

L4 CARRIER REPEATERS TESTS

GENERAL MAINTENANCE AND TEST INFORMATION

CONTENTS	PAGE
1. GENERAL	1
2. SAFETY	2
3. MONITORING OSCILLATOR SYSTEM . .	2
4. MAINTENANCE AT LINE REPEATER STATIONS	2
A. General	2
B. "Make Good" Regulating Repeater	2
C. Test Equipment Used at Line Repeater Stations	4
5. MAIN STATION REPEATER	5
A. Replacement Maintenance	5
B. Periodic In-Service Tests and Adjustments	6
6. MAINTENANCE CENTER MAINTENANCE	6
A. General	6
B. Repeater Test Set	7
C. Preheating Rack (SD-50674-01) . .	8
D. Early L4 Repeater Test Sets . . .	8

1. GENERAL

1.01 General maintenance philosophy for the L4 carrier repeaters is discussed in this section. An introduction to various test sections and test equipment used for maintenance is also included.

1.02 This section is reissued to include information about additional test equipment and test procedures. Arrows are used to indicate significant changes. *Equipment Test Lists are not affected.*

1.03 Maintenance of the L4 carrier repeaters is divided into two main categories:

- (a) In-place maintenance
- (b) Maintenance center maintenance.

The L4 line repeater equipment units contain both power and transmission circuits required for a particular function. These circuits can be replaced on a plug-in package basis, thus limiting in-place maintenance at the line repeater locations primarily to removal and replacement of the plug-in units. Performance tests and alignment of repeater equipment units are made at properly equipped and stocked maintenance centers. Some in-place measurements are necessary at the line repeater location, but are held to a minimum.

1.04 In general, there are neither provisions for in-place periodic transmission or maintenance tests at the L4 line repeater stations nor alarms directly associated with the repeaters. The need for replacement maintenance of repeater equipment units is indicated by transmission failure alarms associated with the protective switching circuits and by routine measurements, checks of line stability, and other tests utilizing the remote control system.

1.05 Through the analysis of monitoring (fault locating) oscillator tones, A and B equalizer test-tone measurements, and other tests made via the control center, the attendant can locate faulty repeaters and detect deteriorating performance that could lead to failure of repeaters. Operating procedures for the remote control system are in Section 359-220-300.

2. SAFETY

2.01 The test sections for in-place and maintenance center maintenance emphasize the various hazards that exist and precautions that must be taken to avoid injury to personnel or damage to equipment.

2.02 Prescribed methods for entering and leaving manholes and for opening and closing apparatus cases are provided in the outside plant series of Bell System Practices.

2.03 *Extreme care should be exercised when working in the L4 repeater manholes. Hazardous voltages as high as 1800 volts may be present within the repeater apparatus cases. No attempts should be made to make measurements in the manholes except as prescribed in the detailed test procedures. Only approved test equipment should be used. See Part 4 for appropriate test equipment.*

2.04 ♦To avoid damage to test equipment when making measurements at the input and output jacks of the L4 line repeaters, the test equipment must be isolated from the high dc voltage which is present on the center conductor of the coaxial line. The J68898() pilot test set is equipped with test probes which provide the necessary dc isolation.

2.05 When the AT463 TMS is used for transmission measurements, an L4 high-voltage isolation test probe (SD-50676-01) is used to connect the TMS to the input or output jacks of the repeater.

Caution: *To avoid voltage surges which could damage test equipment, first connect the isolation test probe into the repeater IN or OUT jack and then to the test equipment.*

3. MONITORING OSCILLATOR SYSTEM

3.01 Monitoring oscillators provide a means for evaluating the performance of individual repeaters and aid in locating troubles along the route.

3.02 In order to use the monitoring oscillator tones to detect small gain change trends at the remote line repeaters, a precision alignment of the monitoring oscillator at the repeaters is

required. Refer to Section 359-200-503 for alignment procedures.

3.03 The L4 line must be in good working order and equalized before starting the monitoring oscillator alignment. The alignment begins at the receiving main repeater nearest the control center and proceeds backward to the transmitting repeater. Measurements are made at each repeater to ensure that the 11.648-MHz pilot level at the repeater input and the repeater gain are correct. Then the monitoring oscillator is adjusted for a precise signal level at the control center. By comparing subsequently measured levels with the alignment levels, level changes and trends can be detected. Refer to Section 359-200-502, Issue 2 for methods of trouble analysis using the monitoring oscillators.♦

4. MAINTENANCE AT LINE REPEATER STATIONS

A. General

4.01 In most cases, a trouble condition can be isolated to a particular line repeater through tests made at the control center. Replacement repeater units are then prepared for installation and are dispatched via the L4 line maintenance truck for installation at the remote location. Spare equalizing repeater units can be stored in the equalizing repeater station entrance hut. A typical entrance hut is shown in Fig. 1.

B. ♦"Make Good" Regulating Repeater

4.02 A J68877AB line regulating repeater requires the following:

- (a) A specific deviation equalizer
- (b) A specific setting of the 859C network
- (c) Adjustment of the preregulator for the mean temperature at any given location.

