Delco Remy

1G-286

PRODUCT INFORMATION 1/98

HEAVY DUTY BRUSH ALTERNATOR SERVICE MANUAL

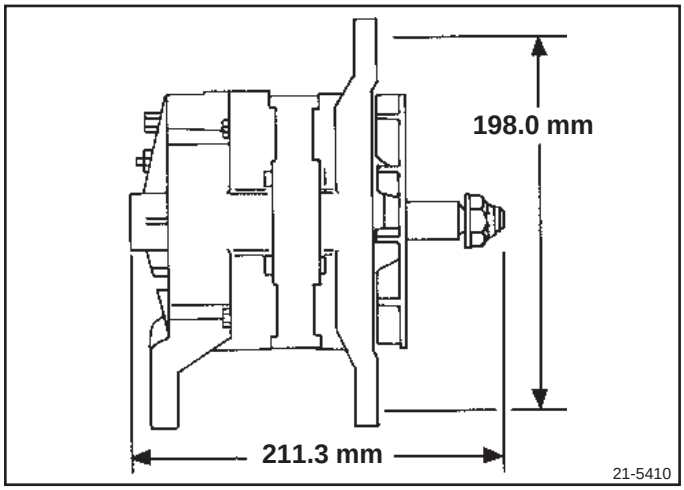
FEATURES

■ High-Output Models
- 100 to 145 Amps, 12-Volt
- 50 to 70 Amps, 24-Volt

■ Applications
- Large and Mid-Range On-Highway Diesel and Gasoline Engines
- Off-Highway, Agriculture and Construction
- Handles Heavy Belt Load and Vibrations
- High Electrical Loads

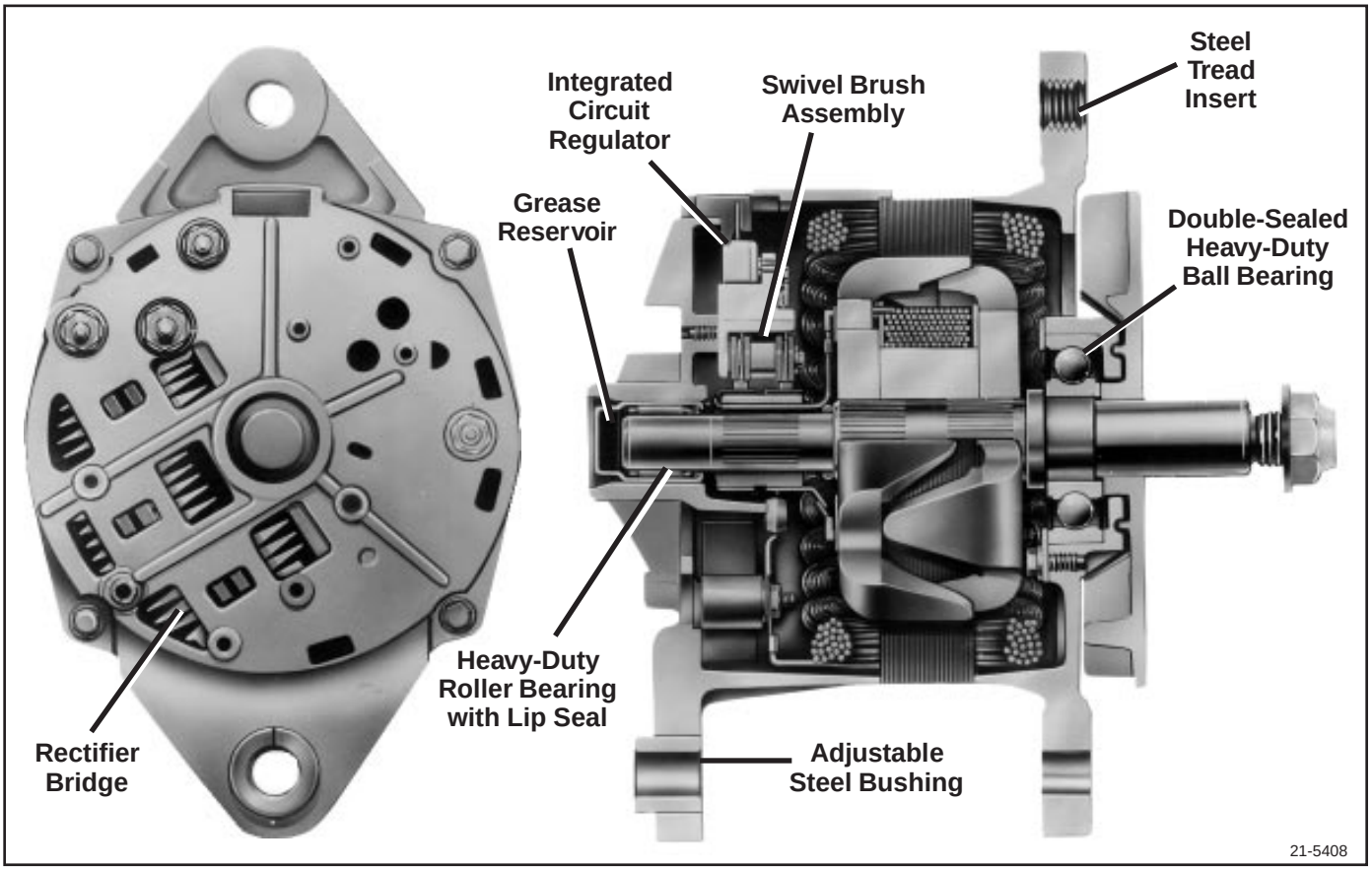
■ Heavy Duty Design
- High-Output Rectifier Bridge
- Double-Sealed Needle Bearing
- 25mm Drive End Ball Bearing
- Swivel Brush Holder Construction

■ Built-in Voltage Regulator
- Solid-State Integrated-Circuit
- Flat Temperature-Compensated
- Low Parasitic Draw
- Low Turn-On Speed
- Improved RFI Suppression
- Load Dump Protection (12-Volt)



■ Specifications
- Maximum Speed, Continuous: 10,000 rpm
- Intermittent: 12,000 rpm
- Ambient Temperature Limits: -34º C to + 93º C (-30º F to +200º F)
- Mounting Span: Conforms to SAE J180
- Polarity: Negative Ground
- Rotation: Clockwise or Counterclockwise
- Weight: 6.46 kg (14.2 lbs.)

■ Charging System Wiring
- One, Two or Three-Wire Design
- Terminal Boots Prevent Damage
- Optional “R” and/or “I” Terminals



PRODUCT INFORMATION AND SERVICE MANUAL
21-SI HEAVY DUTY BRUSH ALTERNATOR

CONTENTS

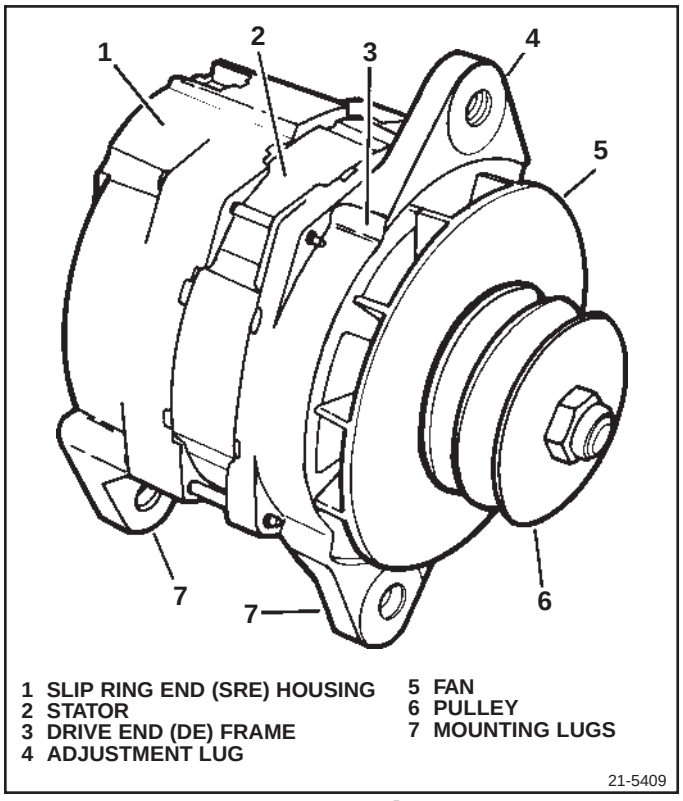


Figure 1. 21-SI Alternator

INTRODUCTION

The 21-SI Heavy Duty Alternator is a high output integral charging system with built-in diode rectifier and voltage regulator, producing DC current for battery electrical systems. The 21-SI series is designed for use on large and mid-range diesel and gasoline engines in over-the-road service, as well as for off-road, agricultural, and construction equipment.

The 21-SI Alternator may be operated in either clockwise or counterclockwise directions (external fan may require changing to reverse rotation) at continuous speed of up to 10,000 alternator rpm. Intermittent speeds of up to 12,000 alternator rpm are also acceptable. The ambient temperature range for proper operation is -34º C to + 93º C (-30°F to +200º F)

The solid state, integrated circuit voltage regulator built into the 21-SI Alternator limits system voltage by switching the ground circuit for the rotor field on and off. When the ground circuit is on, field current passes from a diode trio through the rotor via brushes and slip rings on the rotor shaft. Nominal regulated voltages of 13.8, 14.0, and 14.2 volts are available for 12-volt systems and 27.5 volts for 24-volt systems.

Various output levels are available. For 12-volt systems, output ratings range from 65 amperes to 160 amperes. For 24-volt systems, output ratings are 50 to 70 amperes. Refer to Figure 2 for graphs of typical outputs over a range of alternator speeds. For output ratings of specific 21-SI models call 1-800-DRA-0222.

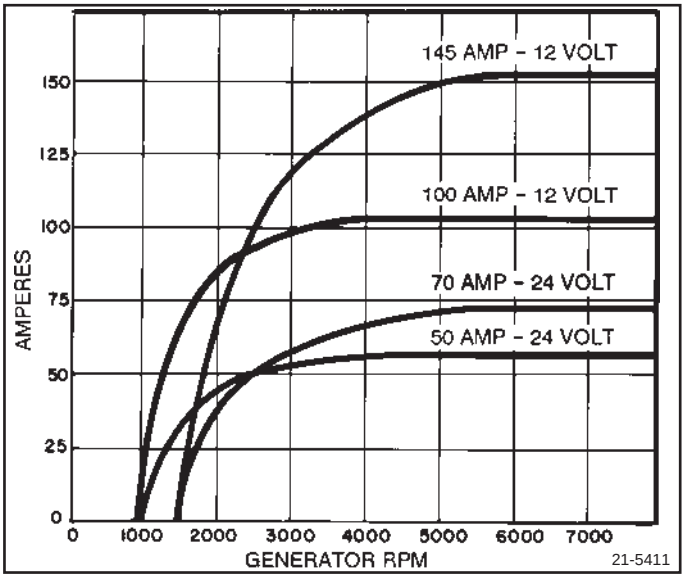


Figure 2. Typical Output vs Alternator RPM

FEATURES

The 21-SI Heavy Duty Brush Alternator is available in either a 1-wire, 2-wire, or 3-wire configuration. These wire configurations refer to the minimum number of lead wire connections necessary at the alternator for operation. Some applications may use additional connections for accessory operation, and/or an additional ground lead connection.

The one-wire type requires only that the alternator output ("BAT") terminal be connected to the battery positive terminal and that a ground path be provided between the alternator housing and the battery negative terminal (refer to Figure 3). "R" and/or "I" terminal connections are optional and do not affect alternator operation.

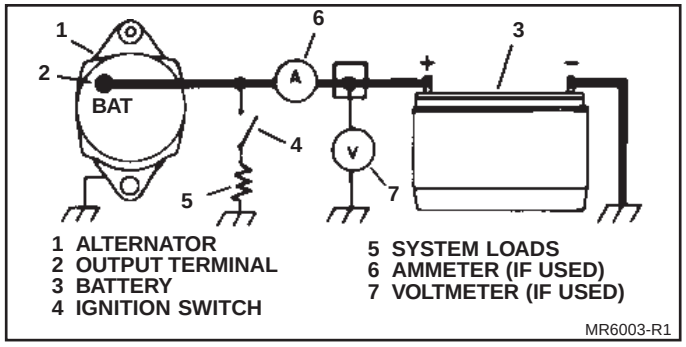


Figure 3. Basic One-Wire System

The two-wire type requires the "BAT" terminal connection to battery positive and the ground path to the alternator housing, along with an additional connection (See Figure 4). This additional lead should initiate at the ignition switch and through an indicator light (or 10-50 ohm resistor or diode to prevent alternator feedback) and attach to alternator "I" terminal.

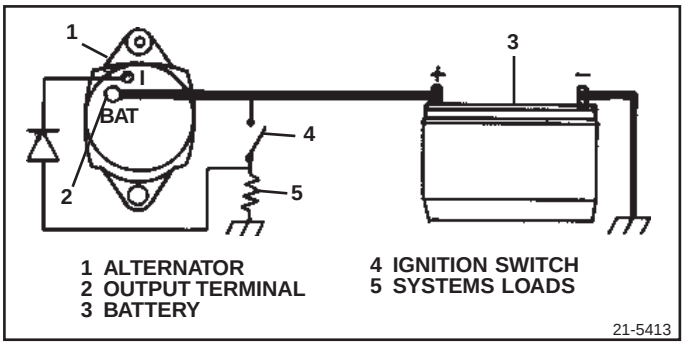


Figure 4. Basic Two-Wire System

The 3-wire type requires the "BAT" terminal connection to battery positive and the ground path to the alternator housing, along with two additional connections (refer to Figure 5). The first, to the regulator #1 terminal, is a switched battery positive field current/indicator light lead with an overall circuit resistance of 10 to 50 ohms. The second, to the regulator #2 terminal, is a system voltage sense lead for voltage control. An "R" terminal connection is optional and does not affect alternator operation.

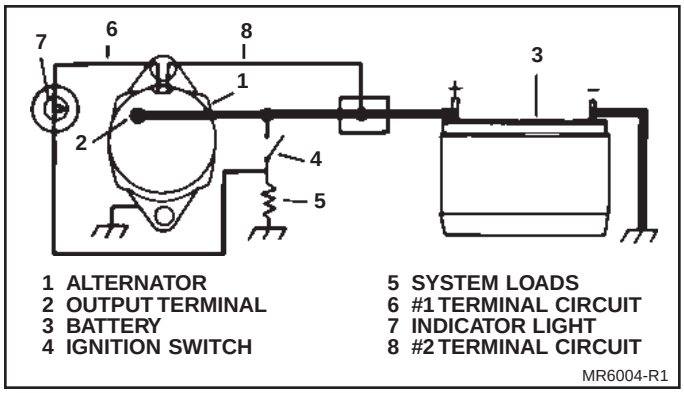


Figure 5. Basic Three-Wire System

External connections to the 21-SI Alternator are made to terminals as shown in Figure 6. The "BAT" terminal may be 1/4", 5/16", or M6 (metric) size, depending on the application requirement. Connections to terminals 1 and 2 on 3-wire systems are made by installing a special Packard connector with two blade terminal receptacles and latch feature, available in wiring package 1870921.

