ELECTRO-MOTIVE

M.I. 9109
*Rev. C

MAINTENANCE INSTRUCTION

BATTERY CHARGING ASSEMBLY USED WITH DC AUXILIARY GENERATOR

DESCRIPTION

The battery charging assembly permits the auxiliary generator to charge the locomotive batteries when the engine is running, but prevents battery current from flowing through the auxiliary generator, 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.

The assembly consists of a matched set of silicon diodes (the battery charging rectifier) and a selenium suppression rectifier, all mounted to heat sinks. In some versions, it also includes a ribbon type battery charging resistor. The ribbon resistor is mounted above the rectifier assembly. 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 circuit. It protects the diodes by passing reverse current when transient 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 be jumpered together. After high potential tests are completed, remove the jumper before closing the main battery switch.

The battery charging resistor protects the entire battery charging circuits, 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.

MAINTENANCE

The battery charging assembly requires no routine maintenance other than visual inspection. Do not disassemble it 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 are blown upon engine shutdown, or if an extremely high rate of battery discharge is indicated by the battery charging ammeter at engine shutdown, failure of the battery charging rectifier should be suspected. The entire battery charging circuit and the battery charging assembly should be inspected for defects.

BATTERY CHARGING RECTIFIER

With a lantern battery and test lamp, or with an ohmmeter, test the rectifier assembly for blocking. A good rectifier assembly will conduct only in the

*This bulletin is revised and supersedes previous issues of this number.

forward direction (black terminal-to-red terminal, anode-to-cathode, - to +). Refer to next sections (Suppression Rectifier and Diodes) if the rectifier assembly fails the blocking test.

SUPPRESSION RECTIFIER

Visually inspect for blistered paint and points of metal. These are general symptoms of a shorted suppression 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, the rectifier 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.

DIODES

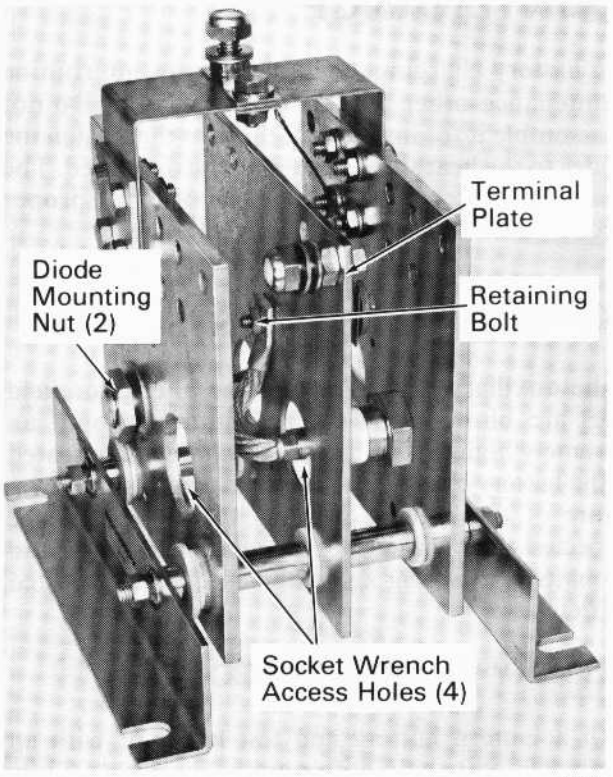
If the battery charging rectifier is faulty, and the suppression rectifier is all right, the diodes must be disconnected and tested individually for blocking characteristics.(See Bench Testing section.) Faulty diodes must be removed and replaced by matching diodes. The diode matching number appears on 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 one of the diodes 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 RECTIFIER ASSEMBY 8333841, Fig. 1

1. Disconnect the diode lead from the terminal plate by removing nut from the retaining bolt, Fig. 1.

2. Insert special diode socket wrench, Fig. 2, through the access holes, Fig. 1, and seat it firmly on the hex portion of the diode.



