ELECTRO-MOTIVE

M.I. 9108

MAINTENANCE INSTRUCTION

RECTIFIER ASSEMBLIES USED WITH AC AUXILIARY GENERATOR

DESCRIPTION

BATTERY CHARGING ASSEMBLY

The battery charging assembly converts the AC auxiliary generator output to DC and enables the generator to safely charge the locomotive batteries when the engine is running, but prevents battery current from flowing through the alternator, fuel pump motor, and cab heaters when the engine is not running. Without the battery charging assembly, the batteries would quickly discharge after the engine stopped.

Three main sections comprise the battery charging assembly.

1. The auxiliary generator rectifier section, consisting of two matched sets of silicon diodes (three per set) mounted on heat sinks.

2. The battery charging rectifier section (blocking rectifier) consisting of a matched pair of silicon diodes mounted on heat sinks and a selenium suppression rectifier.

3. The ribbon type battery charging resistor.

The ribbon resistor is mounted above the rectifier assemblies. Circulating air in the electrical cabinet, where the assembly is mounted, keeps the battery charging components at safe operating temperatures.

The suppression rectifier parallels the silicon diodes in the battery charging blocking rectifier circuit. It protects the diodes by passing reverse current when reverse high voltage spikes occur.

CAUTION

Although the suppression rectifier protects the diodes from voltage spikes, a ground fault during locomotive high potential tests can apply continuous high potential across the battery charging rectifier, causing the diodes or the protective suppression rectifier to fail. It is therefore recommended that before a high potential test is made on the locomotive, the battery switch be opened, and the positive and negative terminals of the battery charging rectifier and the auxiliary generator rectifier be jumpered together. After high potential tests are completed, remove the jumpers before closing the main battery switch.

The battery charging resistor protects the entire battery charging circuit, including the auxiliary generator, against overcurrent when it is charging very low (heavily discharged) batteries. The resistor is located on the battery side of the rectifier in the charging circuit.

TRAINLINE LIGHTING RECTIFIER ASSEMBLY

The trainline lighting rectifier assembly serves two purposes.

1. In parallel with the blocking rectifier portion of the battery charging assembly, it provides the additional current carrying capacity necessary to provide 74 VDC trainline lighting power.

2. It converts AC power from a three-phase step-down transformer (originating from the AC auxiliary generator) to 26 VDC trainline lighting power.

The trainline lighting rectifier assembly consists of a blocking rectifier section and a converter section. The blocking rectifier consists of a matched pair of silicon diodes, mounted on heat sinks, and a selenium suppression rectifier; it is connected in parallel with the blocking rectifier portion of the battery charging assembly. The converter consists of two matched sets of silicon diodes (three per set) mounted on heat sinks. Like the battery charging assembly, the trainline lighting rectifier assembly is mounted in the electrical cabinet, where circulating air cools it.

The selenium suppression rectifier in the blocking rectifier parallels the silicon diodes in the circuit. It protects the diodes against reverse high voltage spikes by conducting in the reverse direction before the voltage reaches damaging levels.

CAUTION

Although the suppression rectifier protects the diodes from voltage spikes, a ground fault during locomotive high potential tests can apply continuous high potential across the blocking rectifier, causing the diodes or the protective suppression rectifier to fail. It is therefore recommended that before a high potential test is made on the locomotive, the battery switch be opened, and the positive and negative terminals of the trainline lighting rectifier assembly be jumpered together. After high potential tests are completed, remove the jumper before closing the main battery switch.

MAINTENANCE

The rectifier assemblies require no routine maintenance other than visual inspection. Do not disassemble them for inspection; the nuts that fasten the diodes to the heat sinks should not be disturbed. The diodes have been uniformly tightened to the proper torque value to ensure proper heat transfer.

INSPECTION AND TESTS

If the auxiliary generator and the alternator field fuses or circuit breakers are discovered to be blown or tripped upon engine shutdown, or if an extremely high rate of battery discharge is indicated by the battery charging ammeter at engine shutdown, you should suspect failure of the battery charging assembly or the trainline lighting rectifier assembly. Inspect the entire battery charging circuit as well as the rectifier assemblies.