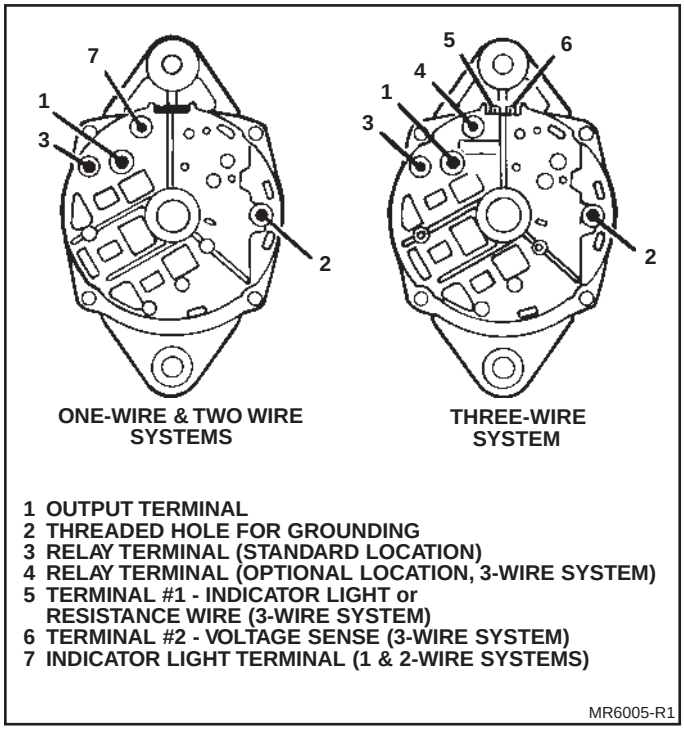


Figure 6. 21-SI Electrical Terminals

Optional connections to the 21-SI series, include "R" (relay) and "I" (indicator light) terminals, and a ground lead connection to the alternator housing.

A Relay terminal may be located either counterclockwise from the BAT terminal where an R is molded into the casting, or at an opening clockwise from the BAT terminal and labeled "RELAY" by a permanent adhesive label next to the terminal. On a replacement unit, there will be a round push-on label on the terminal itself. This terminal may be used to operate a charge indicator, ADLO system,

tachometer, or similar device by providing voltage pulses at about half of system voltage and at a frequency of 6 times the alternator rpm.

When an "I" terminal is present it will be located where there is an I molded into the casting, clockwise from the BAT terminal. An "I" terminal is connected internally to the field circuit. If an indicator light is connected in series with this terminal, the light will be on whenever there is a voltage difference between the "positive" side of the field circuit and the system voltage at other side of the indicator light. During normal alternator operation, the light will be off since the diode trio output voltage equals the system voltage.

The R and I terminals are available in either threaded (10-24 or M4) or pin types.

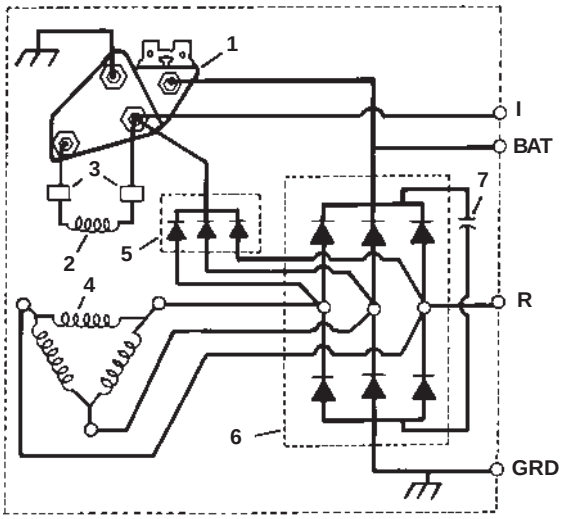
A threaded 1/4" or 5/16" hole in the slip ring end (SRE) frame is provided to connect a ground lead if used; otherwise, the ground path is through the mounting hardware and brackets to the engine.

Some applications use a debris shield on the outside of the SRE housing of the alternator. Such shields are added by the engine manufacturer to reduce the amount of airborne debris that enters the alternator in severe environments. A stud mounted in the "I" terminal hole may be used to attach the debris shield to the alternator. The stud is not connected electrically inside the unit.

OPERATING PRINCIPLES

An alternator is a voltage-creating machine. The voltage regulator limits the maximum voltage that the alternator will produce at the output (BAT) terminal by controlling the magnetic field present in the rotor. The voltage produced allows current to flow to satisfy the electrical loads placed on the system, up to a maximum current characteristic of the alternator design.

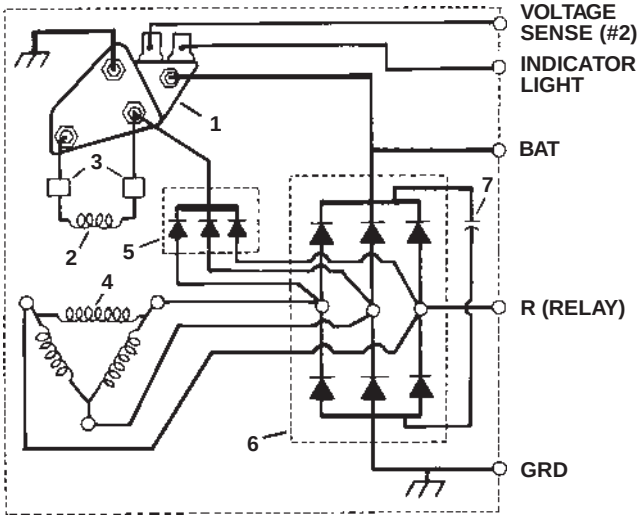
Schematic of the alternator circuitry are shown in Figure 7 (one-wire systems) and Figure 8 (three-wire systems). With the alternator rotor turning, magnetic fields around the rotor induce voltages in the stator windings. The faster the rotor turns, the higher the induced voltage will be. In a one-wire system, the voltages at start-up are generated by residual magnetism in the rotor. In a 3-wire system, rotor magnetism is boosted at start-up by field current entering through the #1 regulator terminal then flowing through the rotor windings. Because of the boosted magnetism, a 3-wire system will have a lower turn-on speed (rpm) than a comparable one-wire system. However, once turned on, the output curves are identical.



1 REGULATOR
2 ROTOR (FIELD)
3 BRUSHES
4 STATOR
5 DIODE TRIO
6 RECTIFIER BRIDGE
7 CAPACITOR

MR6006-R1

Figure 7. One-Wire Alternator Schematic



1 REGULATOR
2 ROTOR (FIELD)
3 BRUSHES
4 STATOR
5 DIODE TRIO
6 RECTIFIER BRIDGE
7 CAPACITOR

MR6007-R1

Figure 8. Three-Wire Alternator Schematic

As speed and output increase, voltage available at the diode trio becomes sufficient to supply field current for normal operation. When the output voltage exceeds the battery voltage, the alternator begins to drive the system voltage. If the wiring system includes an indicator light, the presence of system voltage at the diode trio equalizes the voltage on both sides of the indicator light and the light goes out.

While the system voltage is below the voltage regulator setting, the regulator turns on the field current through the rotor and allows the alternator to produce as much output as possible for the alternator speed (rpm), temperature and system voltage. When the voltage setting is reached, the regulator turns the field current off. When the field current is turned off, the magnetic field in the rotor collapses and the alternator output voltage begins to fall. The falling voltage causes the regulator to turn the field current back on and the magnetic field to rebuild. This switching action of the regulator continues rapidly, keeping the output and system voltage very close to the voltage setting. This will continue unless the electrical demands of the system cause the system voltage to fall below the voltage setting. Should this happen, the regulator will again allow full field current to flow so that the maximum output of the alternator at the given speed, temperature and systems voltage is realized.

One-wire systems use system voltage at the alternator to control the output voltage, and extra sense wiring is not needed. With a 3-wire system, the voltage present in the sense lead is used to control the output voltage. Using a sense lead makes it possible to sense the system voltage at another location (such as at a junction closer to the battery) for voltage control.

TROUBLESHOOTING

Trouble in the charging system will normally be indicated by one of the following:

- Indicator light “on” with engine running.
- Indicator light “off” with key on, engine not running.
- Undercharged or overcharged battery.
- Short life of light bulbs or other electric equipment caused by abnormally high system voltage.
- System voltmeter readings outside normal range.

Diagnose system as follows (refer to Figures 9 and 10.)

A. ALL CHARGING SYSTEMS -

TEST EQUIPMENT NEEDED:

- Belt Tension Gage
- Battery State-of -Charge Indicator

1. Check electrical system wiring and battery terminals for poor connections or other obvious conditions that might result in shorts, opens, grounds, or high resistance. Correct as necessary.

2. Check alternator drive belt for proper tension. Adjust to manufacturer’s specifications.

3. Check battery for state-of-charge. If low, recharge according to manufacturer’s specifications and load test to establish serviceability. Further diagnostic tests require a known good, fully-charged battery for accurate results.

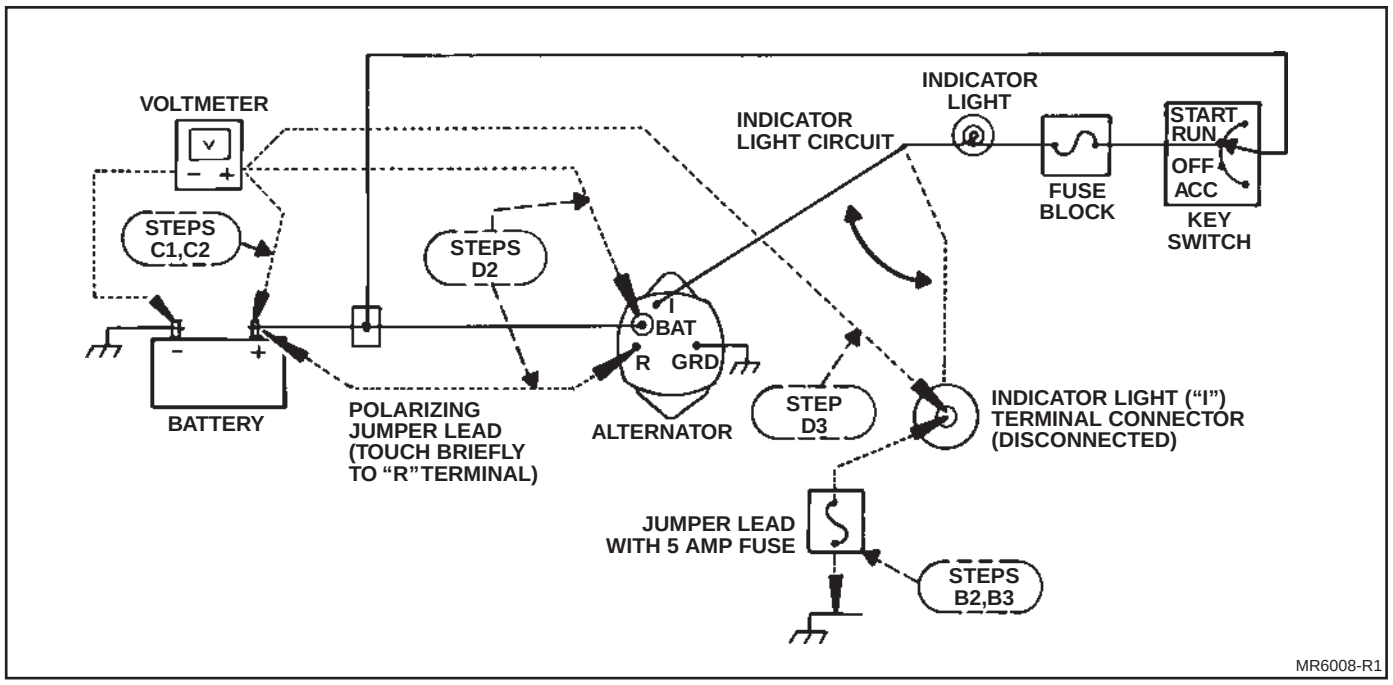


Figure 9. Troubleshooting a One-Wire System

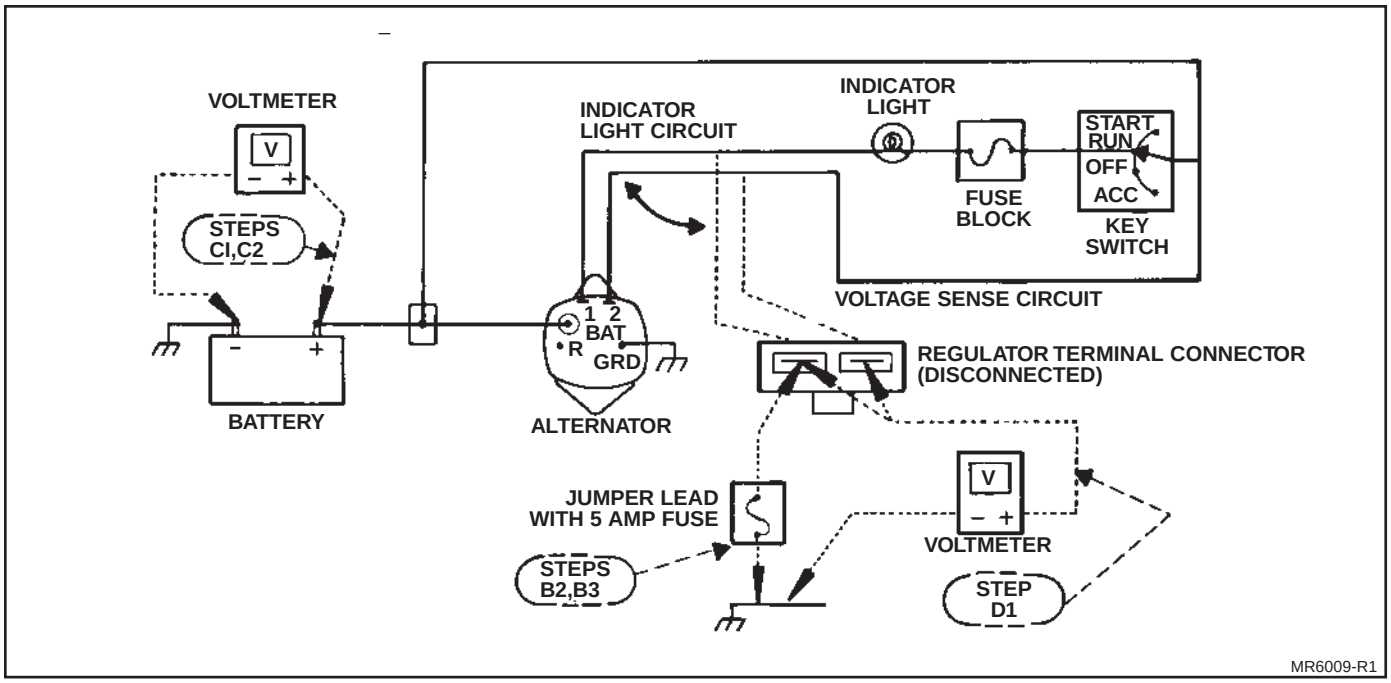


Figure 10. Troubleshooting a Three-Wire System

B. SYSTEMS WITH INDICATOR LIGHT -

TEST EQUIPMENT NEEDED:

- Jumper Lead with 5-Amp Fuse

1. If indicator light is on with engine running:

   Stop engine. Turn key switch to "run" position. Indicator light should be on. If not, go to step 3.