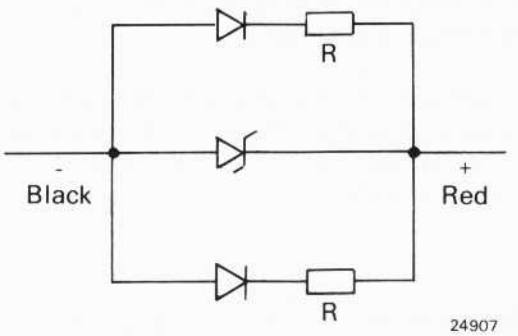
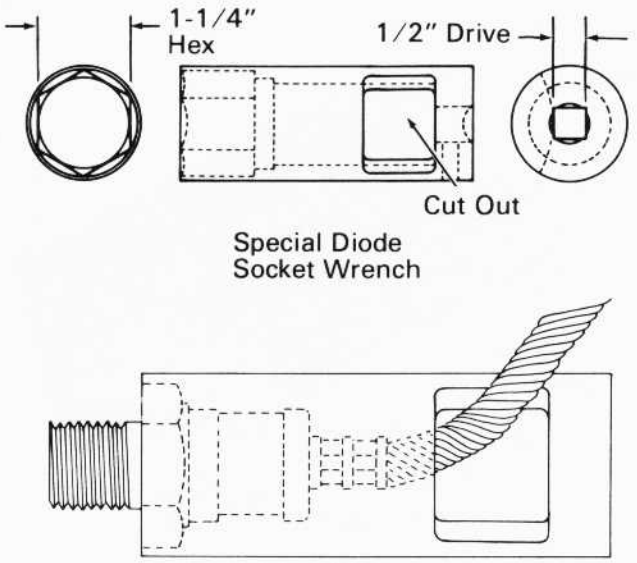


Fig.1 – Battery Charging Rectifier Assembly 8333841, With Schematic



CAUTION

Make certain that socket is firmly seated. Improper seating can stress the crimped area during torquing.

18806

Fig.2 – Special Diode Socket Wrench 8361524

3. Use a box end wrench to hold diode mounting nut while removing diode.

4. Remove diode from heat sink.

5. Remove all contaminants from 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 part number.

7. Apply a thin coat of joint compound under hex portion of the diode, Fig. 3.

CAUTION

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

8. Install diode, seat socket wrench firmly on the hex portion of the diode, and then apply torque to hex portion of the diode as specified in Service Data.

9. Connect diode lead to terminal plate.

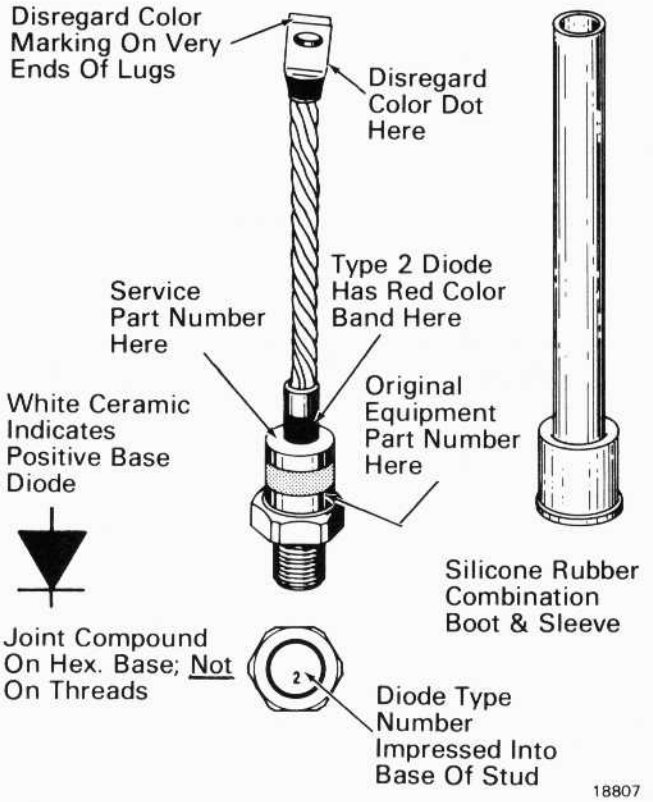


Fig.3 – Positive Base Type 2 Silicon Diode With Identification Markings

REMOVAL AND REPLACEMENT OF DIODES FOR RECTIFIER ASSEMBLIES 8319071 AND 8319696, Fig. 4

The major difference between these rectifiers is the position of the mounting brackets.