CHECKING RECTIFIER ASSEMBLY SECTIONS

Separately check the blocking rectifier section and the converter section of the battery charging assembly and/or the trainline lighting rectifier assembly for blocking operation. Use a lantern battery and a test lamp to make the checks, and refer to Figs. 1 and 2. A good rectifier section will conduct only in the forward (common anode-to-common cathode) direction. Refer to the next sections (Checking Suppression Rectifiers and Checking Diodes) if a rectifier section fails the blocking check.

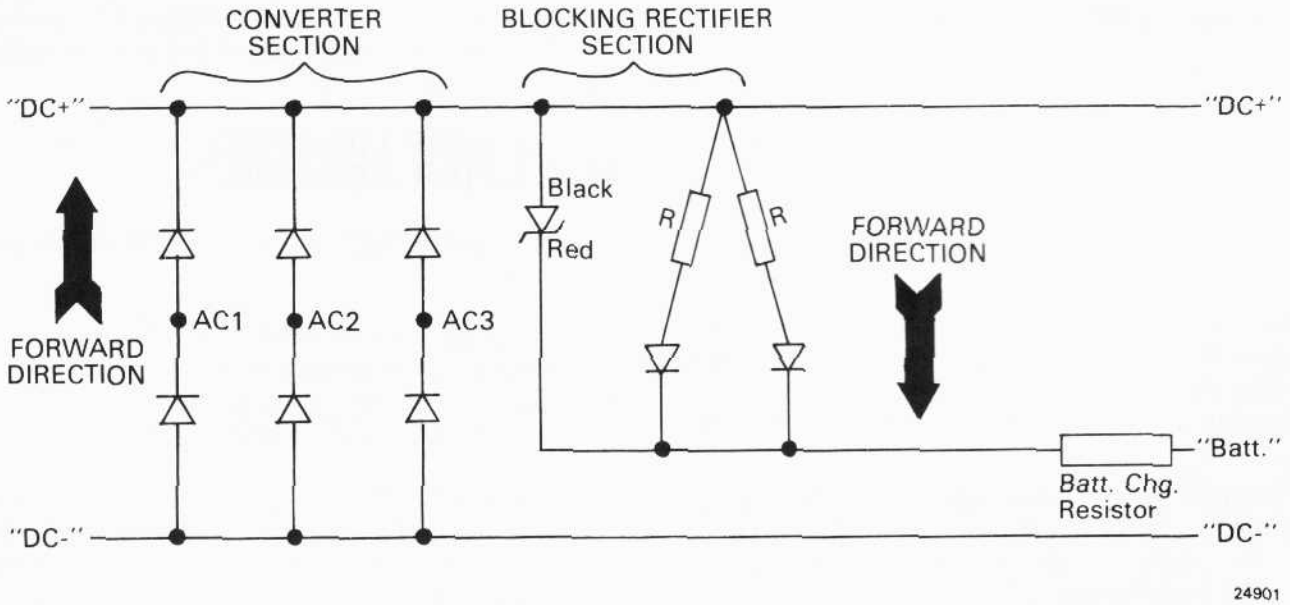


Fig.1 – Battery Charger Assembly 8479400 Schematic

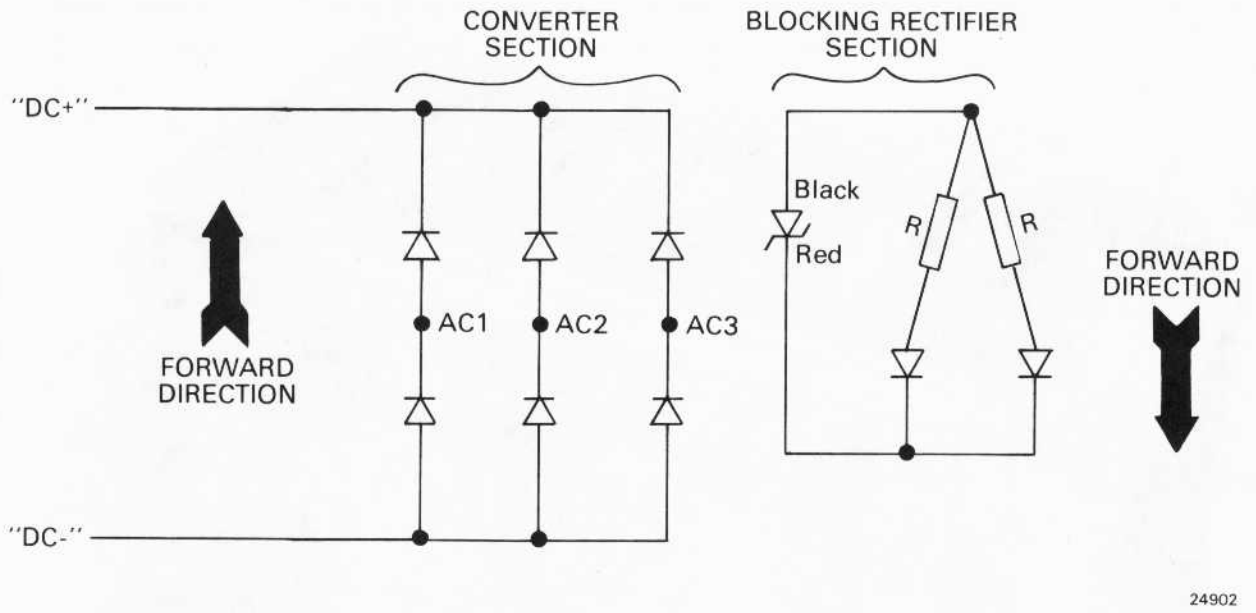


Fig.2 – Trainline Lighting Rectifier Assembly 9319402 Schematic

CHECKING SUPPRESSION RECTIFIERS

Visually inspect the suppression rectifier for blistered paint and points of metal, the general symptoms of a shorted rectifier. To determine whether the rectifier is in working order, first disconnect it from the assembly, then connect a six volt lantern battery in series with the rectifier and a test lamp. The lamp should light when the battery is connected in the forward direction and remain off when the polarity is reversed.

If an ohmmeter is used to check the suppression rectifier, it should first be "formed" by application *of at least two volts in both the forward and reverse* direction for a few minutes before the resistance is checked.

CHECKING DIODES