   Disconnect indicator light lead at alternator. For one-wire systems, this will be the "I" terminal connector. For 3-wire systems, disconnect the regulator terminal connector (terminals 1 and 2).

   If indicator light remains on, locate and correct shorted or grounded condition in indicator light circuit between the light and the alternator.

   If indicator light goes out, light is working properly. Proceed to "C" for check of system with indicator light working properly.

2. If indicator light does not come on with the key switch in the "run" position with the engine stopped ("bulb check" mode):

   Leave key in "run" position with engine stopped. Disconnect indicator light lead from alternator. For one-wire systems, this will be at the "I" terminal. For 3-wire systems, disconnect the regulator terminal connector (terminals 1 and 2) and determine which is the indicator lamp circuit by locating the terminal that connects to the #1 terminal on the regulator. Use fused (5-amp) jumper lead to ground indicator lamp circuit in harness connector to alternator housing.

   - If indicator light comes on with jumper lead in place, repair, or replace alternator.

   - If indicator light does not come on with jumper lead in place, locate and correct open circuit in indicator light circuit. Circuit fuse may be open or light bulb may be burned out. Correct as necessary.

     NOTE: If 5-amp fuse blows, jumper lead has probably been connected to sense circuit instead of indicator light circuit. Replace jumper lead fuse and try again.

3. If indicator light comes on while engine is running, but is not on with engine stopped and key switch in "run" position.

   Leave key in "run" position with engine stopped. Disconnect indicator light lead from alternator. For one-wire systems, this will be at the "I" terminal. For 3-wire systems, disconnect the regulator terminal connector (terminals 1 and 2) and determine which is the indicator lamp circuit by locating the terminal that connect to the #1 terminal on the regulator. Use fused (5-amp) jumper lead to ground indicator lamp circuit to alternator housing.

   - If indicator light comes on with jumper lead in place, replace regulator as described under Unit Repair

- If indicator light does not come on with jumper lead in place, locate and correct open circuit in indicator light circuit between battery and light. Circuit fuse may be open. (With engine running, light is being powered by alternator and grounded through other circuits connected in parallel to indicator light circuit.) Correct as necessary.

  NOTE: If 5-amp fuse blows, jumper lead has probably been connected to sense circuit instead of indicator light circuit. Replace jumper lead fuse and try again.

4. If indicator light is on with key switch in "off" position:

   Disconnect indicator light circuit at alternator.

- If indicator light remains on, locate and correct shorted condition between the light and alternator.

- If indicator light goes out, diode is shorted in rectifier bridge. Replace rectifier bridge as described under Unit Repair.

C. SYSTEMS WITHOUT INDICATOR LIGHT OR WITH INDICATOR LIGHT WORKING PROPERLY -

TEST EQUIPMENT NEEDED:

- Voltmeter

1. If battery is undercharged, indicator light remains on while vehicle is running, or system voltmeter shows operating voltage is below acceptable range:

   With engine stopped and all electrical loads turned off, use voltmeter to check voltage across battery terminals. Record voltage.

   Start engine and run at moderate speed. Check voltage across battery terminals with engine running.

- If voltage reading at battery terminals is different from reading showing at system voltmeter (if equipped), locate and correct cause of incorrect reading.

- If voltage is lower than reading previously recorded with engine stopped, there is no alternator output. Proceed to section on No Output.

- If voltage is higher than previous reading with engine stopped, alternator output is present. Proceed to section on Rated Output Check.

2. If battery is overcharged (as evidenced by excessive water use or electrolyte spewing from battery vents), light bulbs or other electrical equipment have shortened life due to suspected high system voltage, or system voltmeter reads above normal range:

   With fully charged battery, engine running at moderate speed and all electrical loads off, use voltmeter to check voltage at battery terminals. If checking a 3-wire system, locate sense lead (connects to alternator #2 terminal) and gently wiggle the connections at both ends while watching the voltage reading.

   For a 12-volt system, readings should be stable, around 13.5 - 14.5 volts and in no case go above 15 volts. For a 24-volt system, readings should be stable, around 27 - 28 volts and in no case go above 31 volts.

- One-wire system: If voltage is erratic or goes above 15 volts (31 volts on 24-volt system), replace regulator as described under Unit Repair and test field coil for shorts.

- 3-wire system: If voltage is erratic or goes above 15 volts (31 volts on 24-volt system) during any of these checks, check sense lead for continuity and clean and tighten sense lead connections. Recheck voltages with engine running. If problem persists, replace regulator as described under Unit Repair and test field coil for shorts.

D. NO OUTPUT

TEST EQUIPMENT NEEDED:

- Voltmeter
- Jumper Lead (18 ga. min; no fuse)

Note that 21-SI Alternators must be connected to a battery for the voltage sensing circuit to allow initial turn on (refer to section on Features). When properly connected and system checks indicate a "no output" condition, use the following steps to determine if the alternator requires repair:

1. For 3-wire systems, use voltmeter to check voltages present in harness connector at regulator. With connector disconnected and key switch in "run" position (engine not running), both terminals 1 and 2 in harness should read battery voltage. If OK, go to step 4. If not, alternator will not turn on. Locate and correct cause of voltage loss.

2. For one-wire systems <u>without</u> an "I" terminal, battery positive voltage at the "BAT" terminal and residual magnetism in rotor are necessary for alternator to turn on. Use voltmeter to verify that battery voltage is present at "BAT" terminal. If not, locate and correct cause of voltage loss.

   Residual magnetism in the rotor is sometimes lost during servicing of the alternator If the alternator has no "R" or "RELAY" terminal, proceed to step 4. If the alternator has an "R" terminal, the rotor can be remagnetized without removing alternator from application. To

remagnetize rotor, make sure the normal connections are made to the alternator. BAT terminal and to the ground circuit. Disconnect the wiring harness from the "R" terminal. Momentarily connect a jumper lead from battery positive to the alternator "R" terminal. This will cause field current to momentarily flow through the rotor in the proper direction and restore magnetism. Reconnect wiring harness to "R" terminal, then recheck alternator for output.

3. For one-wire systems with an "I" terminal, the indicator light current at this terminal will establish normal magnetism. With engine stopped and key switch on, use voltmeter to check for voltage present at this terminal. With "I" terminal connected and indicator lamp on, voltage will be less than battery voltage. If necessary to disconnect wiring at "I" terminal to make this check, check for battery voltage in harness wire. If voltage is present, proceed to step 4. If no voltage is present, check "I" terminal circuit for cause of voltage loss (bulb may be burned out). Correct as necessary.

4. If no conditions have been found that might prevent the alternator from turning on (step 1, 2, or 3), remove alternator from engine in accordance with engine manufacturer's instructions and proceed to Unit Repair.

E. RATED OUTPUT CHECK

TEST EQUIPMENT NEEDED

- Voltmeter
- Ammeter (current capability at least 15 amperes higher than alternator rating)
- Variable Carbon Pile Load Test

CAUTION: Failure to disconnect negative battery cable at battery before removing or attaching alternator "BAT" terminal lead may result in an injury. If a tool is shorted at alternator "BAT" terminal, the tool can quickly heat enough to cause a skin burn.

1. Refer to Fig. 11 for test equipment hookups as described in following steps. If inductive pick-up ("clamp on") type ammeter is used, place current clamp on alternator output lead and skip to step 4. If series ammeter is used, disconnect negative battery cable at battery.

2. Install ammeter in series with alternator "BAT" terminal.

3. Reconnect negative battery cable at battery.

4. **NOTICE**: When a 12-volt carbon pile load test is used to diagnose a 24-volt system, attach load test only to 12-volt potential in battery pack. Attaching a 12-volt load test to a 24-volt potential will damage the load test.

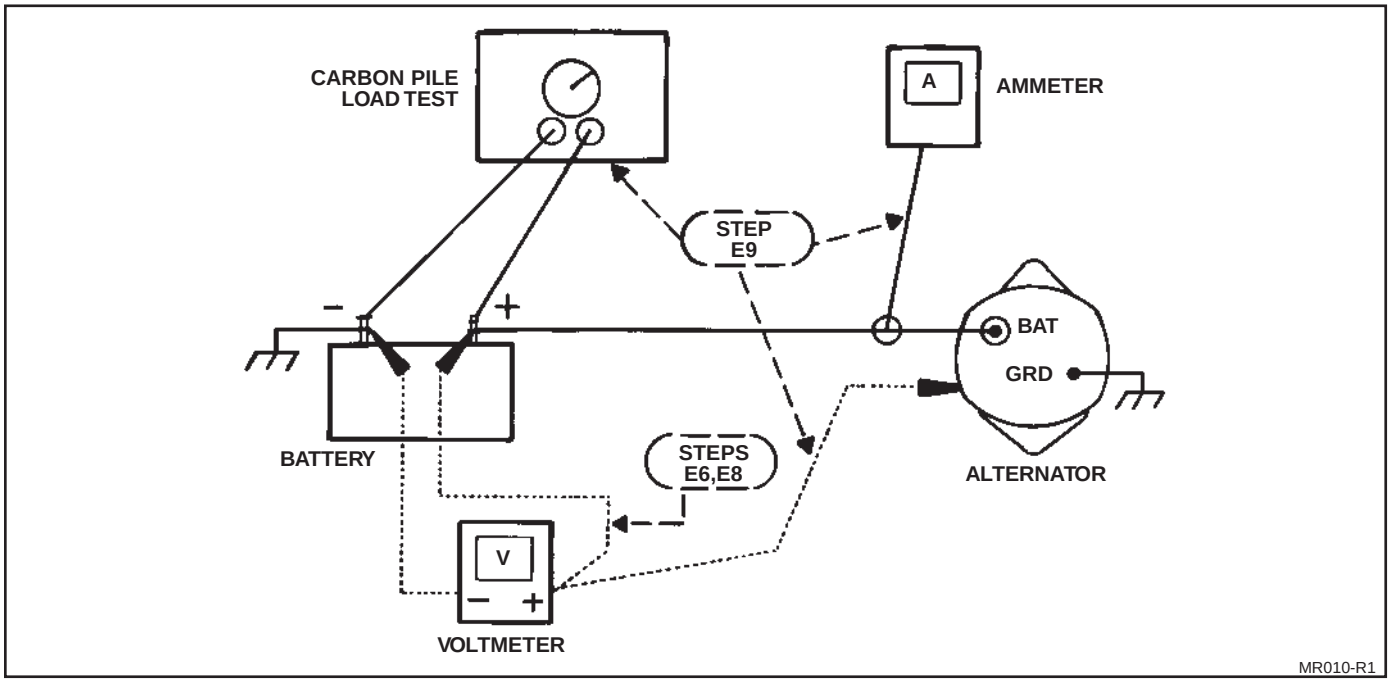


Figure 11. Rated Output Check

With load turned off, attach carbon pile load test across battery.

5. Attach voltmeter negative to grounded negative battery terminal. Leave positive meter lead open for checks at various points.

6. Check and record voltage at battery positive terminal. For multi-battery systems, check positive voltage of battery set connected as if in battery charging mode.

7. With all system electrical loads off, start engine and run at moderate speed (rpm).

8. Recheck voltage at battery positive terminal. Voltage should be higher than previous reading, but below 15 volts on 12-volt system (31 volts on 24-volt system).

- If reading is lower than previous reading (step 6), refer to section on No Output.

- If reading is higher than 15 volts on 12-volt system (31 volts on 24-volt system), refer to section on High Voltage Output.

9. Turn carbon pile load on and adjust to obtain maximum alternator output on ammeter without allowing voltage at battery positive terminal to drop below 13 volts (25 volts on 24-volt system). Record maximum ampere output.

   With alternator still running at maximum output, check and record voltage drop in ground circuit between alternator housing and battery negative terminal. Turn carbon pile load off.

   Maximum ampere output should be within 15 amps of output rating stamped next to part number on alternator drive end (DE) frame, or as listed in Specifications section of this manual. Voltage drop should be 0.25 volts or less on 12-volt system (0.5 volts or less on 24-volt system).

- If ground circuit voltage drop is over 0.25 volts on 12-volt system (0.5 volts on 24-volt system), clean and tighten all ground circuit connections. If this does not correct excessive voltage drop, check ground circuit cables for improper sizing or high resistance conditions. Correct as necessary.

- If within 15 amps of rating, alternator is good. Look elsewhere for cause of problem.

- If more than 15 amps below rating, repair or replace alternator.

ALTERNATOR UNIT REPAIR

CAUTION: Failure to disconnect negative cable at battery before removing or attaching alternator "BAT" terminal lead may result in an injury. If a tool is shorted at alternator "BAT" terminal, the tool can quickly heat enough to cause a skin burn.

NOTICE: Always reinstall fasteners at original location. If necessary to replace fasteners, use only correct part number or equivalent.

- If correct part number is not available, use only equal size and strength. For alternator internal fasteners, refer to Delco Remy America Standard Hardware Fasteners section in Service Parts Catalog.

- Fasteners that are NOT to be reused will be noted in procedure.

- Fasteners requiring thread locking compound will be noted in procedure.

- Use specified torque values when shown.

Using or replacing fasteners in any other manner could result in part or system damage.

If diagnosis determines that alternator repair is needed, remove alternator from engine according to manufacturer's instructions.

DISASSEMBLY AND BENCH CHECKS

TEST EQUIPMENT NEEDED:

- Ohmmeter
- 110-Volt Test Lamp (optional)

NOTICE: On some alternators on certain engine configurations, a 1.5µf capacitor (DRA 1985444) has been installed to the output terminal and attached with a 3/8" long 10-24 self tapping screw. Remove the screw and the capacitor (DRA 1985444) before disassembly.

ALTERNATOR

1. Place alignment mark across slip ring end (SRE) housing and drive end (DE) frame for assembly after repair (Fig. 12).

2. Remove 4 thru bolts.

3. Separate DE frame (with rotor) from SRE housing (with stator). If necessary, carefully pry DE frame from edge of stator with screwdriver (Fig. 13). After separation, place tape over SRE bearing inside unit to prevent dirt from entering during checks.

