

MC-9 MAINTENANCE MANUAL**SECTION 7**
ELECTRICAL SYSTEM

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DESCRIPTION

The coach uses a 24 volt electrical system. A self-rectified alternator is gear driven from the engine and can be reached through the left side rear engine compartment door.

Wiring diagrams for the electrical system are included at the end of this section.

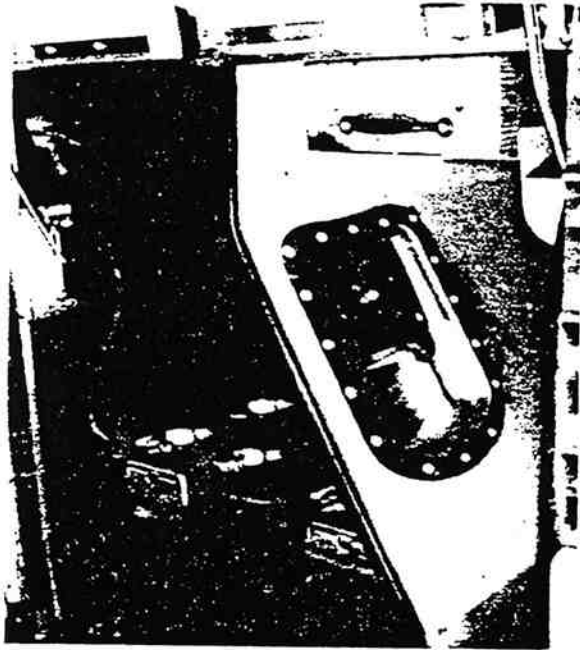


Figure 7-1. Battery Disconnect.

BATTERY DISCONNECT

A main battery disconnect switch is provided to shut off all electrical supply from the batteries. The switch is mounted on a vertical panel above the batteries and can be reached by opening the battery compartment door. To disconnect the batteries, pull knob down to OFF position. See figure 7-1.

TESTING CIRCUITS

A careful study of the wiring diagrams should be made to determine the source and flow of current through each electrical circuit. When a circuit is thoroughly understood, a point-to-point check can be made with the aid of the applicable wiring diagrams. Any circuit may be tested for continuity or shorts with a suitable volt-ohm meter.

All electrical connections must be kept clean and tight. Loose or corroded connections will cause discharged battery, difficult starting, dim lights, and improper functioning of other electrical equipment. Inspect all wiring connections at regular intervals. Make sure knurled nuts on all amphenol plugs are securely tightened.

CIRCUIT BREAKERS

All electrical circuits are protected by circuit breakers. The main circuit breaker and the two circuit breakers protecting the air conditioning system blower motors are located at the front of

the baggage compartment and can be reached through the left front baggage door. See figure 7-2.

The main circuit breaker (105 amp) is an automatic reset type. The condenser motor (105 amp) must be manually reset.

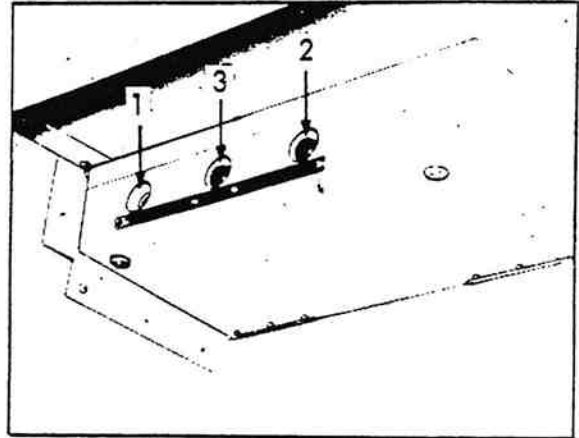


Figure 7-2. A/C Circuit Breaker in Left Front Baggage Compartment.

1. Automatic Reset Circuit Breaker (105 Amp.)
2. Manual Reset Condenser Motor Circuit Breaker (105 Amp.)
3. Manual Reset Evaporator Motor Circuit Breaker (80 Amp.)