If the battery charging rectifier is faulty, and the suppression rectifier is all right,the diodes must be disconnected and tested individually for blocking characteristics. (See Bench Testing section.) Faulty diodes must be removed and replaced by matching diodes. The diode matching number appears on the circular portion of the diode body. If diodes are not matched, one of the parallel diodes will carry greater current than the other(s) and will fail rapidly.

If for some reason mismatching of diodes is suspected and the matching number is not legible, the diodes can be checked on the locomotive by passing high current through the diodes (as when charging low batteries). After approximately 15 minutes a mismatched diode will feel much hotter than the other(s). Matched diodes will not differ in temperature by more than 14° C (25° F).

REMOVAL AND REPLACEMENT OF DIODES FOR BATTERY CHARGING ASSEMBLY 8479400 AND TRAINLINE LIGHTING RECTIFIER ASSEMBLY 9319402, Fig. 3

NOTE

The 9319402 trainline lighting rectifier assembly *is almost identical to the 8479400* battery charging assembly. It lacks the battery charging resistor and the link connecting the converter "DC+" bus bar to the blocking rectifier anode resistors, present on the battery charging assembly.

1. Remove bolt and washers holding diode lead to the bus or resistor bar.

2. If removing a lower diode from the converter rectifier section (i.e. one of the positive base, common anode diodes), also remove the bolts and washers holding the remaining lower diode leads to the "DC-" bus bar, then remove the bar.

3. Insert special diode socket, Fig. 4, over diode lead, through heat sink, and seat it firmly onto the diode hex; seat 1-1/4" hex socket on diode retaining nut/washer on other side of heat sink.