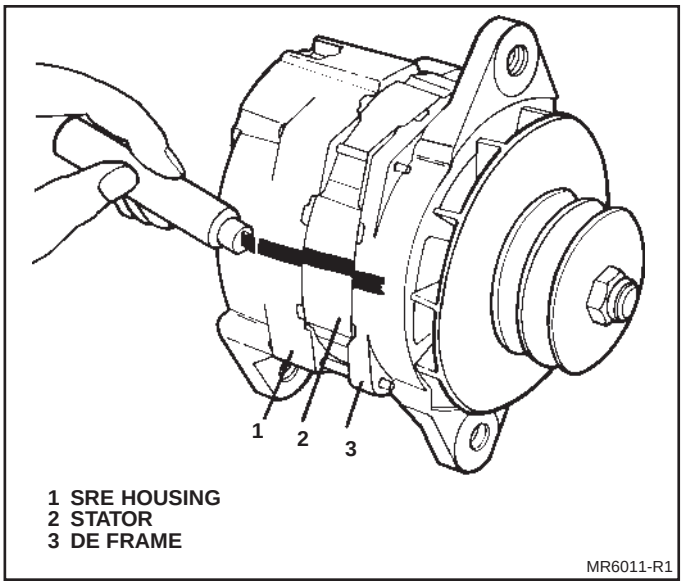


Figure 12. Marking Alignment for Reassembly

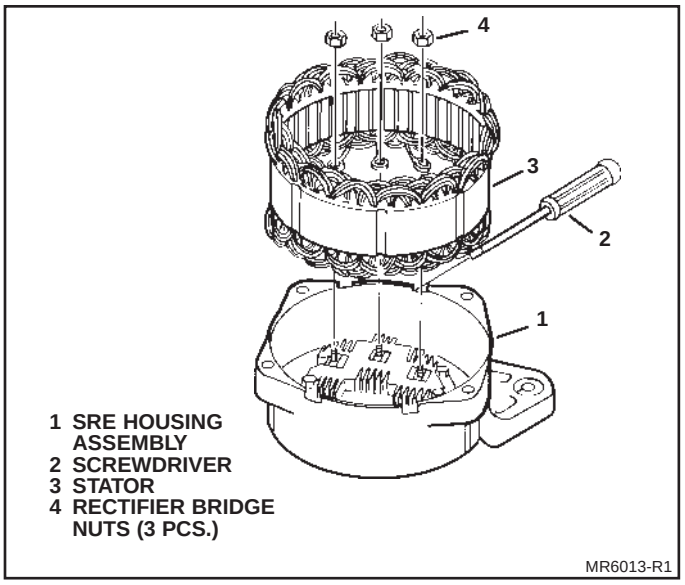


Figure 14. Removing Stator

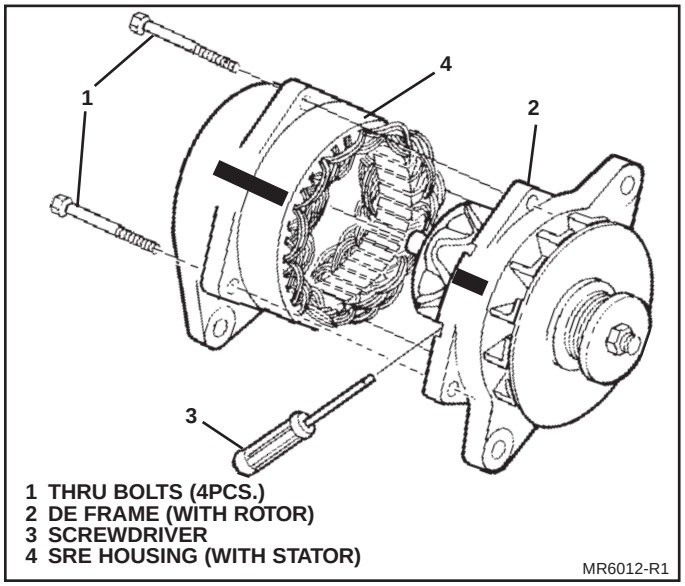


Figure 13. Disassembly of Alternator

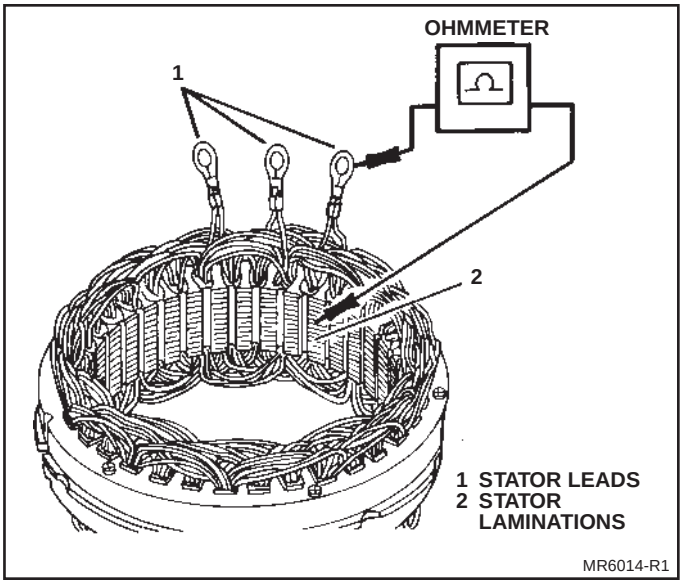


Figure 15. Electrical Check of Stator

SRE HOUSING AND COMPONENTS

4. Inspect SRE housing assembly for loose connections or other obvious conditions. Correct as necessary. If none are found, proceed with SRE checks.

5. Remove 3 rectifier bridge nuts to disconnect stator. Lift stator from SRE housing. If necessary, carefully pry stator away from SRE housing with screwdriver (Fig. 14).

6. Inspect stator winding for a dark, burned appearance. View winding from inside of unit - black paint on outside of windings does not indicate burned windings. If all windings are uniform in color and varnish covering is not flaking off, proceed with electrical check. If some windings are dark and others are light, a shorted, open or grounded condition is indicated. Replace the stator. The stator should also be replaced if the windings are uniformly dark and burned, with the varnish coating flaking off to expose bare wires.

7. Perform electrical check on stator. Use ohmmeter or 110-volt test lamp (Fig. 15). There should be no continuity between any of the stator leads and the stator laminations.

- If continuity is present, windings are grounded. Replace stator.

- If there is no continuity, stator is probably good. However, there is no service electrical check for shorted or open delta stator windings. If all other electrical checks are normal and the alternator did not produce within 15 amps of the rated output, a shorted or open stator in indicated and the stator is to be replaced.

8. Remove insulated regulator attaching screw to disconnect diode trio (Fig. 16). Lift trio from SRE assembly.

   NOTE: Wherever "Ohmmeter" is specified for use when checking diodes, the "Diode Test Functions" setting should be used for "Digital Type" multimeters.

9. Use ohmmeter to check diode trio (Fig 16). Place negative ohmmeter lead on regulator strap and use positive ohmmeter lead to check for continuity to each of the three rectifier bridge straps. All three readings should indicate continuity. Reverse the ohmmeter leads and perform checks again. Readings should all indicate open circuits.

   - If all readings are proper, diode trio is good.

   - If any reading is wrong, replace diode trio.

10. Use ohmmeter to check rectifier bridge (Fig. 17). Bridge may be checked in place in the SRE frame. Check 6 diodes as follows:

    Place negative ohmmeter lead on grounded heat sink. Touch positive ohmmeter lead firmly to metal diode clips that surround each of the 3 threaded studs. All 3 readings should be the same, and indicate open circuits. Switch leads and repeat. All 3 new readings should indicate continuity.

    Repeat checks using insulated (positive) heat sink in place of grounded heat sink. With negative ohmmeter lead on insulated heat sink, all 3 readings should indicate continuity. Switch leads and repeat. All 3 new reading should indicate open circuits.

   - If all readings are correct, the rectifier bridge is good.

   - If any reading is wrong, an open or shorted diode is indicated and rectifier bridge should be replaced. To remove bridge, remove inside BAT terminal nut, nut and connector from regulator stud, inside "R" (relay) terminal nut and connector (if used), two bridge attaching screws, and insulated capacitor attaching screw. Lift capacitor and rectifier bridge from SRE housing (Fig 18).

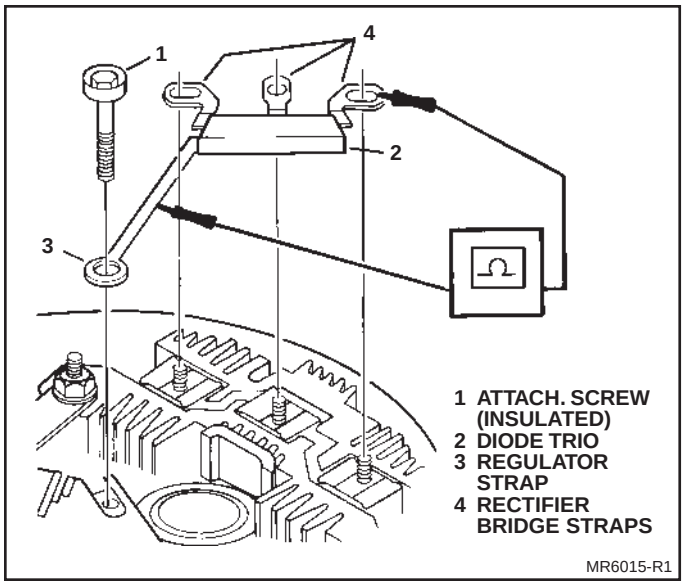


Figure 16. Electrical Check of Diode Trio

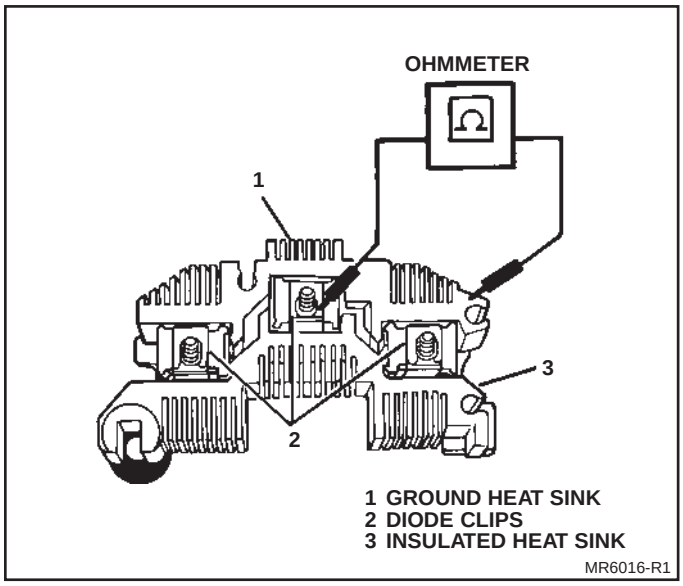


Figure 17. Electrical Check of Rectifier Bridge

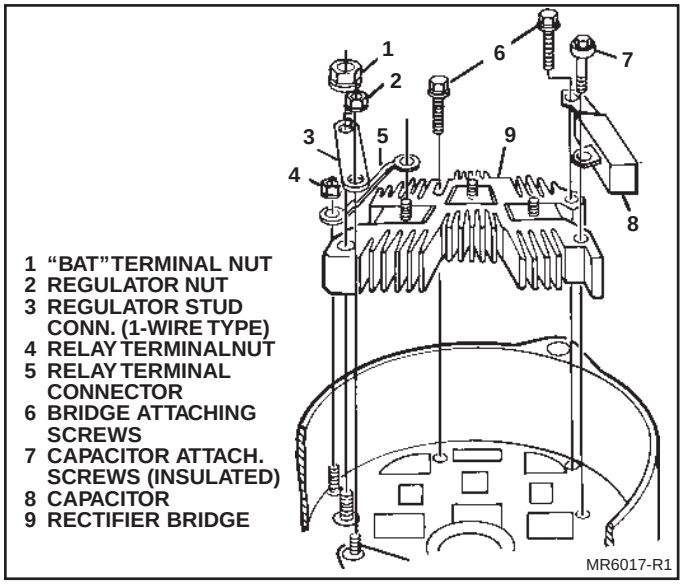


Figure 18. Removing rectifier Bridge

11. Brush holder assembly must be removed to service brushes or regulator (Fig 19). Hold brushes in retracted position and insert brush pin to keep brushes in retracted position. Remove insulated regulator attaching screw. Remove regulator nut and stud connector (if used). Loosen or remove inside "I" terminal nut to move "I" terminal connector (if used) as necessary for clearance. Finally, remove brush holder pivot screw. Lift brush holder assembly from housing without bending regulator connector from diode trio or "I" terminal connector.

12. Check brushes and leads for excessive wear, breakage, etc. If necessary to replace, note routing of lead wires and position of lead clips for later assembly; brushes are identical but leads and clips are positioned differently. Carefully remove brush pin to release brushes (Fig. 19). Remove brushes and spacer one at a time, placing fingers around springs to prevent loss. It may be necessary to spread the brush lead clips slightly to disengage retaining tabs.

13. Remove remaining regulator attaching (ground) screw. If previous checks lead to an instruction to replace the regulator, replace it. If it is not known whether regulator is good, use an approved tester for SI-type regulators. Always check field coil for shorts when replacing regulator.

14. Remove protective tape (see step 3) and check bearing in SRE housing. Bearings are permanently lubricated; do not add grease. If bearing is dry or damaged, replace bearing. If bearing is being replaced without removing brushes from SRE housing, use brush pin to hold brushes in retracted position while bearing is removed. To remove bearing, use tube slightly smaller than opening in SRE housing and drive bearing through to inside of housing (Fig. 20). If bearing is not removed, place tape back over bearing.

DE FRAME AND COMPONENTS

15. Use ohmmeter to check rotor field resistance. Place ohmmeter leads on the two slip rings on the rotor shaft to make this check (Fig. 21). Refer to Service Specifications at the end of this section for proper value. Also use ohmmeter to check for a grounded field by touching one lead to a slip ring and one lead to rotor frame or shaft. Reading should be infinite (open) to show that field is not grounded. If field resistance is outside specifications or if field is grounded, replace rotor as described in following steps.