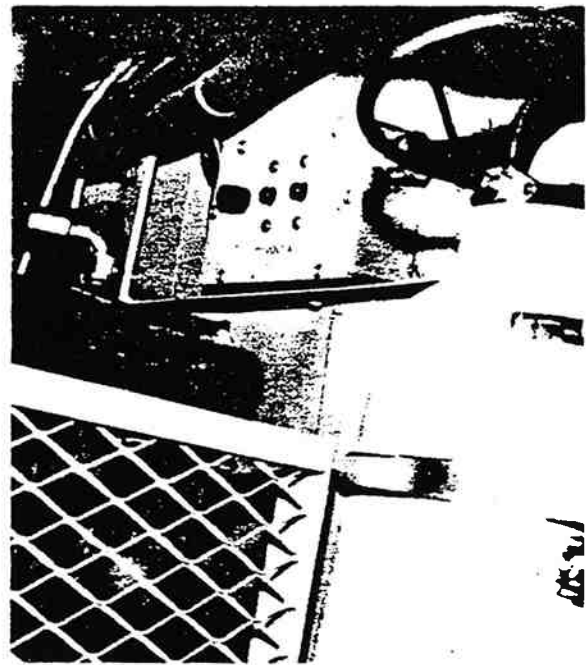


Figure 7-3. 110V In-Station Lighting Circuit Breaker Box in Left Front Service Compartment.

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The evaporator motor circuit breaker is 80 amp. The evaporator motor circuit breaker is also a manual reset type.

Smaller circuit breakers of the self-resetting type are located in an external junction panel at the left hand front below driver's window and in a panel at the left hand rear engine compartment wall. When one of these circuit breakers opens due to a shorted circuit, it will automatically reset itself when the breaker element cools. As long as the short exists, the breaker will continue to open and close intermittently. In this case, turn the defective circuit off until the cause can be located and corrected.

The circuit breaker box for optional in-station lighting is mounted to the rear wall of the left hand front service compartment. See figure 7-3.

RELAYS

Relays are used to automatically energize or de-energize a circuit from a remote location. The relay draws a very low current to energize its coil. Once the coil is energized, it develops a magnetic field which will pull a switch arm closed or open to either energize or de-energize a given component. Because the control current required for the coil is very low, the relay allows a remote station (e.g. driver's switch panel) to control a high energy circuit without running great lengths of costly high capacity cable. With the use of a relay, the need for high amperage switches and heavy connectors is eliminated.

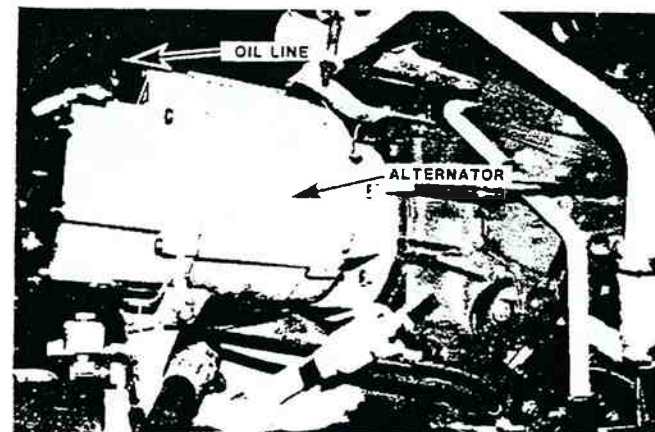


Figure 7-4. Alternator.

The MC-9 uses control relays for the Low and High Note Horns, Headlamps, Discharge and Blower cut-ins, Engine Stop, Stop Lights, Turn Lights, Reverse Solenoids, Starter Solenoid, Condenser and Evaporator Motor, Temp. & Level Sensors, Driver's Defroster, Step-Down Lamps at aisle, Alternator Field, and Heat Control Box.

NOTE: The relays should have the 5/16" stud nuts tightened to 50 ± 10 in. lbs. (5.6 ± Nm) torque.

GEAR DRIVEN ALTERNATOR — OIL COOLED

The gear driven, oil cooled alternator (figure 7-4) is a brushless, self-rectifying unit, in which all current carrying members, windings, diodes, and field coils are stationary. The only moving component is the rotor.

The oil-cooled alternator is a totally enclosed unit, cooled and lubricated by engine oil. The oil inlet is on the diode end cover, the oil drains back into the engine crankcase internally or through the drive end frame, drive adapter housing and the oil drain tube. The alternator should never be operated with the oil supply line disconnected. A continuous flow of engine oil flows through the alternator to lubricate the bearings and cool the assembly.

A relay or "R" terminal is tapped to energize a control relay in the electrical system.