4.03 It is not practical to carry spares for every combination of options and adjustments on the line maintenance truck. A "make good" regulating repeater should be preadjusted and carried on the maintenance truck for a temporary replacement of a defective regulating repeater. The "make good" repeater will function until a repeater unit of appropriate list number can be equipped with the correct deviation equalizer and

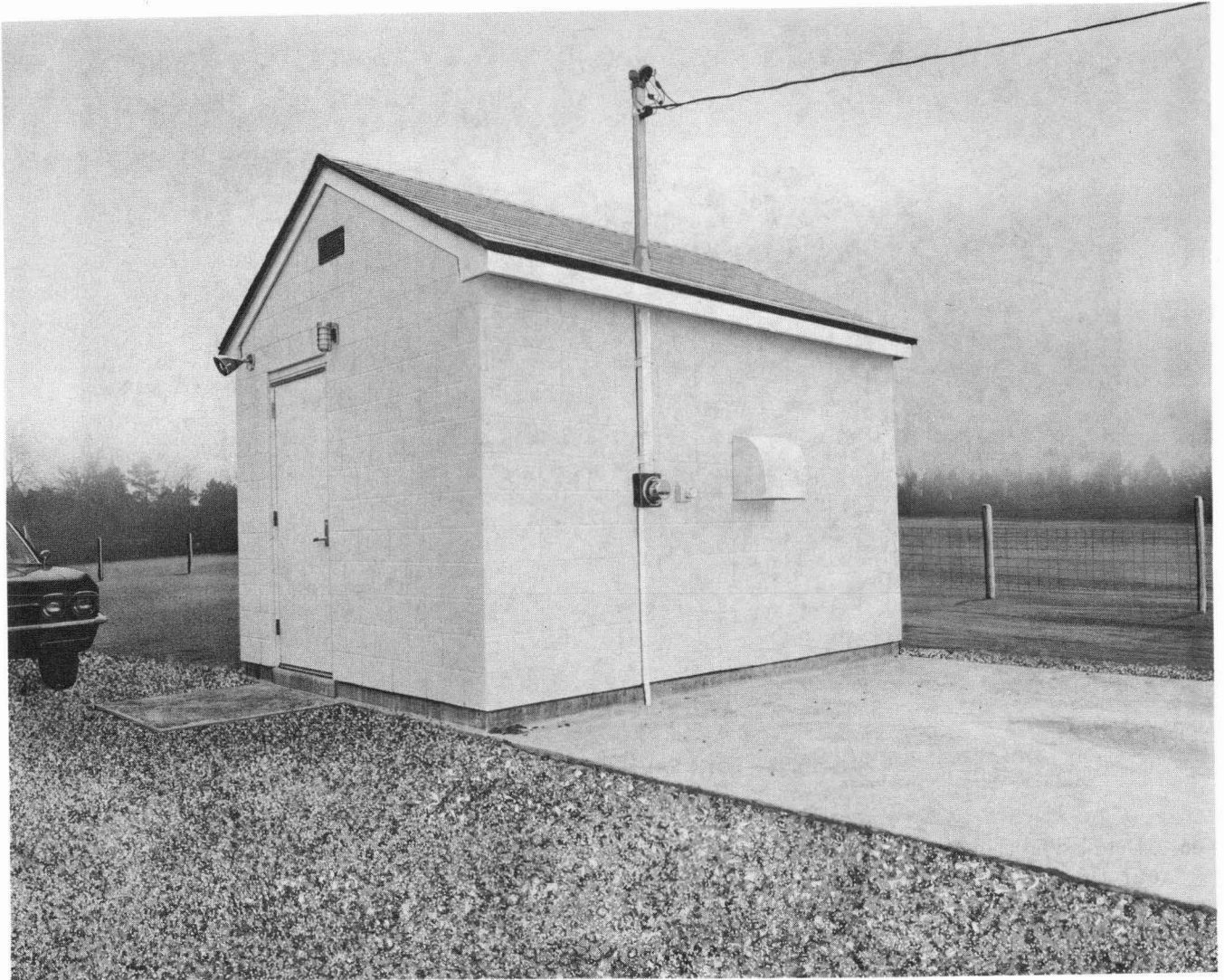


Fig. 1—Equalizing Repeater Station — Entrance Hut

LBO networks and adjusted for installation at the particular location.

4.04 The "make good" repeater should be conditioned as follows:

- (a) Equipped with an F-57216 deviation equalizer (12-mile spacing between regulators)
- (b) 859C network switch A2 turned down (adjusted for 12-mile spacing of regulators—63° to 70°F temperature)

- (c) Preregulator adjusted for the mean temperature of the line section in which the repeater will be used as a "make good" unit.♦

4.05 The outside plant series of sections include procedures for opening, ventilating, and closing manholes and for depressurizing, opening, closing, and repressurizing apparatus cases. After entering the manhole, the apparatus case containing the suspect equipment must be located. The removal and replacement maintenance of the repeater equipment units begins once the apparatus case cover has been removed. A typical basic repeater apparatus case is shown in Fig. 2.