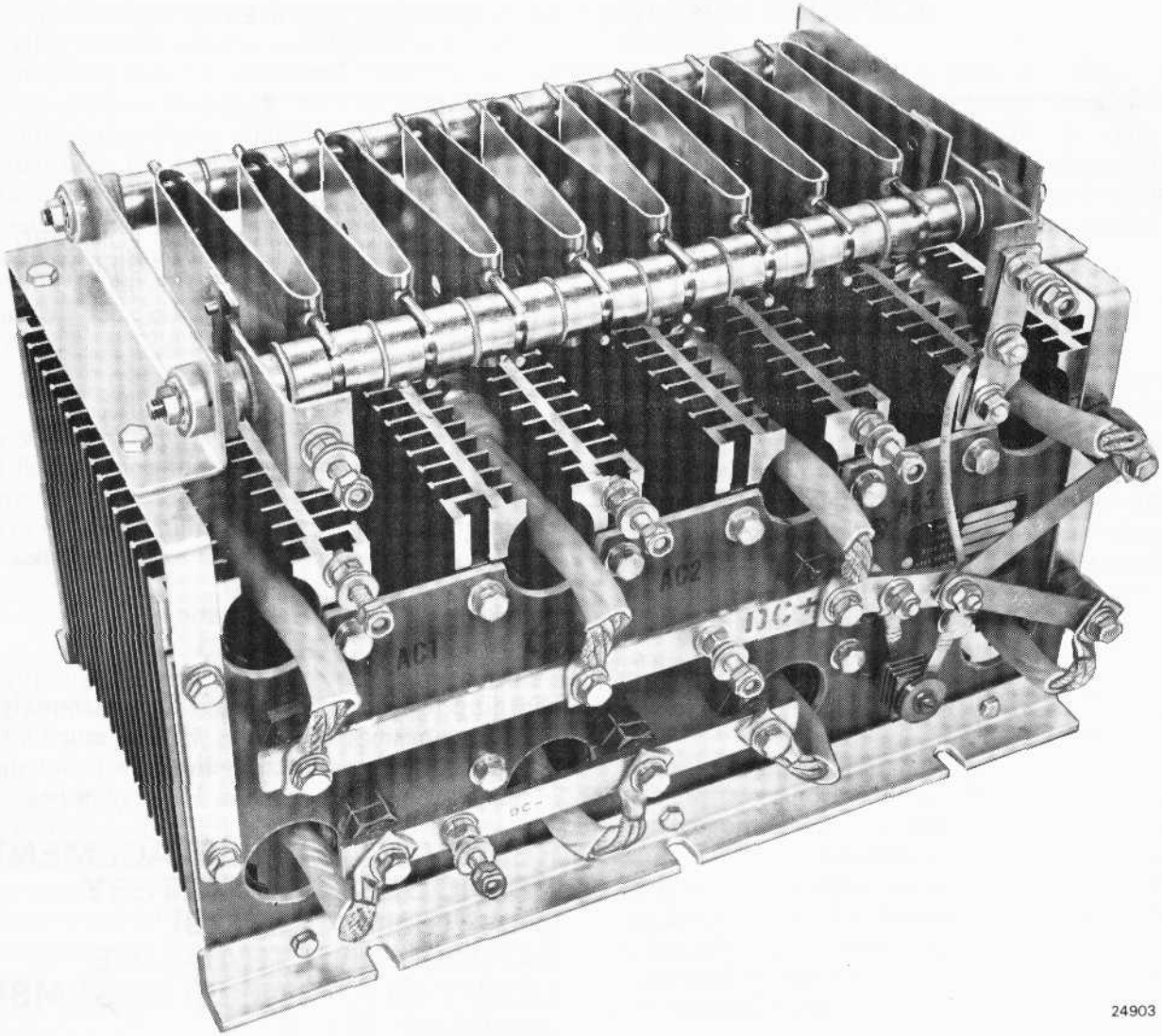


Fig.3 – Battery Charging Assembly 8479400

4. Remove diode from heat sink.

5. Remove all contaminants from diode hex side of heat sink in at least a 38 mm (1-1/2") diameter circle concentric with the diode mounting hole.

6. Select matching diode(s). Refer to Service Data for type and number.

7. Apply a thin coat of joint compound under hex portion of diode, Fig. 5.

CAUTION

Do not apply joint compound to stud portion of the diode. The specified torque value is for dry threads.