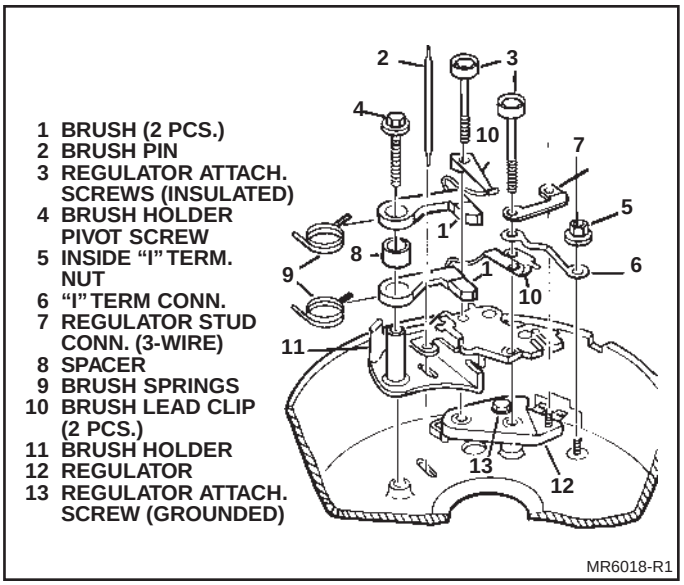


Figure 19. Brush Holder Disassembly

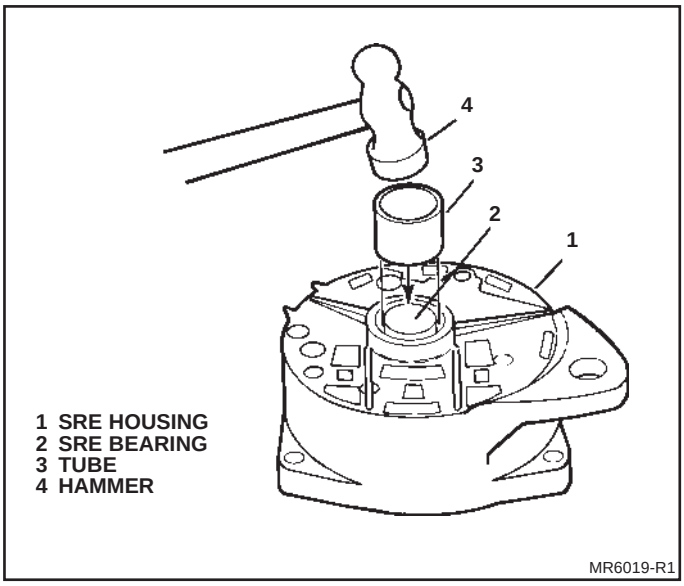


Figure 20. Removing SRE Bearing

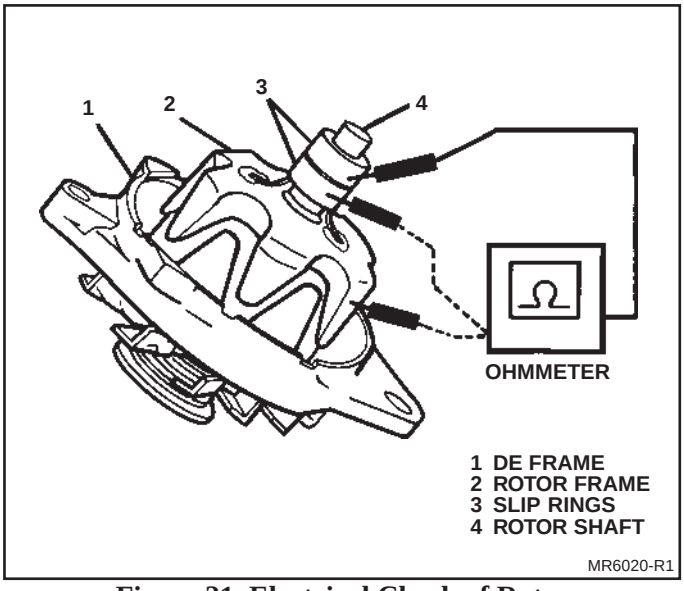


Figure 21. Electrical Check of Rotor

16. Hold DE frame and spin rotor by hand to see that it spins freely in ball bearing. Bearing is permanently lubricated; do not add grease. If movement is rough or wobbly, replace DE bearing as described in following steps.

17. Remove shaft nut by placing 5/16" hex wrench in end of shaft to hold while removing nut with common wrench (Fig. 22). Turn nut counterclockwise to remove. If hex wrench is not available, wrap rotor in shop cloth and place in vise, tightening just enough to hold while removing shaft nut.

18. Lift shaft nut washer, pulley and fan from shaft (Fig. 22).

19. Pull rotor from DE bearing (Fig. 22).

    If rotor checked good electrically (step 15), inspect slip rings. If rough or out of round, turn in lathe, removing only enough material to make rings smooth and round. Maximum indicator reading for roundness is 0.05 mm (.002"). Finish with 400 grain polishing cloth. Blow away all copper dust. Clean shaft of any grease that may have accumulated copper dust.

20. Remove three attaching screws and bearing retainer plate from DE frame (Fig. 22).

21. Inspect DE bearing. If bearing appears dry or if rotor did not turn smoothly when checked during alternator disassembly, replace DE bearing. Bearing is permanently lubricated. Do not attempt to add grease.

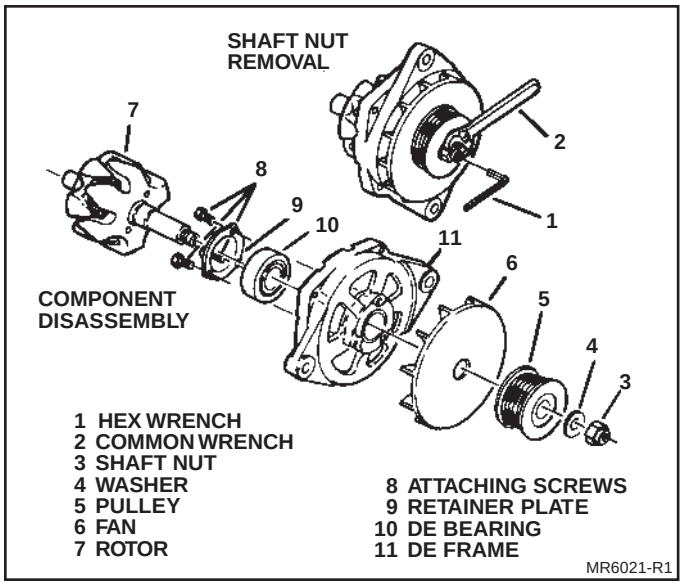


Figure 22. DE Frame and Components

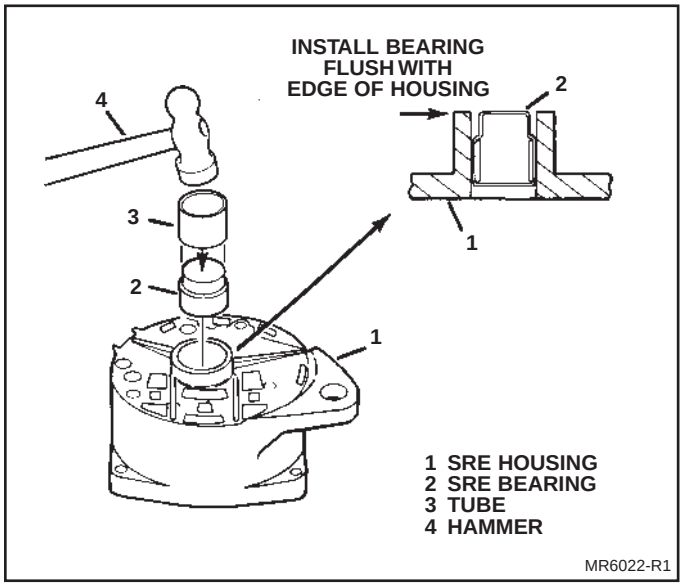


Figure 23. SRE Bearing Installation

ALTERNATOR ASSEMBLY

ASSEMBLY OF DE FRAME AND COMPONENTS

Install

1. DE bearing and bearing retainer plate to DE frame. Install 3 attaching screws (Fig. 22).

   Tighten

   Retainer plate attaching screws to 3.0 N.m (26 lb. in.).

2. Rotor shaft into DE bearing (Fig. 22).

3. Fan, pulley, shaft nut washer, and shaft nut onto rotor shaft (Fig. 22). Hold shaft with 5/16" hex wrench in end or wrap rotor in shop cloth and tighten in vice just enough to hold while tightening shaft nut.

   Tighten

   Shaft nut to 100 N.m (75 lb. ft.).

ASSEMBLY OF SRE HOUSING AND COMPONENTS

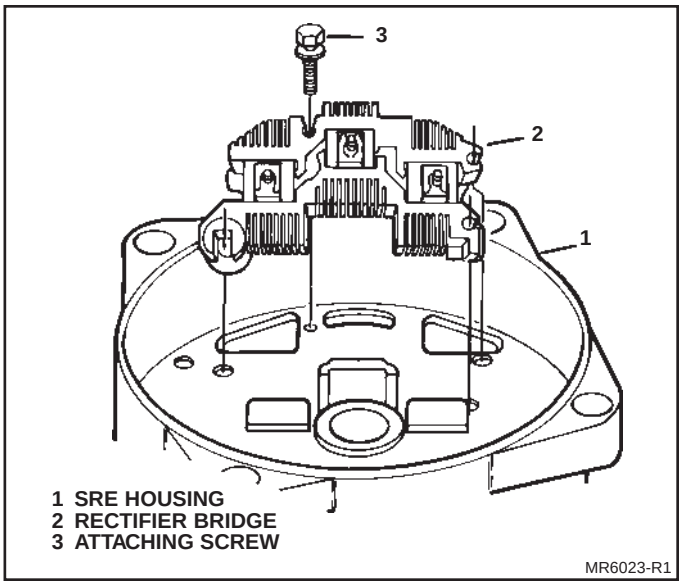


Figure 24. Installing Rectifier Bridge

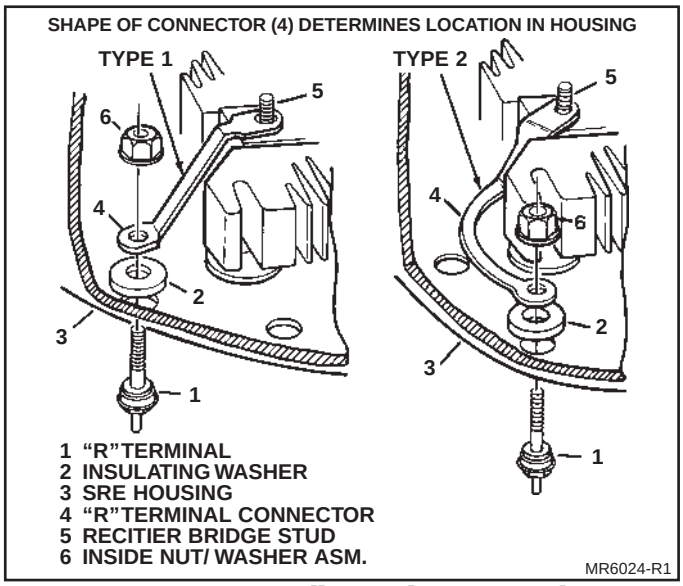


Figure 25. Installing Relay Terminal

Install or Connect

4. SRE bearing into SRE housing (Fig. 23). Use thin-wall socket or tube slightly smaller than hole in SRE housing to drive bearing in from outside. Position bearing flush with outside lip of SRE housing. Cover opening in bearing with piece of tape to prevent dirt from entering during rest of procedure.

Install or Connect

5. Rectifier bridge assemble to SRE housing. Install one rectifier bridge attaching screw/washer assembly through grounded heat sink into SRE housing (Fig. 24). Finger tighten.

   Relay "R" terminal (if used) to SRE housing and hold in place (see Fig. 25). Place inside insulating washer over "R" terminal stud. Place relay terminal connector over stud on rectifier bridge and "R" terminal stud. Be sure inside insulating washer is between connector and SRE housing at terminal end. Connector must not touch SRE housing. Also be sure outside insulator is properly centered in hole so terminal stud cannot touch SRE housing. Install inside nut/washer assembly onto "R" terminal stud.

Tighten

Inside nut/washer assembly to 2.5 N.m (22 lb. in.)

6. Output (BAT) terminal to SRE housing, being sure to seat square insulator flange in hole, then inside output terminal nut/washer assembly onto terminal stud (Fig. 26). Finger tighten.

7. Capacitor to holes in end of rectifier bridge assembly (Fig 26). Install rectifier bridge attaching screw/washer assembly through capacitor connector, grounded heat sink, and into SRE housing (finger tighten).

8. Insulated capacitor attaching screw, through capacitor connector, insulated heat sink and into SRE housing (finger tighten).

Inspect

9. Regulator mounting area for presence of grease or dirt (Fig. 27). Good electrical contact is necessary in this area.

Clean

NOTICE: Do not immerse or wet regulator with solvent. Internal damage to regulator could result.

Regulator mounting bosses in SRE housing, metal base plate and contact rings on regulator by wiping with clean, dry cloth.