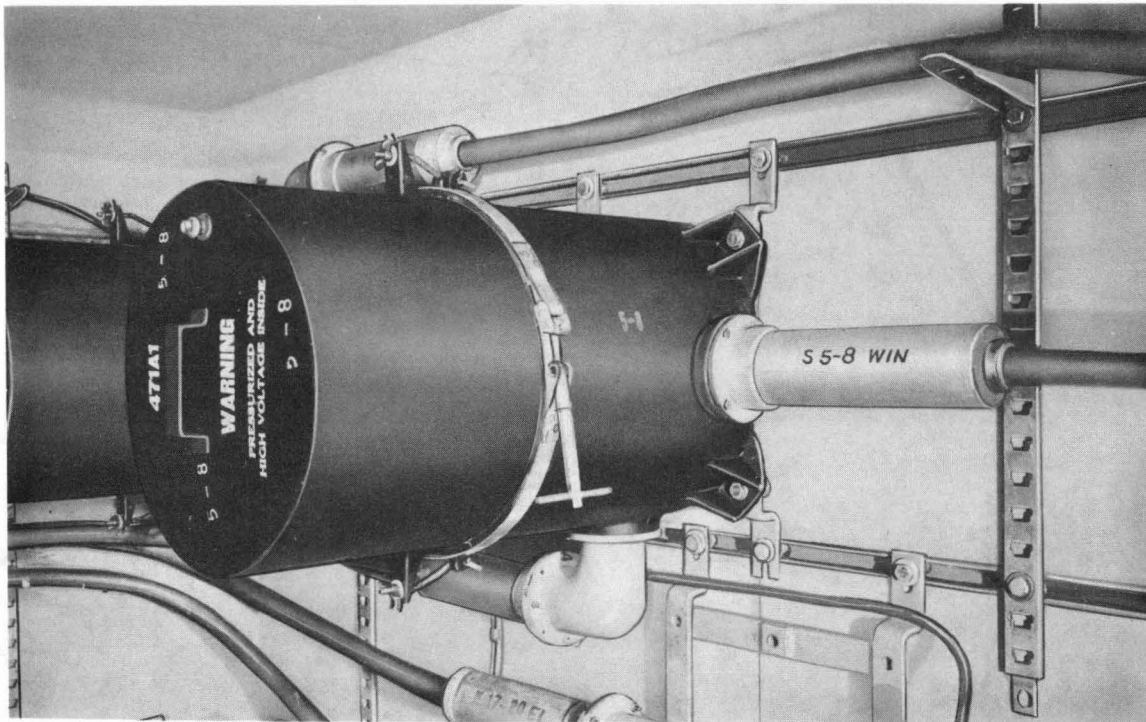


Fig. 2—Basic Repeater Apparatus Case

4.06 Detailed procedures for replacement operations at the basic, regulating, and equalizing repeater locations are provided in Sections 359-205-501, -502, and -503, respectively. The procedures ensure that the suspect equipment has been located in the appropriate apparatus case and that the affected line has been removed from service. Power is then bridged around the suspect repeater using the J68898() pilot test set. Checks for the presence of line power and 11.648-MHz pilot signal and measurements of relative gain are made, as required, using the pilot test set. The suspect equipment is removed and is replaced with a replacement unit. Removed repeater units must be discharged immediately upon removal from their mounting positions. A special jack (566A) is provided for discharging the repeaters. No maintenance is performed on the removed units in the manhole.

4.07 Once the replacement equipment is installed and its operation confirmed with the controlling main station, the apparatus case is closed, purged, and repressurized. Then the maintenance equipment is removed from the manhole and the manhole is closed, thus completing the maintenance operation.

C. ♦Test Equipment Used at Line Repeater Stations

4.08 Only approved test equipment should be used in line repeater stations. Approved test equipment is described briefly in the following paragraphs.

4.09 A *J68898() pilot test set* (SD-50778-01) is used as follows:

- (a) To bridge power around a repeater
- (b) To check for the presence of line power
- (c) To measure the 11.648-MHz pilot signal
- (d) To make gain measurements.

See Section 103-456-000 for a description of the test set.

4.10 The *portable transmission measuring set* (Fig. 3) (Wandel Goltermann model AT463) may be used to make transmission measurements at the line repeater stations. See Section 103-406-000 for a description of the AT463 TMS.