CAUTION: The alternator is designed for use only on a negative ground system. If a positive ground battery is connected to the alternator, the alternator and wiring harness will be instantly destroyed. Always ensure that the alternator and batteries are negative ground. The alternator will not reverse to accept inverse polarity. Also, do not ground or short across any of the alternator or regulator terminals.

There are three components in the alternator which require electrical checks; the field winding, the six diodes, and the stator winding. See figure 7-5.

CAUTION: Before checking the alternator, turn off the battery disconnect switch.

FIELD WINDING — The field winding may be checked for shorts and opens with an ohmmeter. To check the field winding, connect the ohmmeter from the field terminal to ground. The normal resistance value is 3.0 to 3.3 ohms at 80°F (27°C.). A resistance reading above normal indicates an open, and a reading less than normal indicates a short.

An alternate method of checking is to place a battery of specified voltage, and an ammeter in series with the field winding. The current should register 7.2 to 8.3 amperes at 24 volts.

A defective field can be replaced by removing the end frame on which the field terminal is located and then removing the four field coil mounting screws. See the section entitled Disassembly for a detailed procedure.

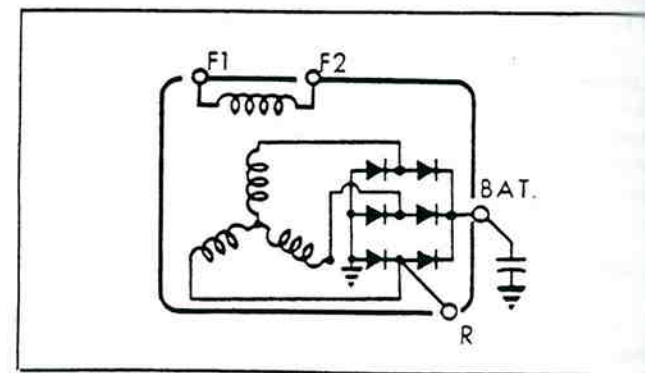


Figure 7-5. Alternator Wiring Diagram (Typical).

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CHECKING DIODES — Each diode may be checked for shorts and opens as follows:

1. Check to ensure the battery is disconnected.
2. Remove the pipe plug from underneath the end housing to drain the oil in the rectifier engine oil supply.
3. Remove the screws attaching the diode cover to the end housing.

CAUTION: Do not operate the alternator unless this unit is completely assembled.

4. Detach the DC terminals and relay terminal and disconnect the diode leads.

Each diode may be checked for shorts and opens with an ohmmeter as illustrated in figures 7-6, 7-7 and 7-8.

To check the diodes mounted in the diode supports for shorts, connect the ohmmeter positive lead to each diode lead and the ohmmeter negative lead to each support as shown in A, B and C (figure 7-6). To check the diodes mounted in the end frame for shorts, connect the ohmmeter positive lead to each diode lead and the ohmmeter negative lead to the end frame as shown in D, E and F. Ohmmeter readings may vary considerably when checking diodes for shorts, but if the reading is 300 ohms or less, the diode is likely defective and should be replaced. If the diode reads 300 ohms or less, it will allow excessive reverse current from the battery.

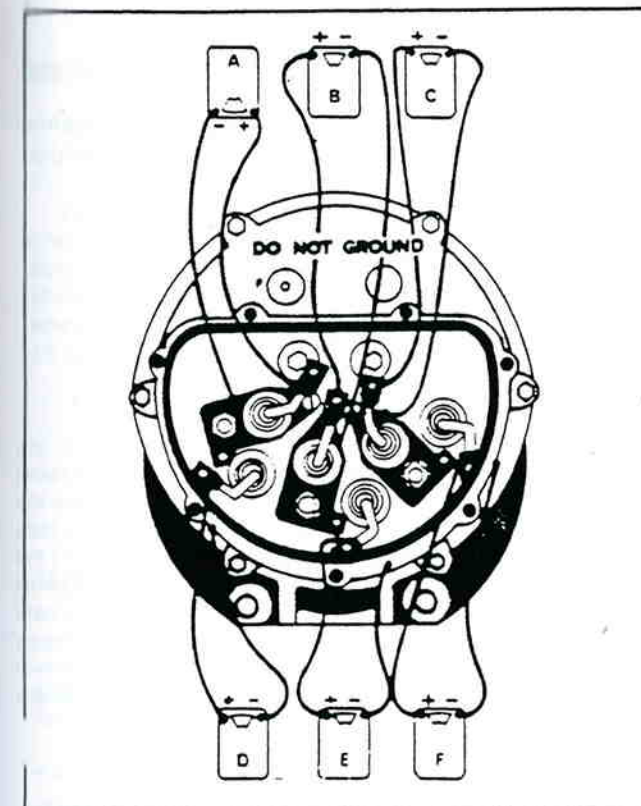


Figure 7-6. Checking Diodes for Opens Using Ohmmeter.