1. Remove "Glastic" side panel from negative side of rectifier as follows. (Refer to Fig. 4.)

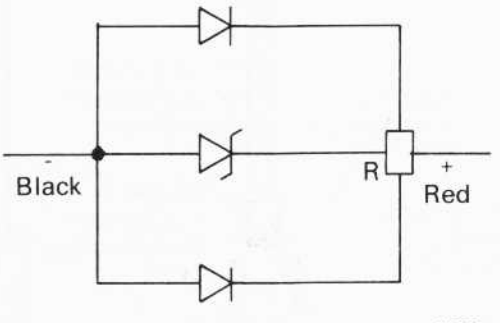
   a. Remove two 7/16" nuts.

   b. Remove eight retaining screws.

   c. Remove nut from suppression rectifier mounting stud.

   d. Carefully separate "Glastic" side panel from heat sink.

2. Remove diode leads from negative bus bar.



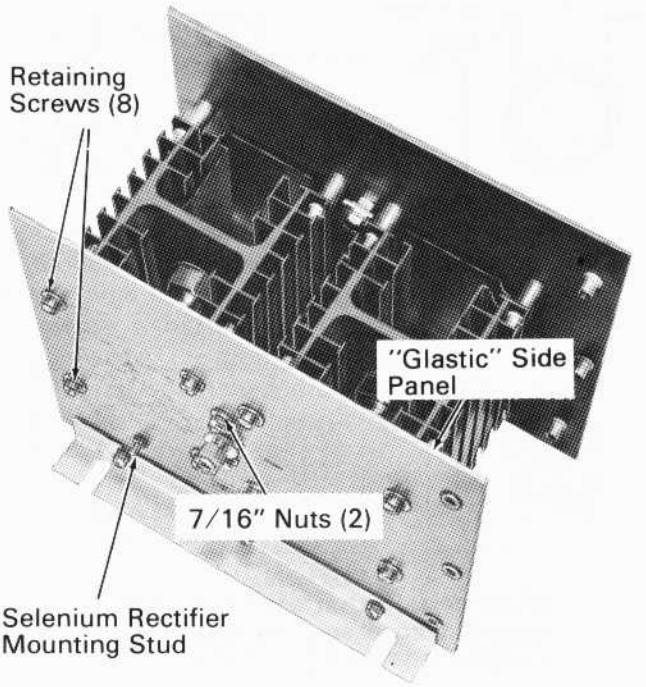


Fig.4 – Battery Charging Rectifier Assembly 8319071, With Schematic (Schematic Also For 8319696)

3. Insert special diode socket wrench, Fig. 2, and seat it firmly on the hex portion of the diode.

4. Use a box end wrench to hold diode mounting nut while removing diode.

CAUTION

Be careful not to damage heat sinks.

5. Remove diode from heat sink.

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

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

8. Apply a thin coat of joint compound under hex portion of the diode, Fig. 3.

CAUTION

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

9. Install diode, seat socket wrench firmly on the hex portion of the diode, and then apply torque to hex portion of the diode as specified in Service Data.

10. Reassemble in reverse order of disassembly. Be sure that negative lead of suppression rectifier is connected to the negative bus bar.

REMOVAL AND REPLACEMENT OF DIODES FOR RECTIFIER ASSEMBLIES 8321535 AND 8333596, Fig. 5

The major difference between these rectifiers is the position of the mounting brackets. Procedures for removal and replacement of diodes for these rectifiers are essentially the same procedures for removal and replacement of diodes for rectifiers 8319071 and 8319696. The major difference is that rectifiers 8321535 and 8333596 contain 4 rather than 2 diodes, and the side panels are attached to the heat sinks with 16 rather than 8 retaining screws.

REMOVAL AND REPLACEMENT OF DIODES FOR RECTIFIER ASSEMBLIES 8416094 AND 8416095, Fig. 6

The major difference between these rectifiers is the position of the mounting brackets.