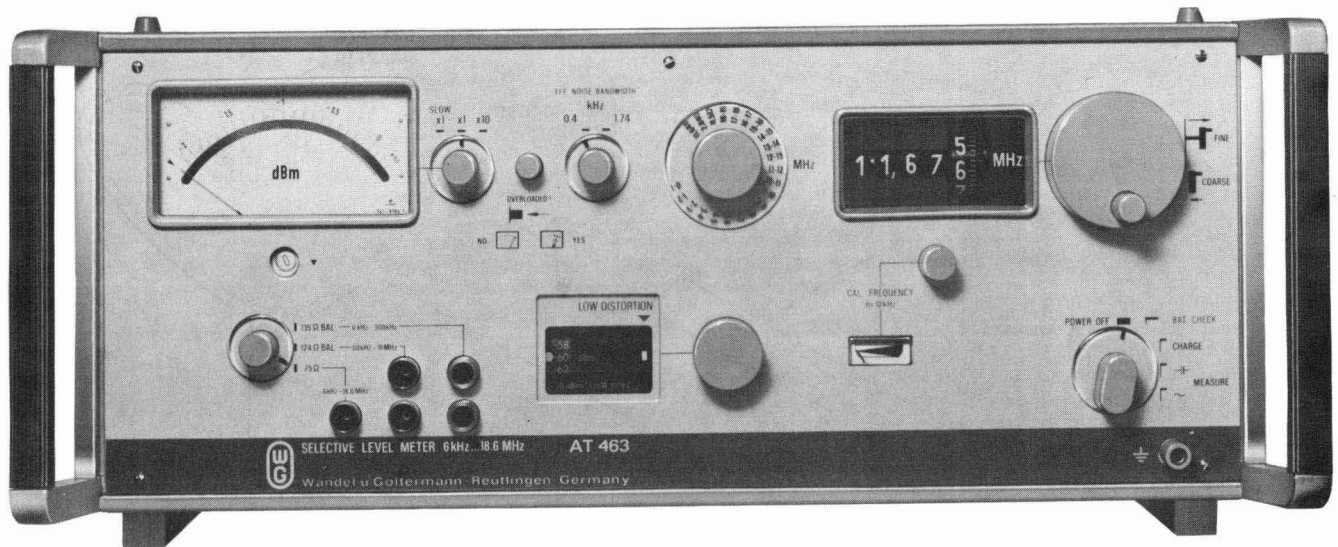


Fig. 3—Wandel-Goltermann Selective Level Meter AT463

4.11 An *L4 high-voltage isolation test probe* (SD-50676-01) is used to bridge the test equipment onto the line. This probe isolates the test equipment from the high dc voltage on the L4 line and allows making transmission measurements at the repeater input and/or output dual jacks. The probe causes approximately 0.3-dB change in level in the through transmission path when bridged across the repeater input or output. The probe bridging loss is 30 dB and the terminated transmission loss is 24.25 dB $\pm$ 0.25 dB.

4.12 A *pilot hit detector* (SD-50675-01) (Fig. 4) detects "hits" (short interruptions) in the 11.648-MHz pilot signal and isolates the repeater causing the hits. The detector is described in Section 103-455-000. The detector unit is installed in the repeater apparatus case (Fig. 5) and is bridged onto the L4 line via the repeater input dual jack. Two modes of operation, local and remote, are available. In the local mode, detected hits are indicated by a lighted lamp on the hit indicator unit. In the remote mode, the detector is connected to the monitoring oscillator power circuit and a hit is indicated as a missing monitoring oscillator tone at the control center. These hit detector circuits are incorporated in later versions of the pilot test set.

4.13 The *plug-in manual oscillator control unit* (ED-50919-30 and SD-50864-01) provides

a means for manually applying power to the monitoring oscillator power loops normally powered from the equalizing repeater. It is also useful during initial lineup or during trouble conditions when the monitoring oscillators cannot be powered in the normal manner via commands from the control center.

5. MAIN STATION REPEATER

A. Replacement Maintenance

5.01 Detailed procedures for replacement maintenance and in-place adjustment of equipment units which make up the main station transmitting and receiving repeaters are provided in Section 359-205-301. As with the line repeaters, most in-place maintenance consists of removal and replacement of suspect equipment units. However, the outputs of the A and B equalizer test-tone oscillators, as well as the monitoring oscillator outputs, must be adjusted to a specific power level. The monitoring oscillator power supply circuit is adjusted via a slidewire resistor for the required current in the power loop.

5.02 The J68877AN List 2 and List 3 main station receive repeater units are equipped with a manual gain adjustment which permits the repeater gain to be adjusted in the pilot off condition. This adjustment is made to minimize transmission level

