OR REPEATER STATIONS AS REQUIRED BY RADIO PATH CONDITIONS ON INDIVIDUAL HOPS.

LEGEND

IF – INTERMEDIATE FREQUENCY SIGNAL
BB – BASEBAND FREQUENCY SIGNAL
VF – VOICE FREQUENCY SIGNAL
DC – DIRECT CURRENT SIGNAL

Fig. 30—TD-3 System—Block Diagram