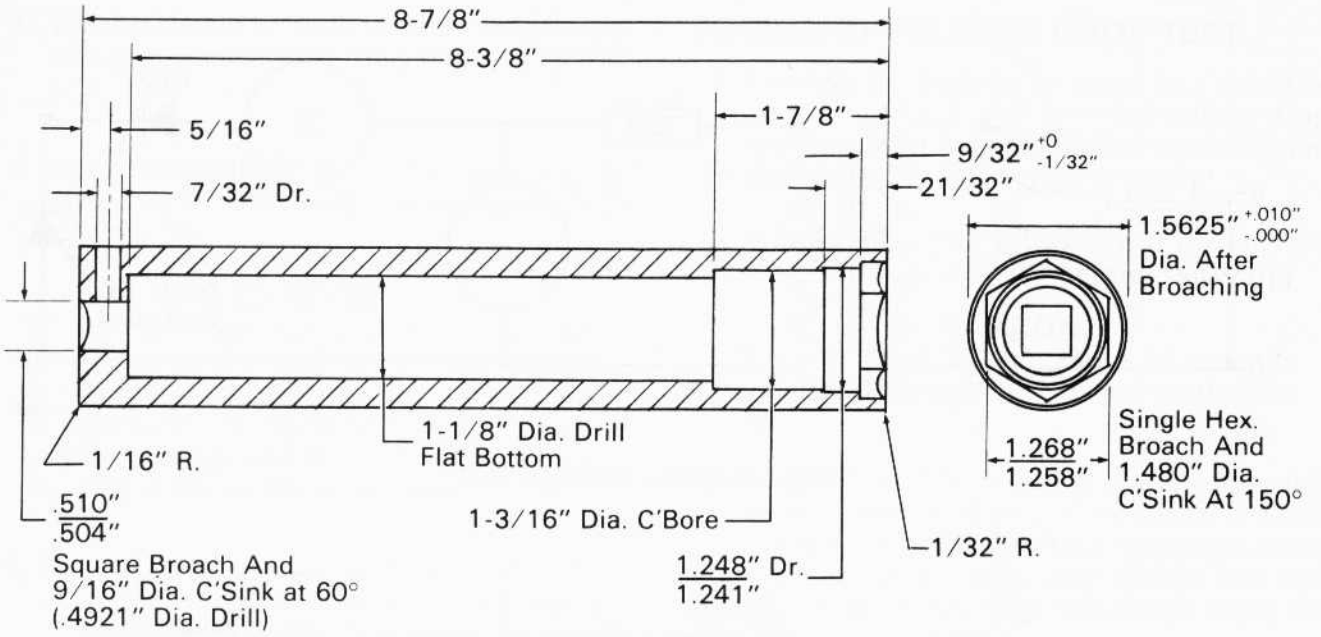
8. Install diode, seat special socket on diode hex and standard socket on retaining nut/washer (as in step 3), and apply torque specified in Service Data to diode hex.

9. Reconnect diode lead(s) to bus and/or resistor bar(s). If "DC-" bus bar was removed in step 2, re-install it. Be sure suppression rectifier leads are still correctly connected, as shown in Fig. 1 or 2.

BENCH TESTING

HIGH-POTENTIAL TEST

Jumper all following terminals together during test: "DC+," "DC-," and suppression rectifier "+" and "-" (red and black). Hi-pot the assembly for one minute at 600 volts RMS between jumpered terminals and mounting bracket. Remove jumpers after test.



Material: 8630 H.R.S. - HDN. To R/C : 44-40
Finish Black Oxide

24913

Fig.4 – Special Diode Socket

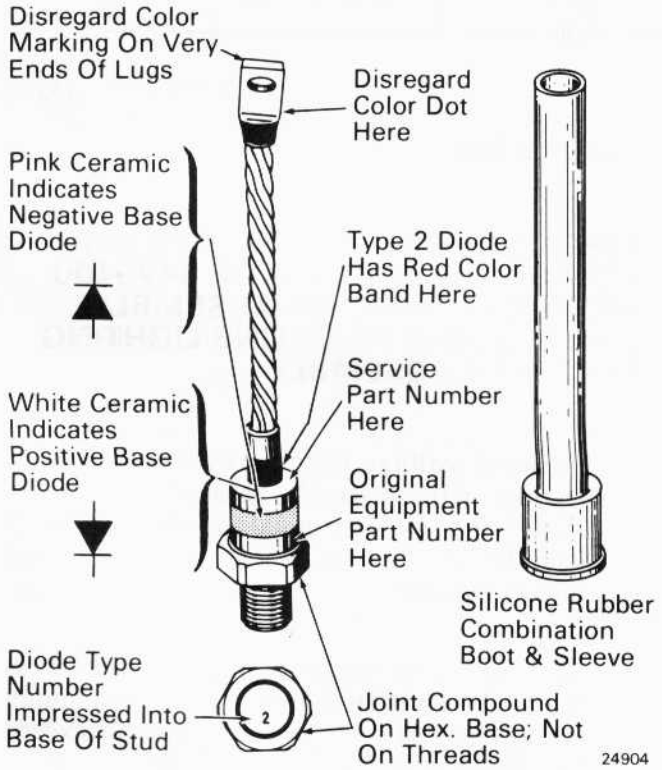


Fig.5 – Type 2 Silicon Diode With Identification Markings

BENCH TESTING OF DIODES

Bench testing of diodes must be performed with extreme care. In any test circuit it is of utmost importance to make sure that no transient voltages are introduced by switching power on or off. The use of test transformers in which the output can be gradually increased from zero to full voltage and back without switching is strongly recommended.