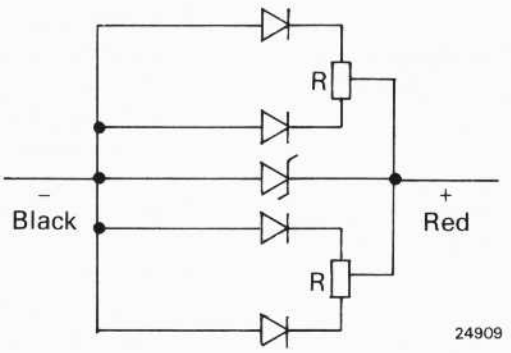
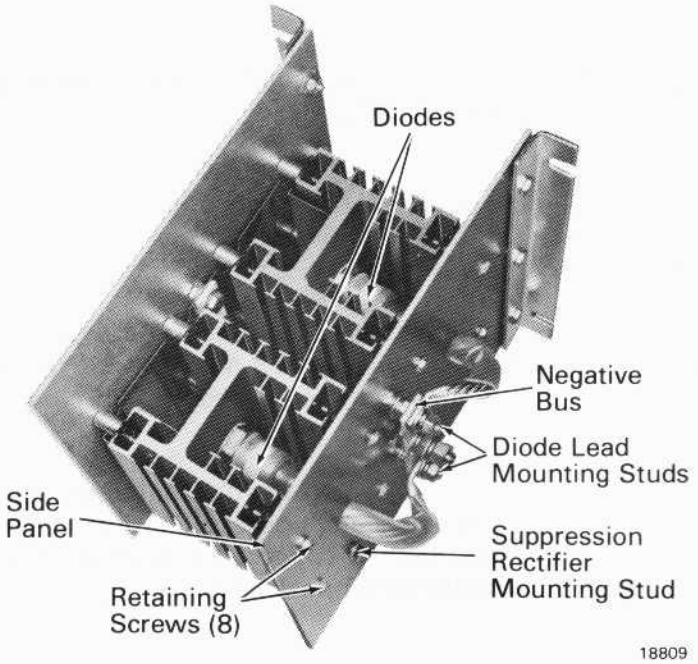


Fig.5 – Schematic For Battery Charging Rectifier Assemblies 8321535 And 8333596



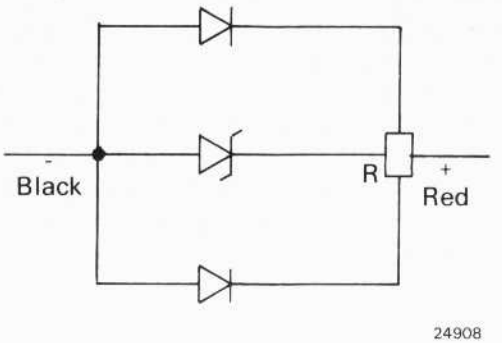


Fig.6 – Battery Charging Rectifier Assembly 8416095, With Schematic (Schematic Also For 8416094)

1. Disconnect diode leads from negative bus by removing the 5/16"-18 retaining nuts, lockwashers, and flat washers.

2. Disconnect lead from red terminal of suppression rectifier.

3. Remove side panel from negative side of rectifier by removing eight No. 10-16 retaining screws.

4. Insert special diode socket wrench, Fig. 2, and seat it firmly on the hex portion of the diode.

5. Use a box end wrench to hold diode mounting nut while removing diode.

CAUTION

Be careful not to damage heat sinks.

6. Remove diode from heat sink.

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

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

9. Apply a thin coat of joint compound under hex portion of diode, Fig. 3.

CAUTION

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

10. Install diode, seat socket wrench firmly on the hex portion of the diode, and then apply torque to hex portion of the diode as specified in Service Data.

11. Reassemble in reverse order of disassembly. Be sure to reconnect lead to red terminal of suppression rectifier.

REMOVAL AND REPLACEMENT OF DIODES FOR RECTIFIER ASSEMBLIES 8416096 AND 8416192, Fig. 7

The major difference between these rectifiers is the position of the mounting brackets. Procedures for removal and replacement of diodes for these rectifiers are essentially the same as procedures for removal and replacement of diodes for rectifiers 8416094 and 8416095. The major difference is that rectifiers 8416096 and 8416192 contain 4 rather than 2 diodes, and the side panels are attached to the heat sinks with 16 rather than 8 mounting screws.

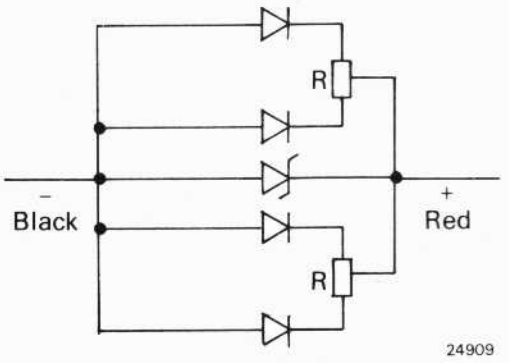


Fig.7 – Schematic For Battery Charging Rectifier Assemblies 8416096 And 8416192

REMOVAL AND REPLACEMENT OF DIODES FOR BATTERY CHARGING ASSEMBLY 9317803, Fig. 8

1. Remove nuts and washers holding diode lead on terminal stud, then remove lead from stud.

2. Insert special diode socket, Fig. 9, over diode lead, through heat sink, and seat it firmly onto the hex portion of the diode; hold diode retaining nut/washer with 1-1/4" hex socket on other side of heat sink.