Install of Connect

10. Regulator to SRE housing (Fig. 27), with regulator attaching screw (grounding). Finger tighten.

11. If placing individual brushes, proceed to step 12. If installing complete brush holder assembly, skip to step 13.

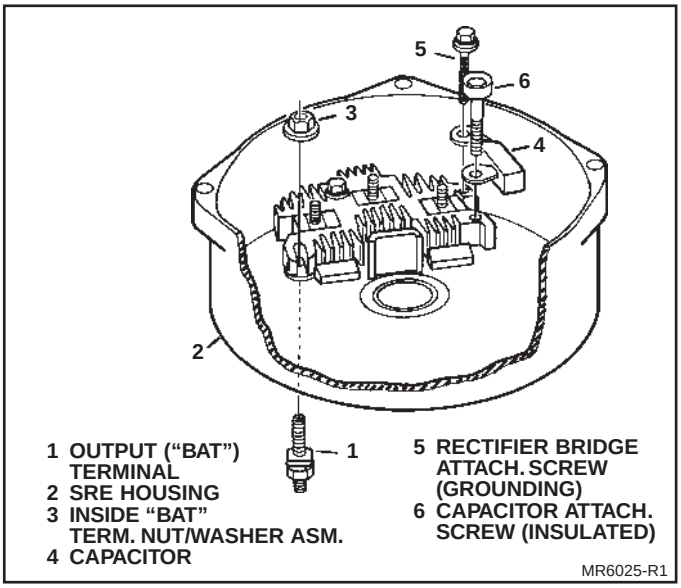


Figure 26. Installing BAT Terminal and Capacitor

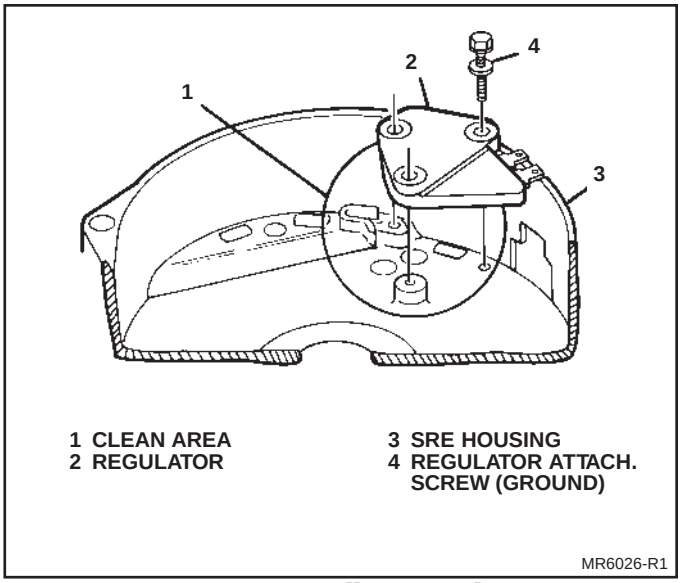


Figure 27. Installing Regulator

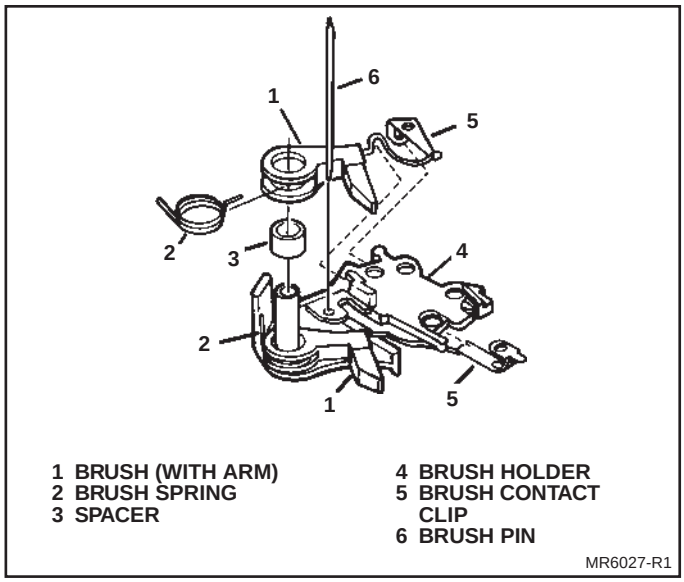


Figure 28. Assembly of Brush Holder

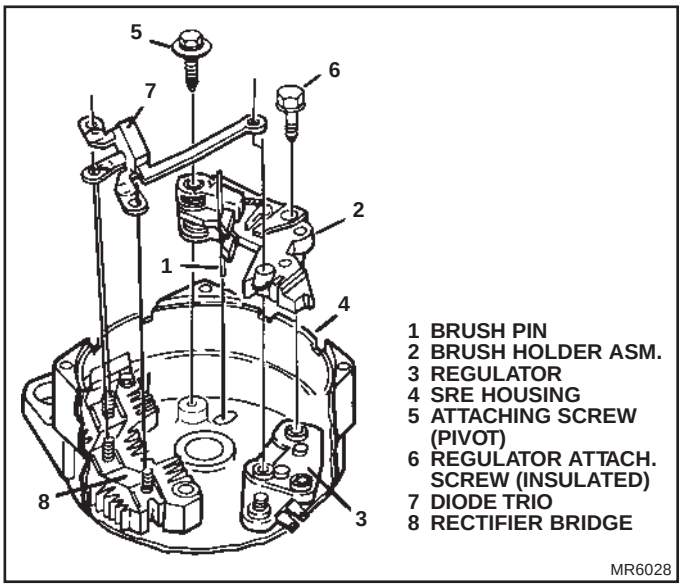


Figure 29. Installing Brush Holder and Diode Trio

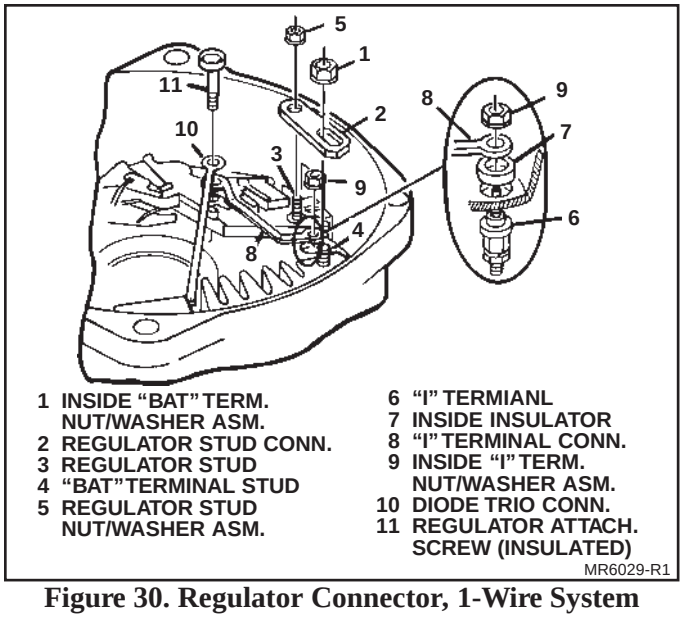


Figure 30. Regulator Connector, 1-Wire System

12. Brush assemblies (with springs) and spacer to brush holder (Fig. 28). Brushes are identical, but leads and contact clips are positioned differently. Pin brushes in retracted position.

Install or Connect

13. With brushes pinned in retracted position (Fig. 29), brush holder assembly to mounting holes in regulator and SRE housing. Install brush holder attaching (pivot) screw and one insulated regulator attaching screw (finger tighten both screws).

14. Diode trio onto 3 threaded studs on rectifier bridge assembly (Fig. 29). Position long connector strap on diode trio over closest mounting hole in brush holder and regulator.

For 3-wire systems, skip to step 18.

15. For one-wire systems (Fig. 30), hold outside output terminal and temporarily remove inside output terminal nut. Install regulator stud connector to threaded stud and to inside output terminal stud. Reinstall output terminal nut/washer and install regulator nut/washer assembly to threaded stud on regulator (finger tighten).

16. "I" terminal (if used) with outside insulator to SRE housing and hold in place (Fig. 31). Inside insulator, then regulator/indicator light connector over "I" terminal stud inside SRE housing. Position other end of connector over mounting hole in brush holder. Inside "I" terminal nut/washer assembly onto terminal stud (finger tighten).

17. Second insulated regulator attaching screw to mounting hole in brush holder, passing through diode trio connector and "I" terminal connector, if used (Fig. 30). Finger tighten.

For 1-wire systems, skip to step 20.

18. For some 3-wire systems (Fig. 31), regulator stud connector onto threaded stud on regulator, positioning other end over brush holder mounting hole. Regulator nut to threaded stud on regulator (finger tighten).

    NOTE: Later regulator designs do not have a threaded stud and the connector is not used. The earlier and later designs are interchangeable. If replacing regulator having stud by new regulator without stud, omit connector and nut; if replacing regulator that does have stud by regulator having stud, add connector and nut.

19. Second insulated regulator attaching screw to mounting hole in brush holder, passing through diode trio connector and regulator stud connector. Finger tighten.

20. Secure SRE component fastener in following order (Fig. 32):

Tighten

(1) Inside output terminal nut to 5.5 N.m (50 lb. in.).

(2) Rectifier bridge attaching screws (2 places) to 3.0 N.m (25 lb. in.).

(3) Insulated capacitor attaching screw to 2.5 N.m (22 lb.in.).

(4) "R" and/or "I" terminal (2 places, if used inside nuts to 2.5 N.m (22 lb. in.). It may be necessary to hold terminal on outside while tightening.

(5) Regulator mounting screw (grounding) to 2.0 N.m (20 lb. in.).

(6) Insulated regulator attaching screws (2 places to 2.0 N.m (20 lb. in.).

(7) Regulator nut (if used) to 2.5 N.m (22 lb. in.).

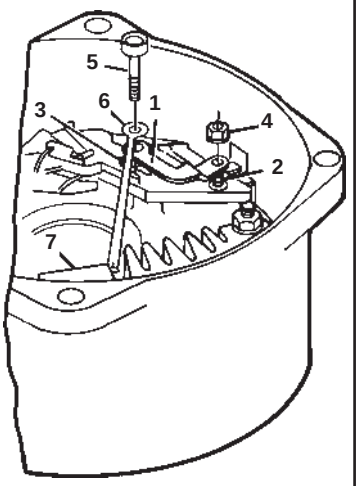
(8) Brush holder attaching screw (pivot) to 2.0 N.m (20 lb. in.).

Install or Connect

21. Debris shield mounting stud (if used) with inside washer to "I" terminal hole in SRE housing. Outside washer, lockwasher, and nut to mounting stud on outside. Tighten nut to 5.5 N.m (50 lb. in.).

22. Stator to SRE housing assembly, placing 3 phase leads over 3 threaded studs on rectifier bridge (Fig. 33). Be sure stator is seated in register around edge of SRE housing.

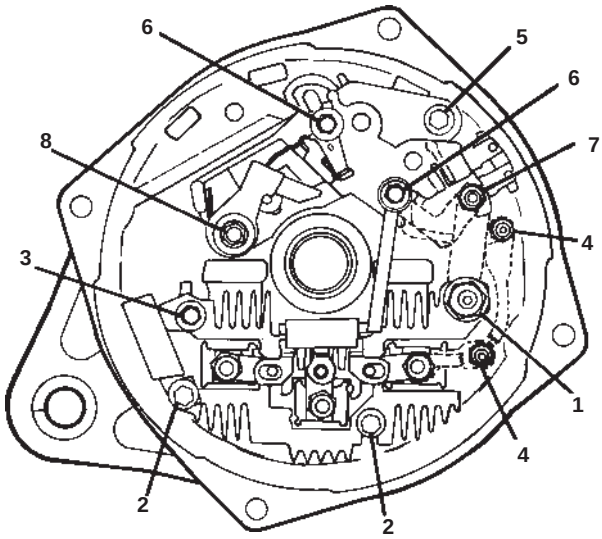
23. Rectifier bridge nuts to 3 threaded studs on rectifier bridge (Fig. 33).



1 REGULATOR STUD CONNECTOR (IF USED)
2 THREADED STUD (IF PRESENT)
3 MOUNTING HOLE
4 NUT/WASHER ASM. (IF USED)
5 REGULATOR ATTACH. SCREW (INSULATED)
6 DIODE TRIO CONN.
7 DIODE TRIO

MR6030-R1

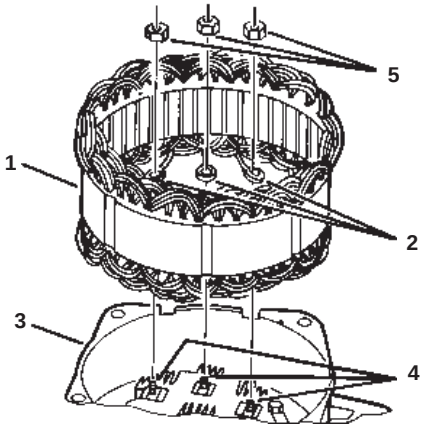
Figure 31. Regulator Connector, 3-Wire System



SEE STEP 20 FOR TORQUES

MR6031-R1

Figure 32. Fastener Tightening Order



1 STATOR
2 PHASE LEADS
3 SRE HOUSING ASSEMBLY
4 THREADED STUDS ON RECTIFIER BRIDGE
5 RECTIFIER BRIDGE NUTS

MR6032-R1

Figure 33. Installing Stator

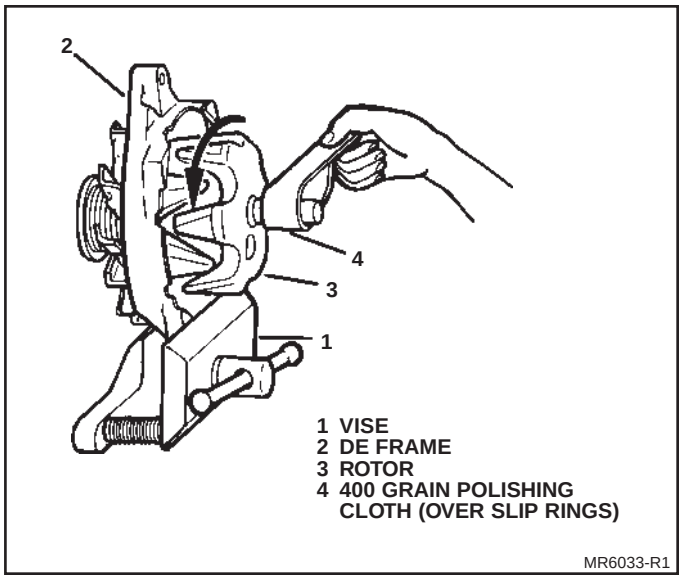


Figure 34. Cleaning Slip Rings

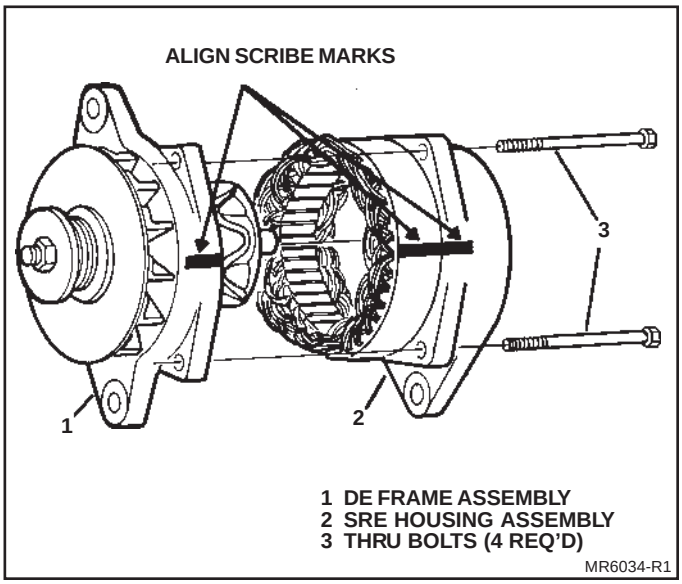


Figure 35. Final Unit Assembly

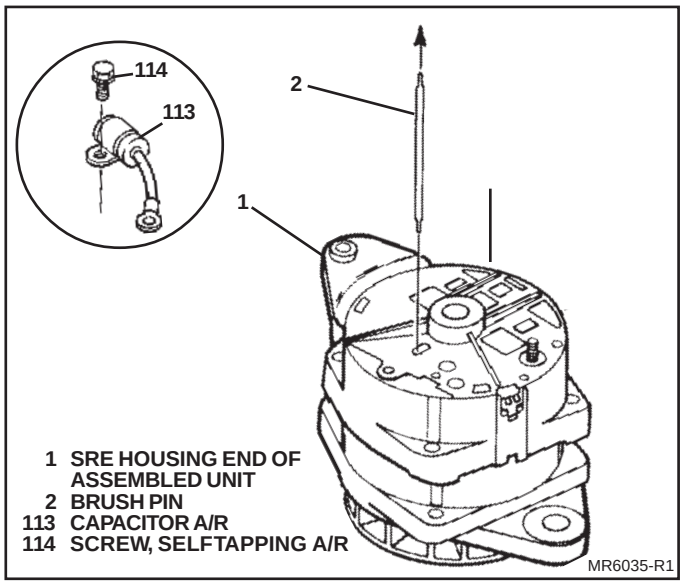


Figure 36. Removal of Brush Pin

Tighten

Rectifier bridge nuts (3 places) to 2.5 N.m (22 lb. in.).