RECOMMENDED TEST EQUIPMENT

The following equipment is recommended for testing diodes. The meters should be of 2% accuracy. Each piece of equipment is identified by a reference designation number in the test circuits, Figs. 6 and 7 as follows:

1. V1 – Average reading DC voltmeter, moving coil type, 0-1 volt.
2. V2 – RMS reading voltmeter, iron vane type, 0-750 volts.
3. I1 – Average reading DC ammeter, moving coil type, range to suit diode.
4. I2 – Average reading DC milliammeter, moving coil type.
5. CR1 – Equivalent to test diode of 500 PRV and 40 mA leakage.
6. CR2 – 1000 PRV and 0.025 mA leakage, or 2000 PRV and 0.025 leakage.

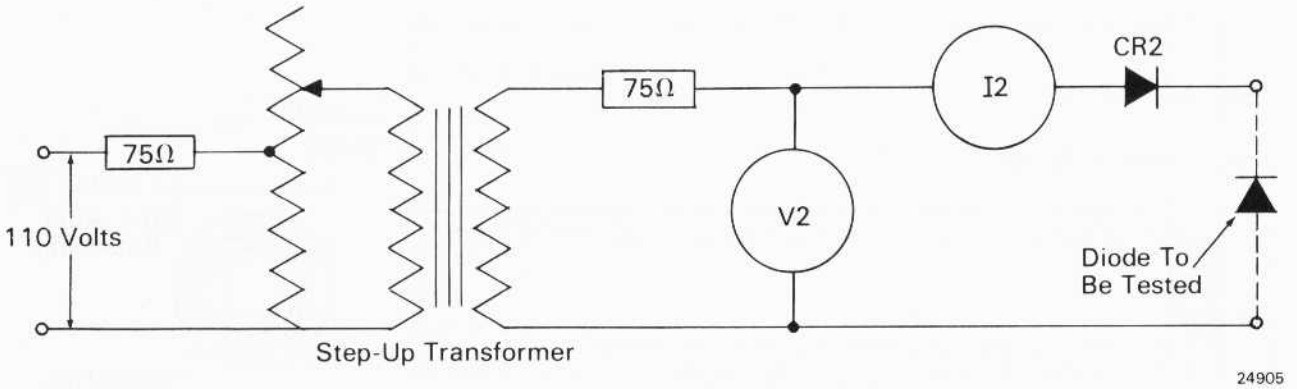


Fig.6 – Reverse Leakage Test

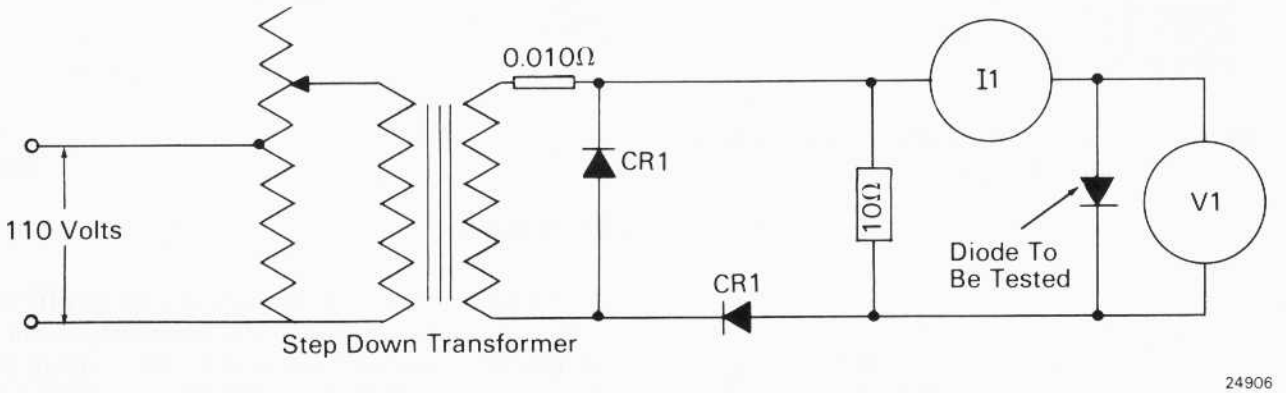


Fig.7 – Forward Voltage Drop Test

ELECTRICAL REQUIREMENTS FOR BLOCKING RECTIFIER SECTION OF 8479400 BATTERY CHARGING ASSEMBLY AND 9319402 TRAINLINE LIGHTING RECTIFIER ASSEMBLY

1. Forward voltage drop across the blocking rectifier portion of the assembly, measured across selenium suppression rectifier terminals, must not exceed 1.50 volts DC at 80° C (176° F) with 150 amperes forward current.

2. Individual diode current shall not exceed 86 amperes with 150 amperes total current into the rectifier assembly at 25° C (77° F).

3. With selenium suppression rectifier disconnected and 400 volts reverse voltage applied, the maximum leakage current of the blocking rectifier portion of the assembly shall not exceed 26.4 milliamperes at 25° C (77° F).

ELECTRICAL REQUIREMENTS FOR CONVERTER SECTION OF 8479400 BATTERY CHARGING ASSEMBLY AND 9319402 TRAINLINE LIGHTING RECTIFIER ASSEMBLY

1. Forward voltage drop across the converter section of the assembly, measured across the "DC+" and "DC-" terminals, must not exceed 5 volts DC at 80° C (176° F) with 250 amperes forward current.

2. With 400 volts reverse voltage applied across the "DC+" and "DC-" terminals, the maximum leakage current of the assembly shall not exceed 19.8 milliamperes at 25° C (77° F).

REVERSE LEAKAGE TEST AT RATED PEAK REVERSE VOLTAGE

1. Connect the diode to be tested in a circuit as shown in Fig. 6.

2. The test should be made at room temperature with a maximum base temperature of 150° C (302° F).