3. Remove diode from heat sink.

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

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

6. Apply a thin coat of joint compound under hex portion of diode, Fig. 3.

CAUTION

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

7. Install diode, seat special socket on diode hex and standard socket on nut as in Step 2, and apply torque on diode hex as specified in Service Data.

8. Reconnect diode lead to terminal stud with necessary nuts and washers. Be sure lead from red terminal of suppression rectifier is still connected to terminal stud.

BENCH TESTING

HIGH POTENTIAL TEST

Jumper red and black terminals of rectifier assembly during test. Hi-pot the assembly for one minute at 600 volts RMS between terminals and mounting bracket.

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.

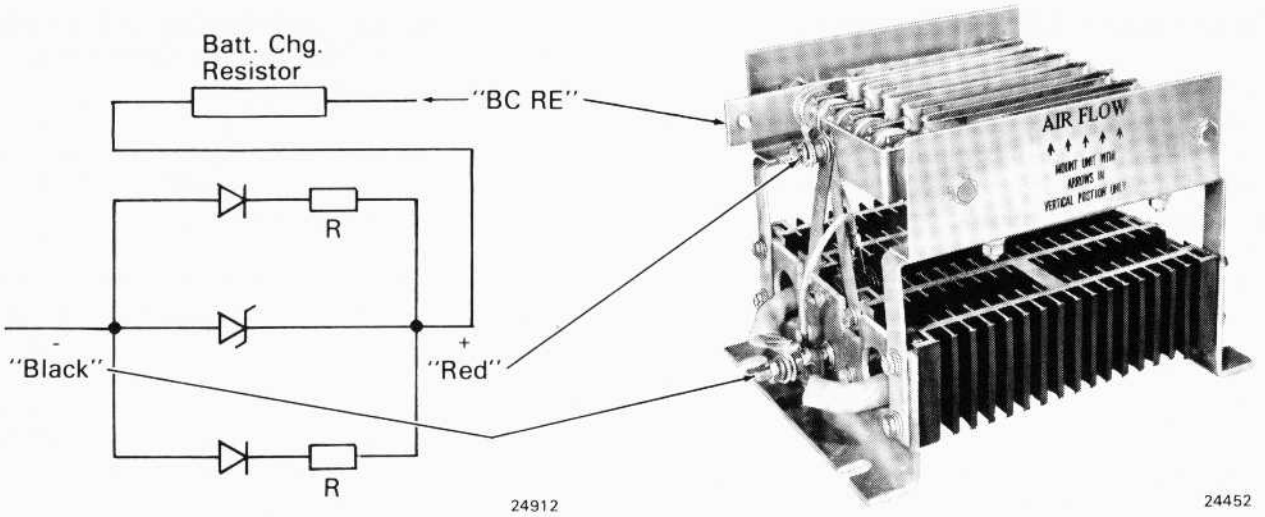
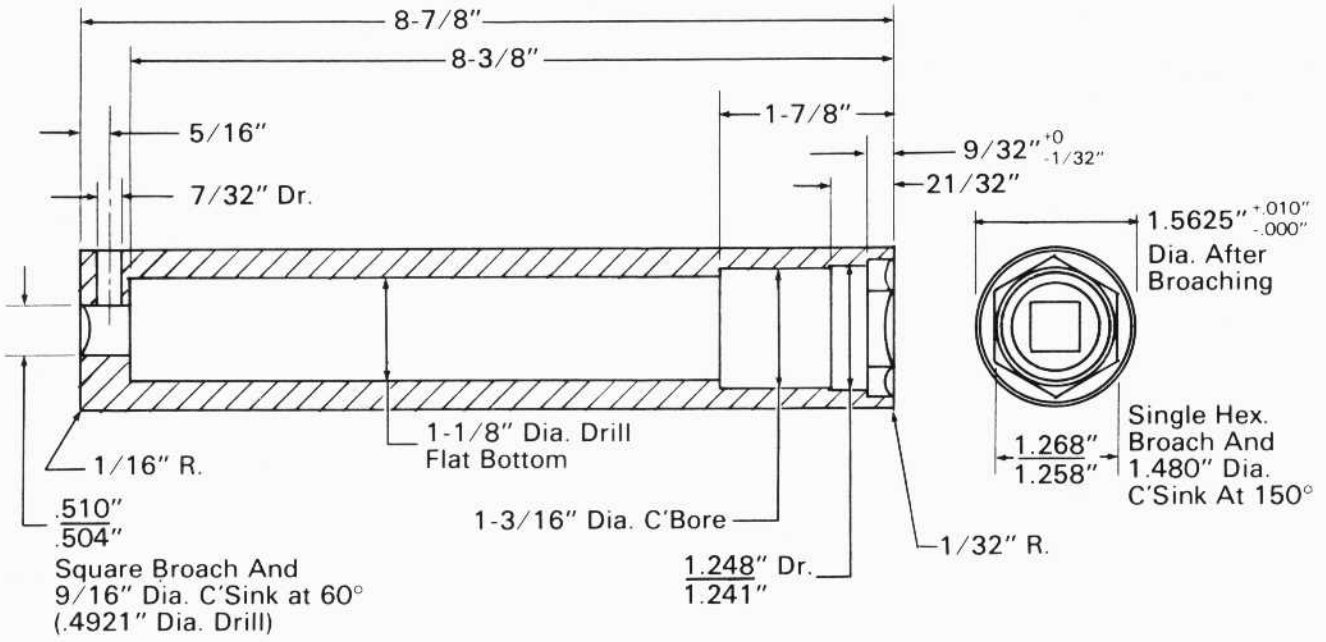