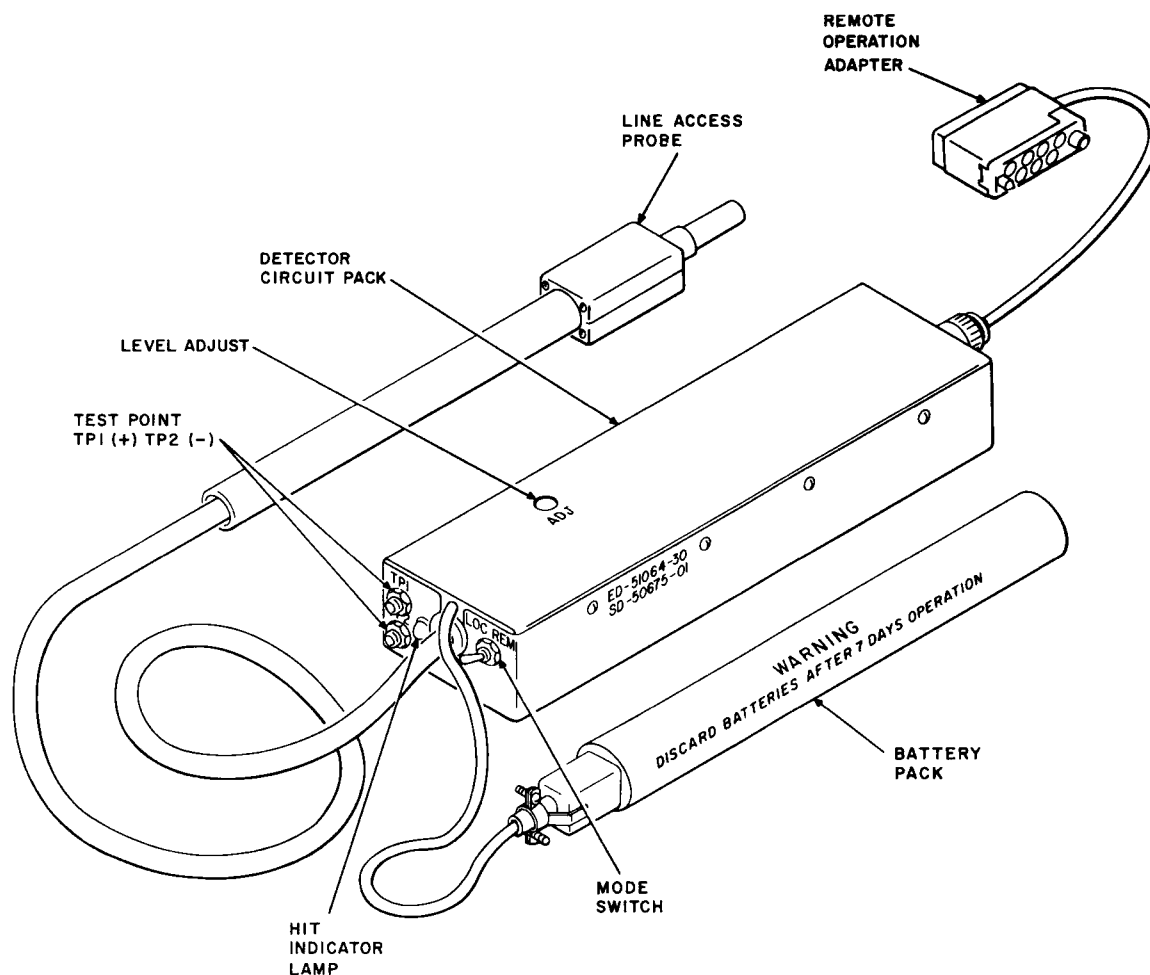


Fig. 4—L4 Pilot Hit Detector

errors which otherwise could occur with the loss of the 11.648-MHz pilot. Detailed procedures for this adjustment will be included in Section 359-205-301, Issue 2 (when issued). This adjustment is made at time of installation and again when the cable is at mean annual temperature. Once the adjustment is made with the cable at mean annual temperature, no further adjustment on a routine basis is required.

B. Periodic In-Service Tests and Adjustments

5.03 Periodic in-service maintenance of the main station repeaters include:

- (a) Adjustment of the J68877AM transmit repeater preregulator circuit for a particular time of year

- (b) Measurement and, if necessary, adjustment of the A and B equalizer test tones.

Refer to Section 359-205-504 for procedures and requirements.♦

6. MAINTENANCE CENTER MAINTENANCE

A. General

6.01 Maintenance centers generally are located at controlling main stations along the L4 routes. Special test facilities are provided for conducting the following tests:

- (a) Acceptance test of repeater equipment units received from the manufacturer

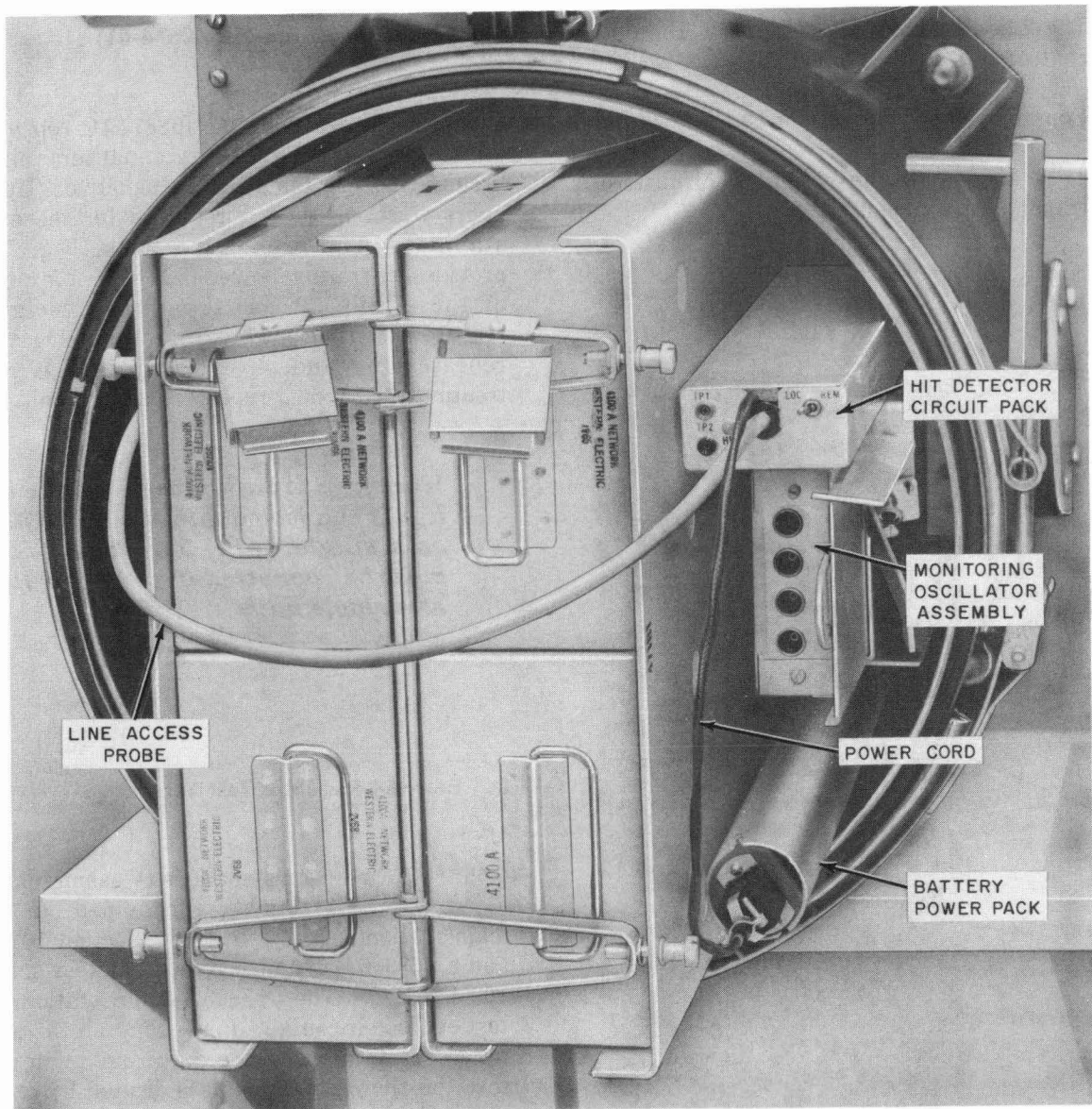


Fig. 5—L4 Pilot Hit Detector—Installation at L4 Repeater Location

- (b) Tests and adjustments of equipment units to ensure performance when installed in a particular repeater location
- (c) Tests to determine if suspect equipment units removed from service are faulty.

B. Repeater Test Set

6.02 To facilitate testing repeater units, special test equipment is provided at maintenance centers. A J68906B, L4 line repeater test set

(Fig. 6) is used in conjunction with transmission measuring equipment to test the L4 repeater equipment units listed in Table A. The section providing detailed test procedures for each repeater unit is also listed. The J68906B test set provides the following:

- (a) Mounting slots for the repeater units
- (b) Operating power for the repeater units

- (c) The 11.648-MHz pilot signal for regulation control
- (d) Command tones for test of control circuits
- (e) Test access to the repeater circuits for transmission measurements.

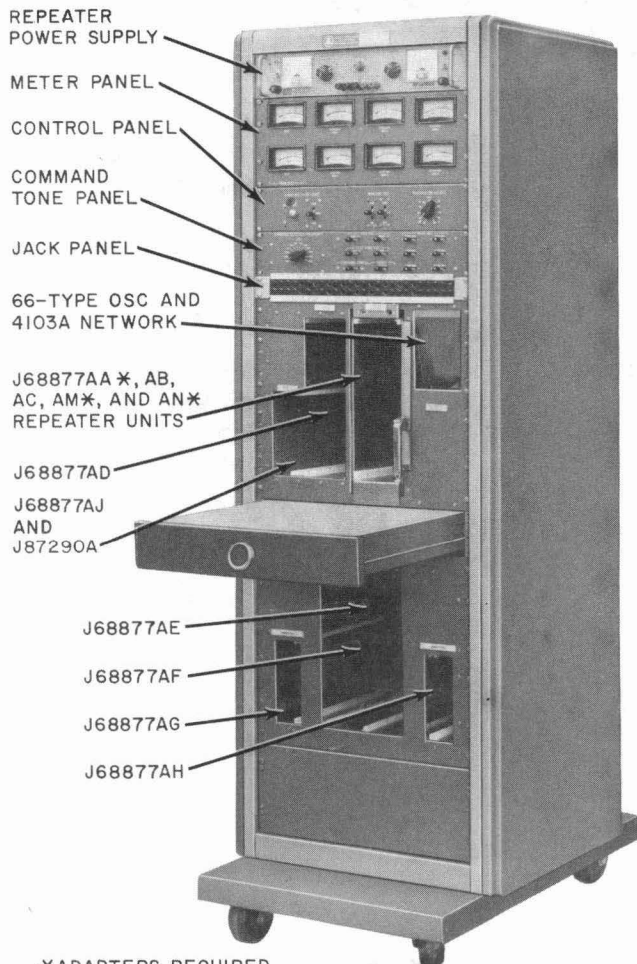


Fig. 6—J68906B L4 Line Repeater Test Set

C. †Preheating Rack (SD-50674-01)

6.03 The J68877AB and J68877AC repeater units and the J68877AD A equalizer unit contain circuits that are temperature-sensitive. Up to four hours warm-up time is required for these units to stabilize. The preheating rack (Fig. 7 and 8) provides operating power (520 mA) for up to four of these units at one time. Up to eight basic repeaters can be powered by connecting two basic repeaters in tandem as shown in Fig. 8 and by treating the tandem repeaters as one unit.

Warning: *A basic repeater will be damaged if it is connected into the preheating rack as a single unit. Two basic repeaters must be connected in tandem and treated as a single unit.†*

D. Early L4 Repeater Test Sets

6.05 At early L4 installations (Washington—Miami), two test sets were provided: a J68899A main station repeater test set (Section 103-457-000) and a J68906A equalizing repeater test set (Section 103-458-000). The J68899A main station repeater test set is self-contained providing all the apparatus necessary to perform the gain regulation and noise tests on the repeater units indicated by an asterisk (*) in Table A. The J68906A equalizing repeater test set is used to test the A equalizer and associated control units indicated by a dagger (†) in Table A. As with the J68906B test set, external transmission test equipment is used for transmission measurements.