3. Apply 280 volts RMS. The voltage may be regulated by observing the voltmeter (V2) reading.

CAUTION

While under test, the circuit must not be interrupted or the diode being tested may be damaged by induced transients. The circuit voltage should be regulated from zero to the specified voltage and returned to zero before any part of the circuit is disconnected.

4. If the diode conducts more than the maximum allowable reverse current of 10 milliamperes, the diode is defective and should be discarded.

FORWARD VOLTAGE DROP TEST

1. Connect the diode to be tested in a circuit as shown in Fig. 7. The forward voltage drop metering leads must be attached separately and directly to the diode under test.

2. Adjust the input voltage until the current through the diode is 70 amperes.

CAUTION

This test must be limited to 10 seconds duration if the diode is removed from the heat sink.

3. The forward voltage drop is measured as a full cycle average, read on a DC voltmeter in a half sine wave constant circuit at room temperature. The maximum voltage drop shall be 0.52 volt DC. If the voltage drop exceeds that value, the diode is defective.

SERVICE DATA

ELECTRICAL CHARACTERISTICS

Max. Peak Inverse Voltage:	400 volts
Max. Continous DC Amperes – Blocking Rectifier Section:	150 amps
Converter Section:	250 amps
Type Load:	Resistive Inductive
Max. Ambient Operating Temp.:	80° C (176° F)
Cooling:	Convection
Suppression Rectifier:	8413523
RMS Operating Voltage:	108 max.

DIODE INFORMATION

All diodes in a rectifier assembly must be matched according to type or part number. Diodes are interchangeable between rectifier assemblies as long as all diodes in a specific assembly are the same type or part number. The manufacturer's type or part number, with corresponding EMD part number, follows.

Polarity	Manufacturer's Type Number	EMD Part Number	Diode Mounting Torque (Min.-Max.)*
Positive (Cathode) Base	Type 2	8413522	33.9 - 40.7 N·m (25-30 ft-lbs)
Negative (Anode) Base	Type 2	8485245	33.9 - 40.7 N·m (25-30 ft-lbs)

*Apply diode mounting torque to diode hex portion, not to retaining nut.

Joint Compound 8346481
Torque Wrench, 0-50 ft-lbs, 1/2″ drive 8375396
Special Diode Socket, Fig. 4