Fig.8 – Battery Charging Assembly (Including Battery Charging Resistor) 9317803, With Schematic



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

Fig.9 – Special Diode Socket Used On 9317803 Assembly

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. 10 and 11, as follows:

1. VI - Average reading DC voltmeter, moving coil type, O-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.

ELECTRICAL REQUIREMENTS FOR EMD RECTIFIER ASSEMBLIES 8416094, 8416095, AND 9317803

1. Forward voltage drop across assembly 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 suppression rectifier disconnected and 400 volts reverse voltage applied, the maximum leakage current of the assembly shall not exceed 26.4 milliamperes at 25° C (77° F).

ELECTRICAL REQUIREMENTS FOR EMD RECTIFIER ASSEMBLIES 8416096 AND 8416192

1. Forward voltage drop across rectifier assembly must not exceed 1.50 volts DC at 80° C (176° F) with 250 amperes forward current.

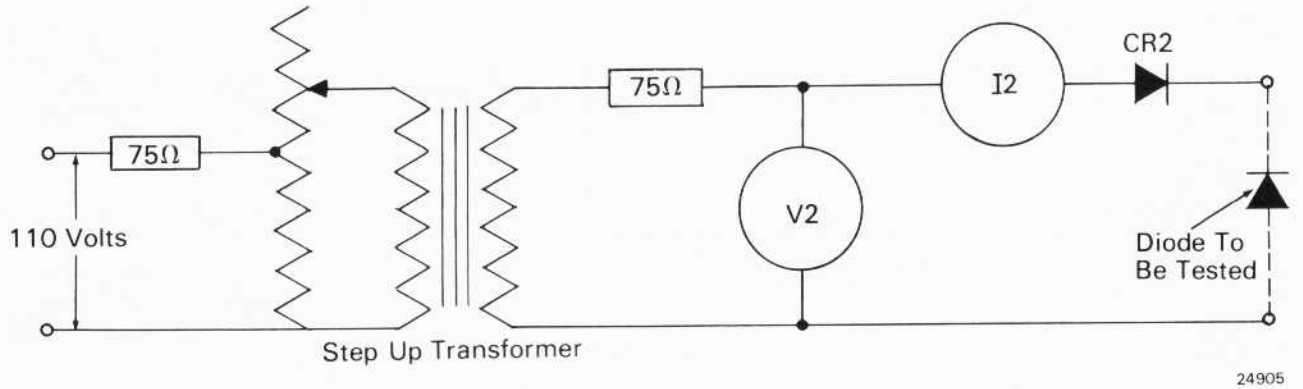


Fig.10 – Reverse Leakage Test

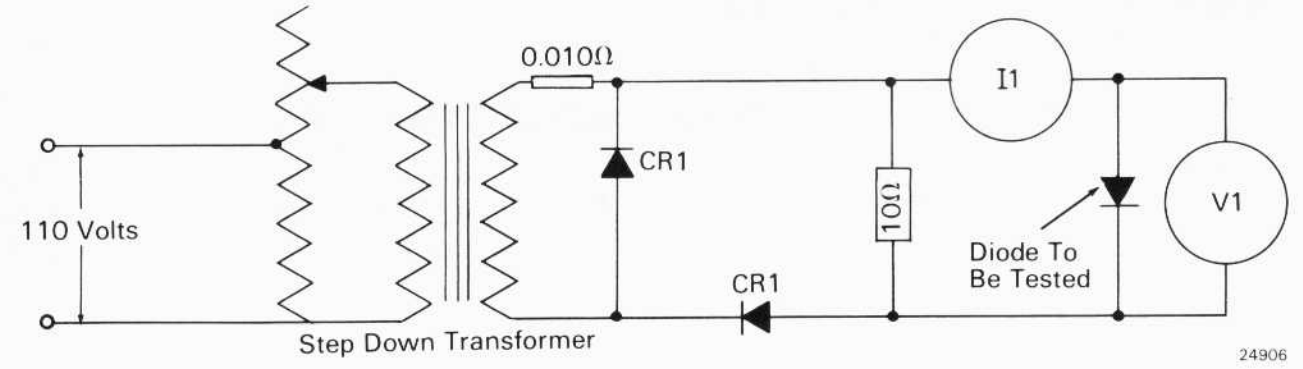


Fig.11 – Forward Voltage Drop Test

2. Individual diode current shall not exceed 72 amperes with 250 amperes total current into the rectifier assembly at 250° C (77° F).

3. With suppression rectifier disconnected and 400 volts reverse voltage applied, the maximum leakage current of the assembly shall not exceed 53 milliamperes.

REVERSE LEAKAGE TEST AT RATED PEAK REVERSE VOLTAGE

1. Connect the diode to be tested in a circuit as shown in Fig. 10.

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 adjusted 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 (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. 11. The forward voltage drop metering leads must 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	8319071 8319696	8321535 8333596	8333841	8416094 8416095	8416096 8416192	9317803