♦ TABLE A♦
L4 REPEATER EQUIPMENT UNITS TESTED WITH
USE OF THE J68906B, L4 LINE REPEATER TEST SET

REPEATER EQUIPMENT UNIT	DESCRIPTION	BSP
J68877AA*	Basic Repeater	359-205-505
J68877AB*	Regulating Repeater	359-205-506
J68877AC*	Regulating Repeater for Equalizing Repeater	359-205-507
J68877AD†	A Equalizer	359-205-511
J68877AE†	Memory Unit	359-205-511
J68877AF†	Filter and Relay Unit	359-205-511
J68877AG†	Command Receiver Unit	359-205-511
J68877AJ†	Filter and Relay Unit	359-205-511
J87290A†	Dc-to-Dc Converter	359-205-511
J68877BU†	Filter and Relay Unit and Dc-to-Dc Converter Assembly	359-205-511
J68877AM*	Main Station Transmit Repeater	359-205-508
J68877AN* 4103A Network*	Main Station Receive Repeater	359-205-509
and 66-Type Oscillator	Monitoring Oscillator Assembly	359-205-510

* A J68899A test set may be used for the test.

† A J68906A test set may be used for the test.

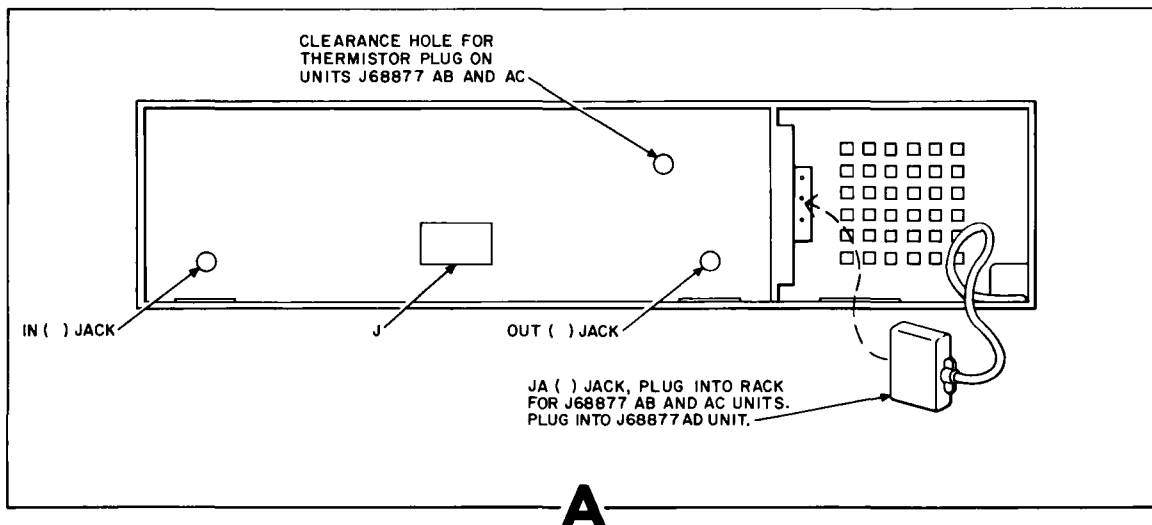
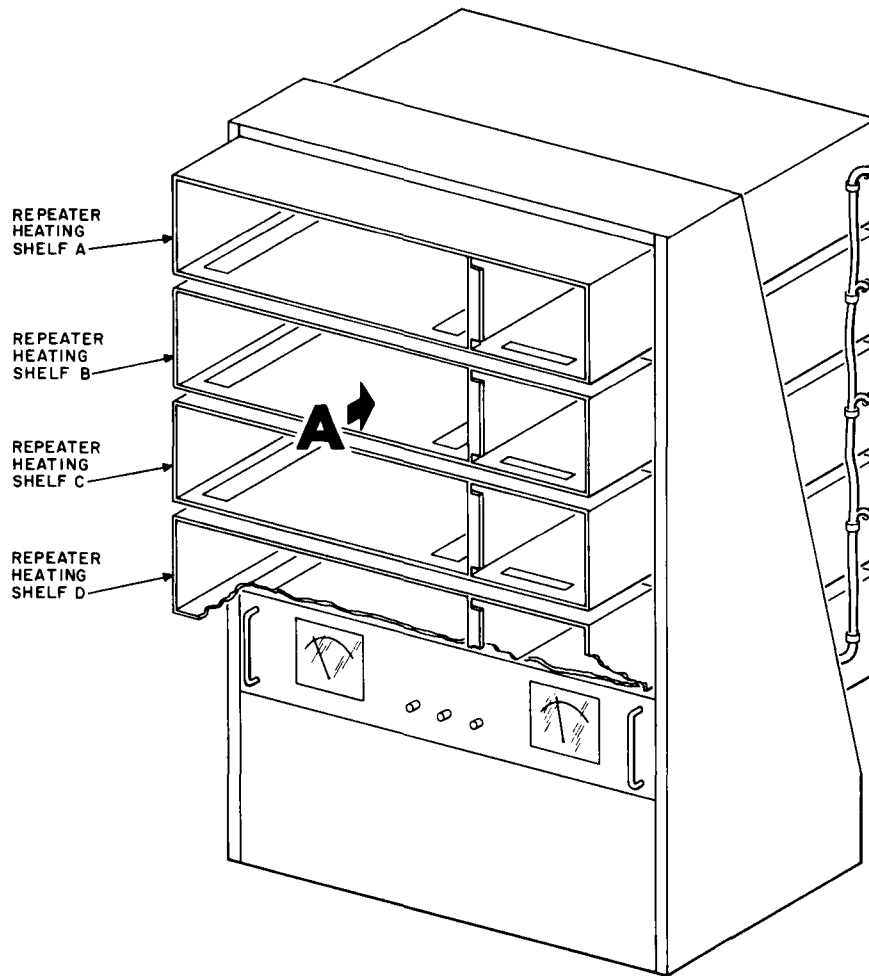
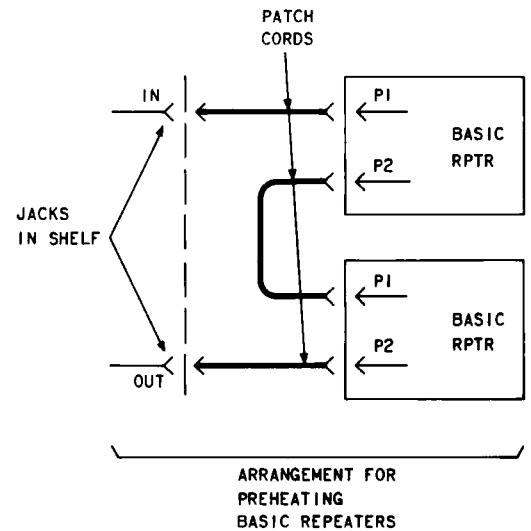
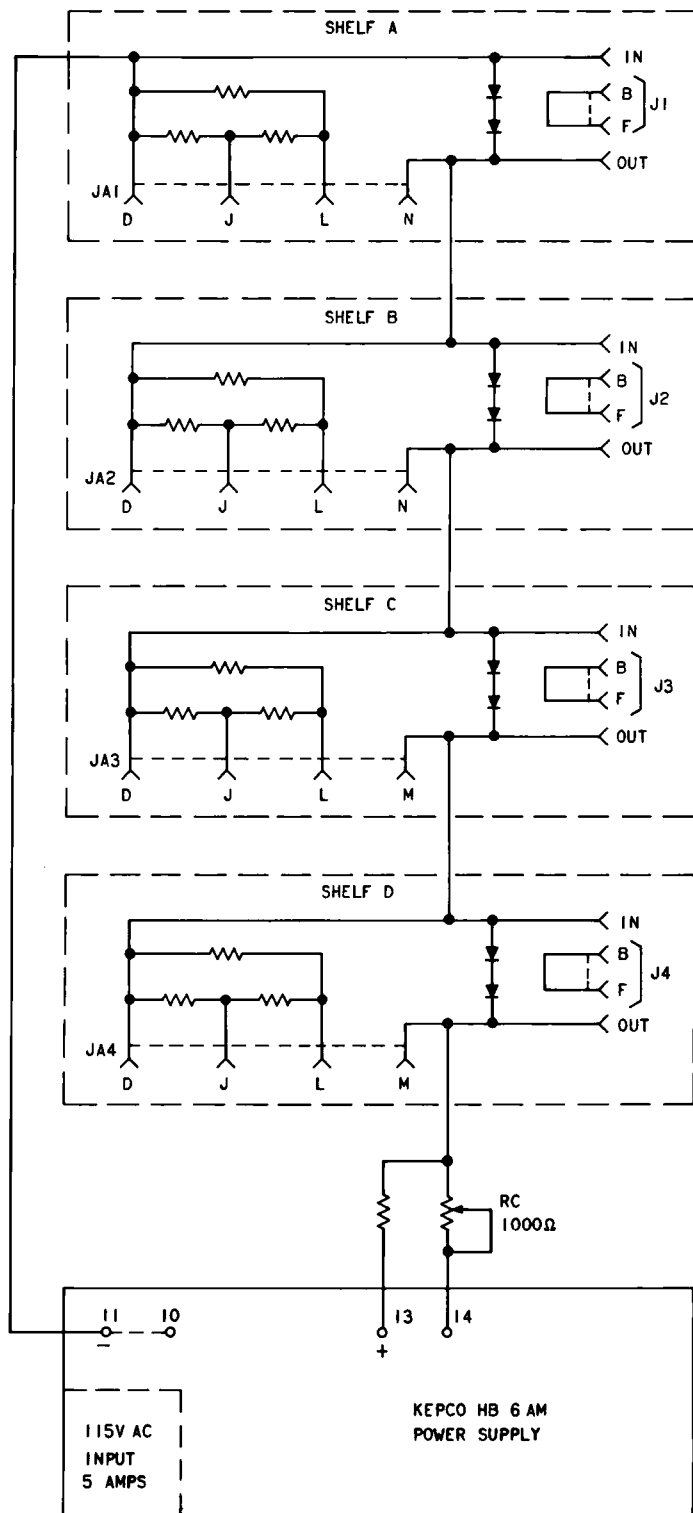


Fig. 7—Preheating Rack



WARNING:
BASIC REPEATERS MUST BE
CONNECTED IN TANDEM.

Fig. 8—Preheating-Rack—Block Diagram