FINAL UNIT ASSEMBLY

Clean

24. Slip rings on rotor shaft (if not previously cleaned) by spinning rotor while holding 400 grain polishing cloth around slip rings (Fig. 34). Blow away all copper dust.

25. Rotor shaft where it will slip into SRE bearing by wiping with soft cloth. Shaft must be free of dirt and other foreign material.

26. Brushes by wiping with clean soft cloth. Contact surfaces of brushes must be free of grease and other contaminants. Be sure brushes are pinned in retracted position and that pin extends through SRE housing for removal after unit assembly. Remove protective tape from opening in SRE bearing

27. As required, Capacitor with self tapping screw securely into available hole in SRE housing.

Install or Connect

27. DE frame assembly to SRE frame assembly, aligning marks made earlier on SRE housing and DE frame (Fig. 35). If mark was lost due to part replacement, use mark on old part or match mounting lugs to application to determine proper frame orientation.

28. Thru bolts (4 places).

Tighten

Thru bolts to 5.5 N.m (50 lb. in.).

29. For one-wire systems only, regulator terminal cover to regulator terminals.

Remove or Disconnect

30. Remove brush pin to release brushes onto slip rings inside unit (Fig. 36).

ALTERNATOR BENCH TEST

TEST EQUIPMENT NEEDED:

- Alternator Test Stand (5000 rpm capability)
- Battery or Battery Set (fully charged)
- Variable Carbon Pile Load Test
- Ammeter (current capability at least 15 amps higher than alternator rating)
- Voltmeter
- Ohmmeter

This bench test procedure is used to verify that the alternator is functioning properly prior to installation on the vehicle. This test checks the alternator output in the same manner as the Rated Output Check covered earlier in this procedure. If bench test equipment is not available, install the alternator on the engine according to manufacturer's instructions and repeat the Rated Output Check to verify alternator operation. If bench test equipment is available, proceed as follows:

1. Mount alternator in suitable test stand, according to test stand manufacturer's instructions. Test stand must be capable of driving alternator at speeds up to 5000 rpm.

2. **IMPORTANT:** Battery or battery set must be fully charged for test results to be valid.

   NOTICE: When a 12-volt carbon pile load test is used to diagnose a 24-volt system, attach load test only to 12-volt potential in battery set. Attaching a 12-volt load test to a 24-volt potential will damage the load test.

   With carbon pile load turned off and with battery or battery set fully charged, make electrical connections as show in Fig. 37. Connect for one-wire or 3-wire type as applicable. Battery voltage and ground polarity must be same as system in which alternator is used. Check and record battery voltage before proceeding with test.

3. Turn on #1 terminal circuit switch (3-wire systems only). With carbon pile load "off" start test stand and slowly increase alternator speed to 5000 rpm. Observe voltmeter.

- If voltage does not increase but remains at or below previous reading (step 2), there is no alternator output. Skip to step 5.

- If voltage increases above 15 volts on 12-volt system (or above 31 volts on 24-volt system), voltage is uncontrolled. Recheck alternator for proper assembly. Assure that test tab in "D" hole is not grounded. If alternator has been assembled properly, replace regulator as described under Unit Repair and test field coil for shorts or grounds.

- If voltage is proper, proceed to next step.

4. With alternator running at about 5000 rpm, turn on carbon pile load and adjust to obtain maximum alternator output on ammeter without allowing voltage on voltmeter to fall below 13 volts (25 volts on a 24-volt system).

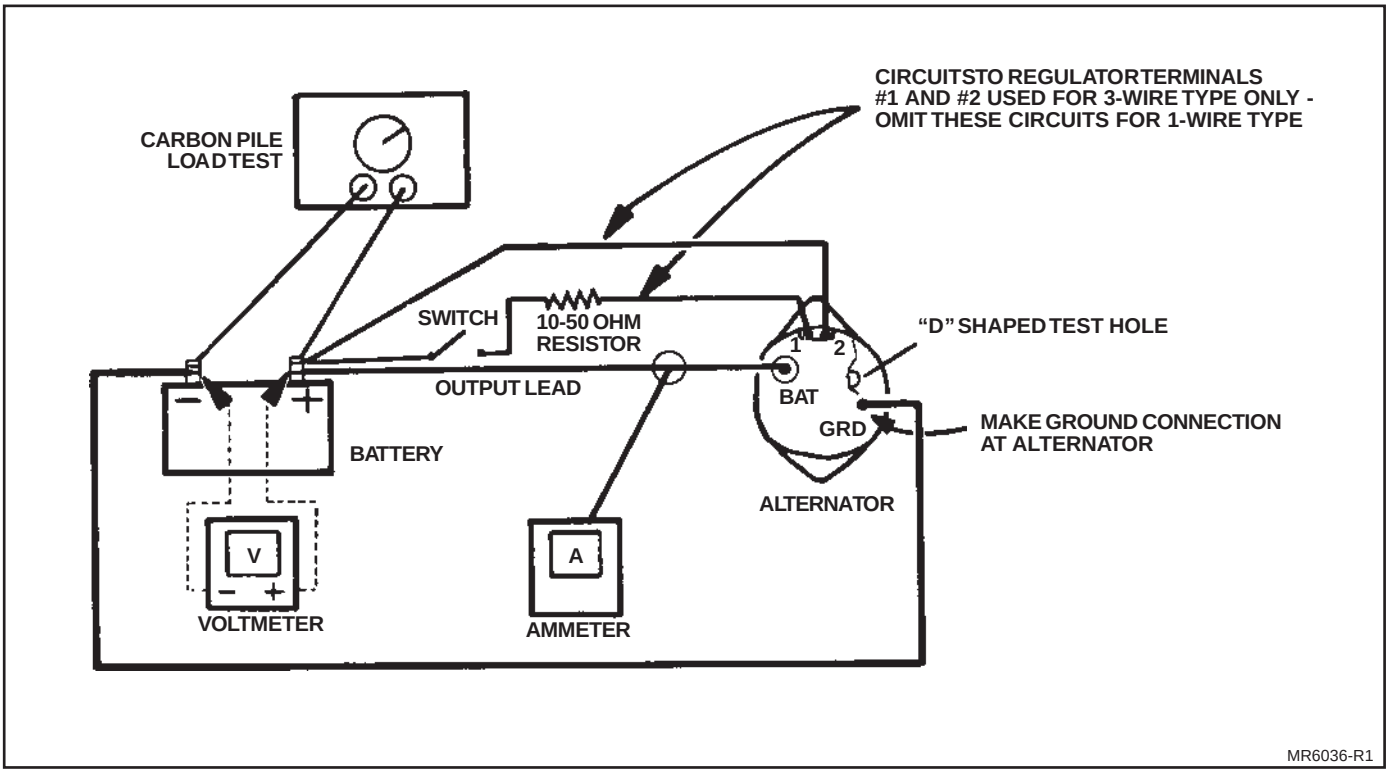


Figure 37. Alternator Bench Test

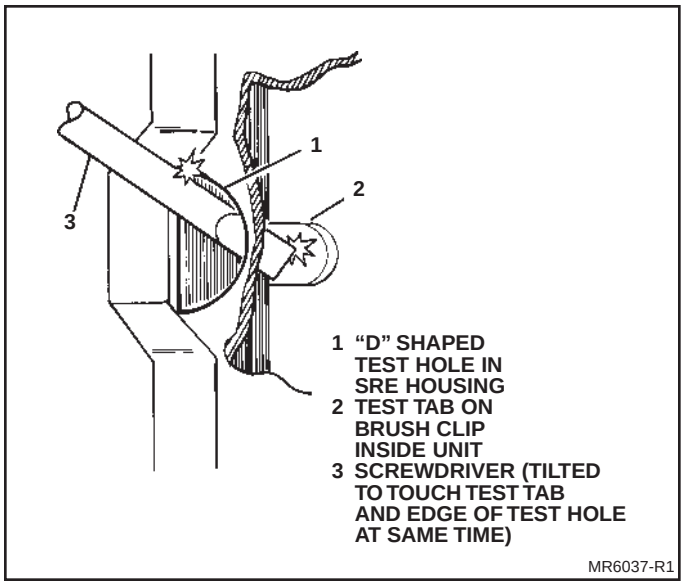


Figure 38. Using Test Hole

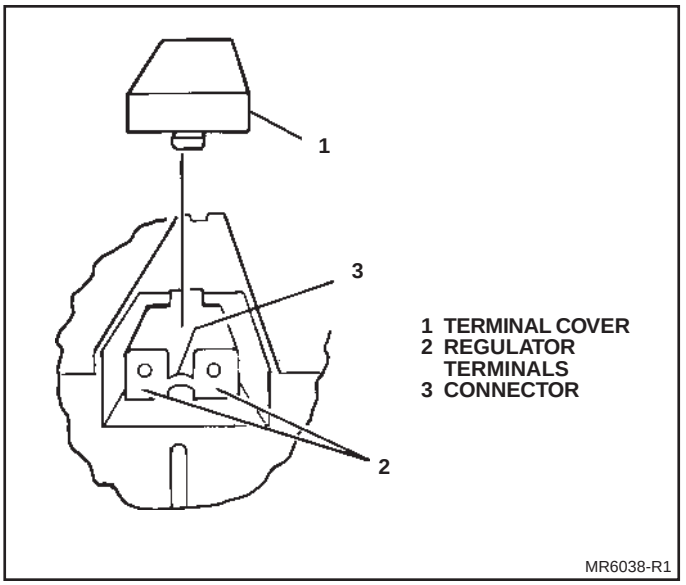


Figure 39. Checking 1-Wire Regulator Terminals

- If ammeter reading is within 15 amps of cold output shown under Specification, (page 22) alternator is good. Turn off carbon pile and stop test stand.

- If ammeter reading is more than 15 amps below specification, alternator is not operating properly. Proceed to step 5.

5. **NOTICE:** Do not insert screwdriver more than 3/4" into test hole during this step. The grounding tab on the brush holder assembly is reached at this distance. Inserting the screwdriver deeper may result in internal damage to the alternator.

   Test hole is provided in SRE housing to allow direct grounding of rotor field circuit (Fig. 38). Grounding the brush tab inside this hole bypasses the regulator and turns the alternator on in "full field" mode. If the alternator output is proper with the brush tab grounded, the previous low output is due to conditions within the regulator. Because the voltage is not regulated and can exceed 16 volts in full field mode, the test hole should be used only for bench test procedures.

   Insert screwdriver straight into test hole in SRE housing to make contact with tab on grounding brush. Tilt handle slightly to ground tab to housing at edge of test hole and hold. Again adjust carbon pile to obtain maximum output on ammeter without allowing voltage on voltmeter to fall below 13 volts on 12-volt system (25 volts on 24-volt system). Record reading then turn off carbon pile and stop test stand.

- If there is still no output, refer to Unit Repair and check rotor and brushes for an open circuit. Be sure that brushes are assembled properly and in contact with the slip rings. Check internal electrical connections to be sure grounding and insulated mounting screws are installed in the proper locations.

  For a one-wire system only, remove the regulator terminal cover and verify that there is a connector between the two regulator terminals (Fig. 39). If not, replace regulator as described under Unit Repair.

- If the output is now within 15 amps of the cold output specification (Page 22), but was not when checked per step 4, check the regulator mounting to assure that grounding and insulated mounting screws are installed in the proper location. If assembly is proper, replace regulator as described under Unit Repair.

- If there is some alternator output, but it is still more than 15 amps below the cold output specification, check the rotor field, brushes, stator, diode trio, and rectifier bridge as described under Unit Repair.

ALTERNATOR MOUNTING

CAUTION: Failure to disconnect negative cable at battery before removing or attaching alternator "BAT" terminal lead may result in an injury. If a tool is shorted at alternator "BAT" terminal, the tool can quickly heat enough to cause a skin burn.

NOTICE: Always reinstall fasteners at original location. If necessary to replace fasteners, use only correct part number or equivalent.

NOTICE: On some engine configurations a 1.5µf capacitor (DRA 1985444) must be installed to the alternator at installation.

- If correct part number is not available, use only equal size and strength.
- Fasteners that are NOT to be reused will be noted in procedure.
- Fasteners requiring thread locking compound will be noted in procedure.
- Use specified torque values when shown.

Using or replacing fasteners in any other manner could result in part or system damage.

Always follow engine manufacturer's instructions for mounting alternator on engine. The following procedure is typical and may not match all steps necessary for a particular application

TEST EQUIPMENT NEEDED:

- Belt Tension Gage

Remove or Disconnect

1. Negative cable at battery.

Adjust

2. SRE hinge bushing position so that the mounting lugs will fit over the bracket spool.

Install or Connect

3. Alternator double mounting lugs to mounting bracket on engine (Fig. 40). Adjust hinge bushing in mounting lug by tapping endways until it just clears the spool on the mounting bracket. Install flanged mounting bolt and flanged mounting bolt nut. If bolt and/or nut are not flanged, 1/8" thick hardened steel washers (part no. 1967343) must be substituted for flanges (Fig. 41).

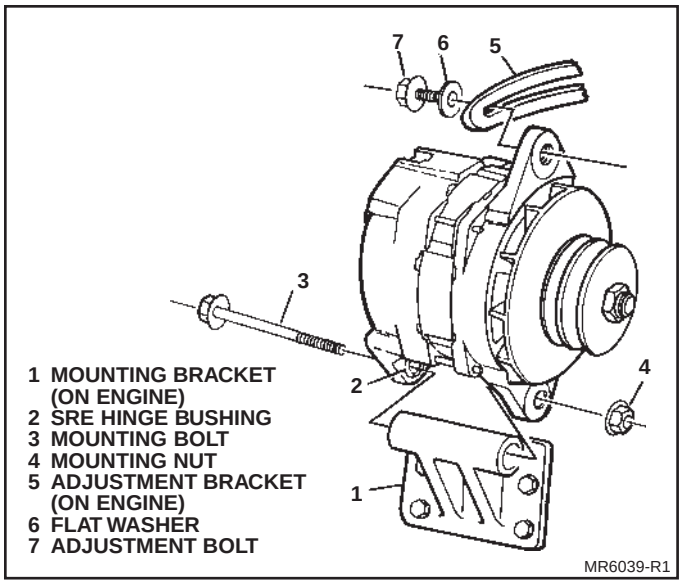


Figure 40. Installing Alternator on Engine

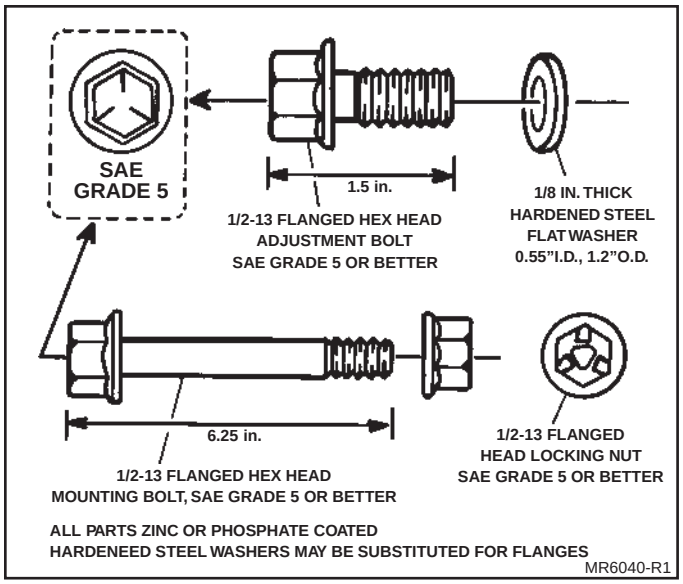


Figure 41. Alternator Mounting Bolts

4. Alternator adjustment lug to adjustment bracket on engine, with 1/8" thick hardener steel washer (part no. 1967343) and flanged adjustment bolt (Fig. 40). Finger tighten.