Max. Peak Inverse Voltage	400 volts	400 volts	400 volts	400 volts	400 volts	400 volts
Max Continuous DC Amperes	150 amps.	250 amps.	150 amps.	150 amps.	250 amps.	150 amps
Type Load	Resistive Inductive	Resistive Inductive	Resistive Inductive	Resistive Inductive	Resistive Inductive	Resistive Inductive
Max. Ambient Operating Temp.	80° C. (176° F)	80° C. (176° F)	80° C. (176° F)	80° C. (176° F)	80° C. (176° F)	80° C. (176° F)
Cooling	Convection	Convection	Convection	Convection	Convection	Convection
Suppression Rectifier	8325166	8325166	8333859	8413523	8413523	8413523
RMS Operating Voltage	104 max.	104 max.	120 max.	108 max.	108 max.	108 max.

SERVICE DATA (CONT'D)

GENERAL INFORMATION

8319071 and 8319696 are identical except for mounting brackets.

8321535 and 8333596 are identical except for mounting brackets.

8416094 and 8416095 are identical except for mounting brackets.

8416096 and 8416192 are identical except for mounting brackets.

NOTE

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, is given below.

Manufacturer's Part or Type Number	EMD Part Number	Diode Mounting Torque (Min. - Max.)*
66-6228	8319901	21.5-28.2 N·m (15.8-20.8 ft-lbs)
66-6227	8329902	21.5-28.2 N·m (15.8-20.8 ft-lbs)
66-6225	8329903	21.5-28.2 N·m (15.8-20.8 ft-lbs)
770-H	8333860	21.5-28.2 N·m (15.8-20.8 ft-lbs)
Type 2	8413522	33.9-40.7 N·m (25-30 ft-lbs)

*Diode mounting torque should be applied to diode hex portion, not to the retaining nut.

Joint Compound 8346481

Torque Wrench 0-50 ft-lbs, 1/2" drive 8375396
Special Diode Socket Wrench, (Fig. 2) 8361524
Special Diode Socket, Fig. 4.