5. Alternator belt to pulley.

6. If engine uses automatic belt tensioner (idler), skip to step 7.

   NOTICE: Do not pry directly against stator or SRE housing to adjust belt tension. Force must be applied to DE frame as described. Prying only against stator or SRE housing may damage the alternator.

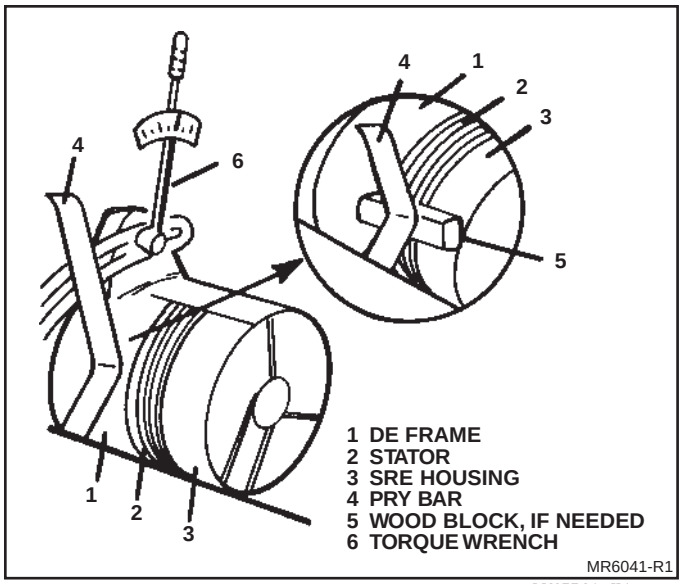


Figure 42. Adjusting Belt Tension

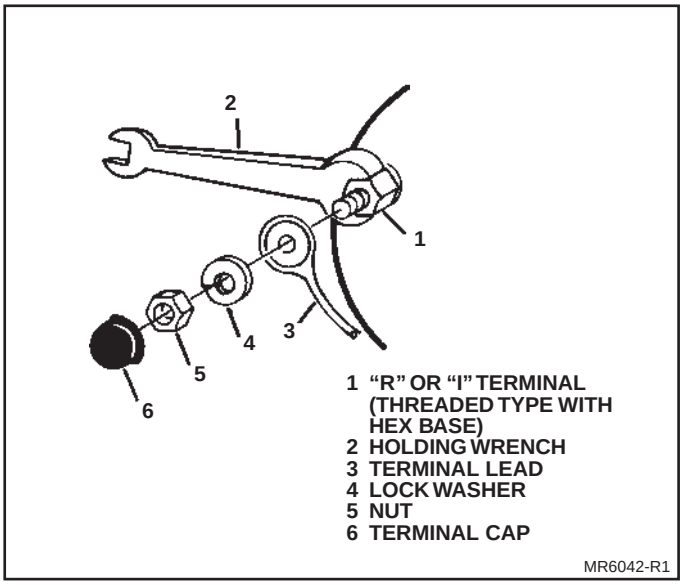


Figure 43. Threaded "I" and "R" Terminals

If belt tension is adjusted by forcing alternator against belt, use suitable pry bar positioned against DE frame of alternator (Fig. 42). If DE frame is not accessible, place wood block along side of alternator against both DE frame and SRE housing and pry against wood block.

Adjust

Using belt tension gage, adjust to engine manufacturer's specification and hold.

Tighten

7. Adjusting lug bolt to 88 N.m (64 lb. ft.).

8. Hex mounting bolt nut to 88 N.m (65 lb. ft.).

Measure

9. Belt tension to be sure specification is maintained. If not, repeat tensioning procedure.

Install or Connect

10. "I" and/or "R" (or "Relay") terminal connectors, if used. For threaded terminals with a hex base, hold hex portion of terminal as anti-turn while tightening nut (Fig. 43).

Tighten

M4 "I" and "R" (or "Relay") terminal nuts to 2.0 N.m (20 lb. in.).

10-24 "I" and "R" (or Relay) terminals nuts to 2.0 N.m (20 lb. in.).

11. Terminal caps to "I" and "R" (or "Relay") terminals as necessary.

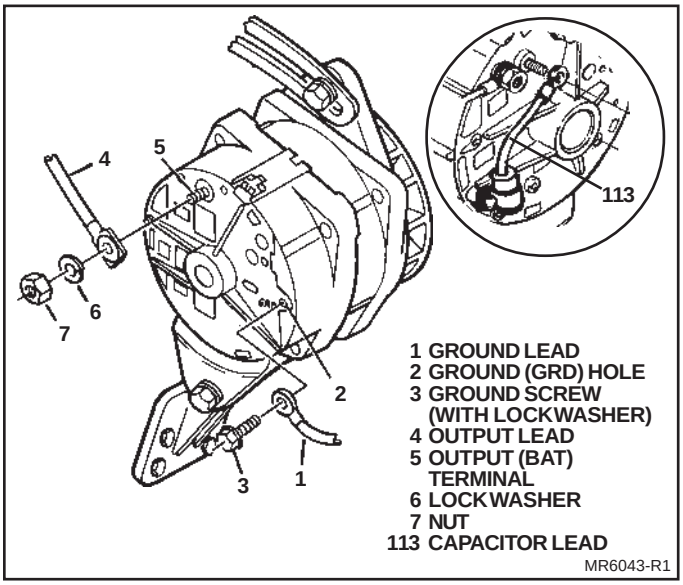


Figure 44. Installing Ground and Output Leads

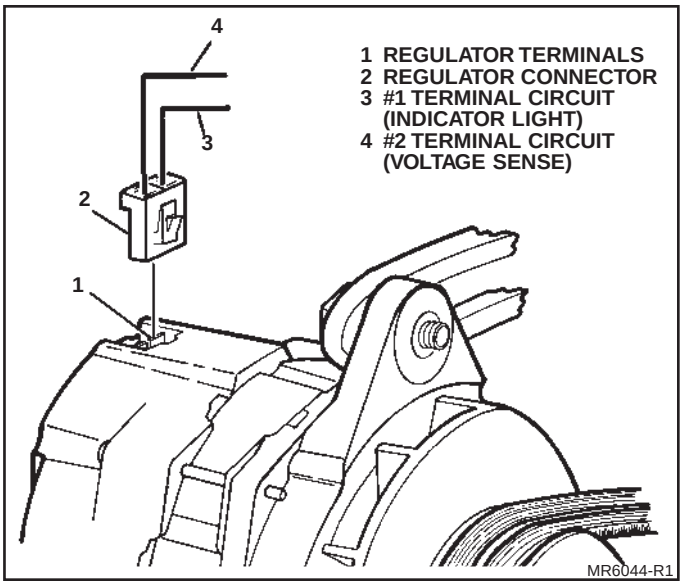


Figure 45. Regulator Connector (3-Wire Systems)

12. Ground lead to "GRD" hole in SRE housing, with ground screw/lockwasher assembly (Fig. 44).

Tighten

1/4" Ground screw to 6 N.m (55 lb. in.).

5/16" ground screw to 11 N.m (100 lb. in.).

13. Output lead to "BAT" terminal, using lock washer and output terminal nut (Fig. 44).

Tighten

M6 output terminal nut to 11 N.m (100 lb. in.).

1/4" output terminal nut to 7 N.m (65 lb. in.).

5/16" output terminal nut to 11 N.m (100 lb.in.).

14. For 3-wire systems only, regulator connector to regulator terminals (Fig. 45).

15. Negative cable at battery.

21-SI ALTERNATOR SPECIFICATIONS

The typical 21-SI Alternator rotor field check at 12 volts is 6.7 - 7.1 current amps and 1.7 - 1.8 ohms at 80° F. The rotor field check at 24 volts is 2.2 - 2.5 current amps and 9.5 - 10.7 ohms at 80° F.

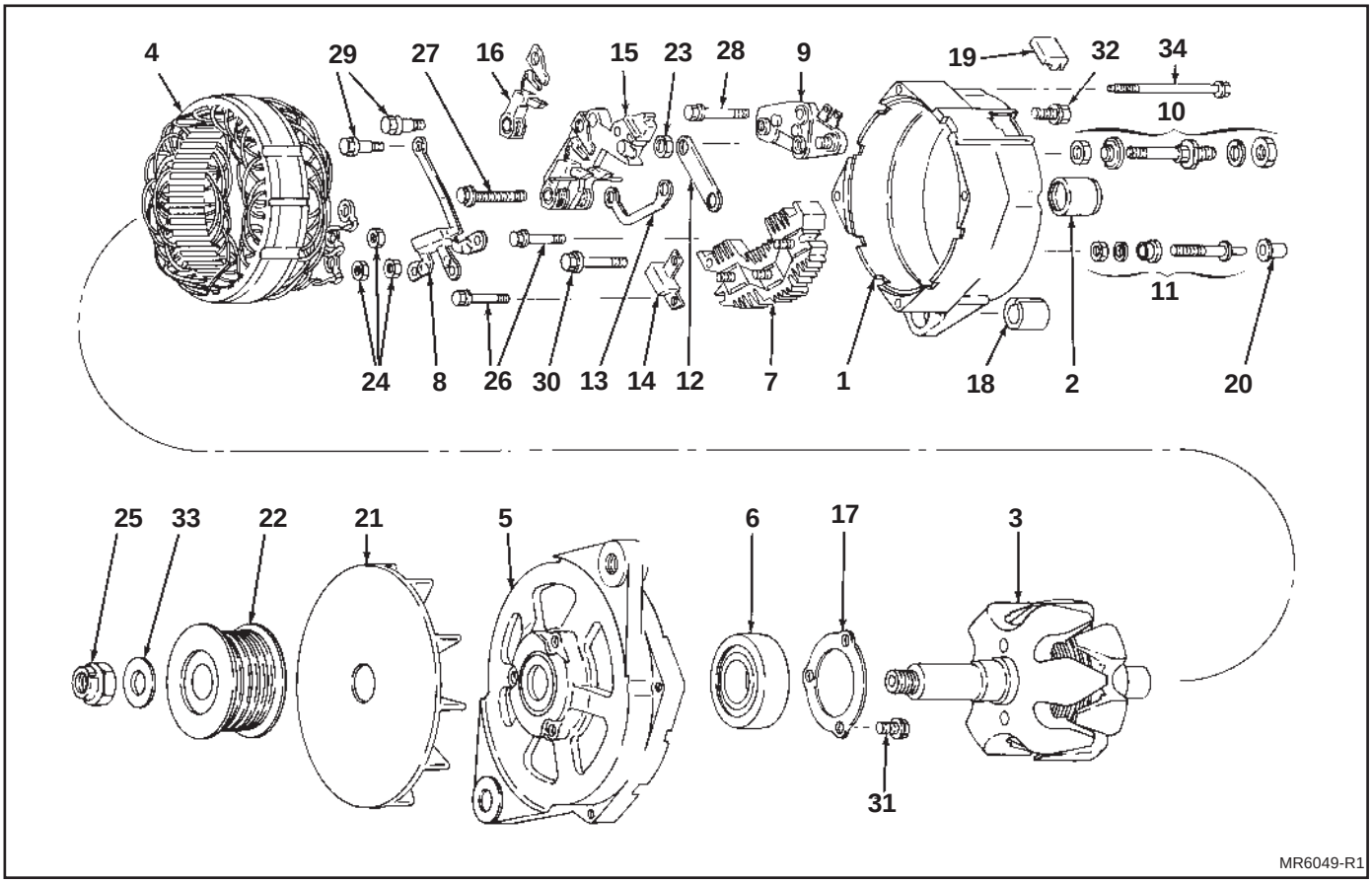
Cold current output at 80° F is shown in the following table.

Alternator Model	Amperes @ 80° F	
	1600 rpm	5000 rpm
12V/65A	45	65
12V/90A	48	90
12V/100A	60	100
12V115A	55	115
12V/125A	50	125
12V/130A	50	130
12V/145A	40	145
12V/160A*	45	150
24V/50A	25	50
24V/70A	15	70

*Rated at 160A @ 8300 rpm.

For further information on rotations and exact specification number on these or other Delco Remy America Products Call: 1-800-DRA-0222

SERVICE PARTS



Illus. No.	Name
1.	Housing, SRE
2.	Bearing, SRE
3.	Rotor Assembly
4.	Stator Assembly
5.	Frame, DE
6.	Bearing, DE
7.	Rectifier Bridge Assembly
8.	Diode Trio
9.	Regulator
10.	Terminal Package, Output
11.	Terminal Package, Relay or “I”
12.	Connector, Regulator Stud
13.	Connector, Relay Terminal
14.	Capacitor
15.	Brush Holder Assembly
16.	Brush and Arm
17.	Retainer Plate, DE
18.	Bushing, SRE Hinge
19.	Cover, Regulator Terminal
20.	Cap, Relay Terminal
21.	Fan
22.	Pulley
23.	Nut, Regulator
24.	Nut, Rectifier Bridge
25.	Nut. Shaft
26.	Screw (& Lockwasher), Rectifier Bridge Attaching
27.	Screw, Brush Holder Attachment (pivot)
28.	Screw, Regulator Attachment (ground)
29.	Screw, Regulator Attachment (insulated)
30.	Screw, Capacitior Attachment
31.	Screw, Bearing Retainer Plate Attachment
32.	Screw (& Lockwasher), SRE Frame Ground
33.	Washer, Shaft Nut
34.	Bolt, Thru

Miscellaneous:
Nut, Debris Shield Mounting Stud
Washer, Debris Shield Mounting Stud (inside)
Washer, Debris Shield Mounting Stud (outside)
Lockwasher, Debris Shield Mounting Stud
Stud, Debris Shield Mounting
Connector, Regulator to “I” Terminal

Delco Remy International, Inc.
2902 Enterprise Drive
Anderson, IN 46013

For further information and specifications on these and other Delco Remy Products call: 1-800-DRA-0222