To check the diodes mounted in the diode supports for opens, connect the ohmmeter negative lead to each diode lead and the ohmmeter positive lead to each support as shown in A, B and C (figure 7-7). To check the diodes mounted in the end frame for shorts, connect the ohmmeter negative lead to each diode lead and the ohmmeter positive lead to the end frame as shown in D, E and F. An infinite resistance reading indicates an open diode.

Diodes can be replaced by following the procedure outlined in the section entitled Disassembly.

NOTE: When reinstalling diodes, tighten to 9-11 ft. lbs. (12-15 Nm) torque. Restake next to the threads in an arbor press with an 1/8" (3.2 mm) round punch. Press the punch with gradual pressure; do not strike as the shock may damage the diodes.

STATOR WINDING CHECKS — The stator windings may be checked for opens and shorts with an ohmmeter as follows (refer to figure 7-8):

OPENS: Connect the ohmmeter leads to two pairs of diode supports as shown in A and B (figure 7-8). The ohmmeter should show a low resistance. If a high or infinite resistance is measured in either one or both checks, the stator windings are open.

GROUNDS: To check for grounds, connect the ohmmeter as illustrated in C (figure 7-8). The ohmmeter should show a very high or infinite resistance. If zero or a very low resistance is measured, the windings are grounded.

The stator windings are difficult to check for shorts without finely calibrated laboratory test equipment due to the very low resistance values of the windings. However, if all other alternator checks are satisfactory, yet the unit fails to perform to specifications, shorted stator windings are likely.

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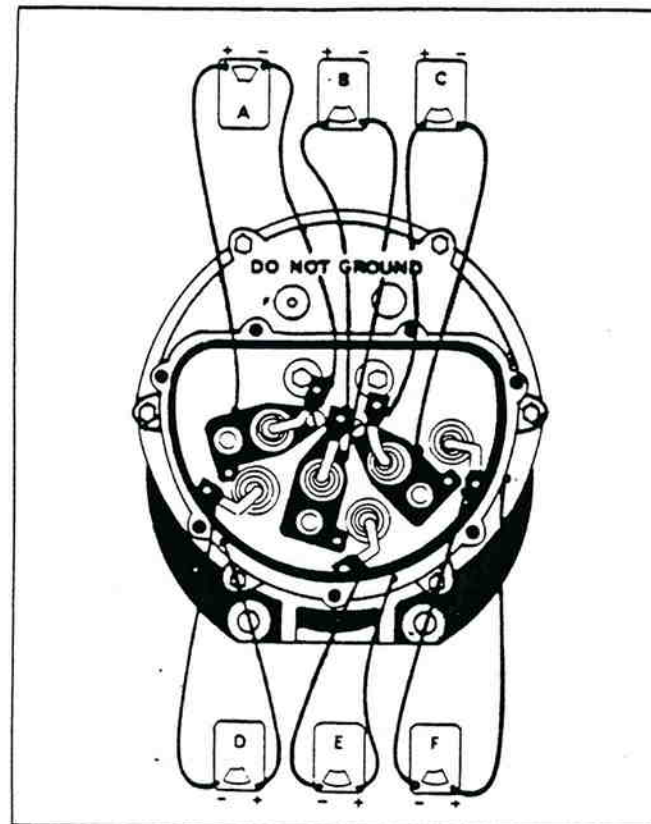


Figure 7-7. Checking Diodes for Shorts Using Ohmmeter.

DISASSEMBLY

The alternator may be disassembled by following the steps below; refer to figure 7-9:

1. Remove nuts and washers from DC terminal on diode end frame.
2. Separate the diode cover plate (3) from the diode end frame by removing mounting screws (1).
3. Remove the washer, nut and lock washer attaching the diode supports to the end frame, the three screws (5) connecting the diode leads to the diode supports, and the three nuts (4) which attach the stator studs to the diode supports.
4. Separate the diode support assemblies from the diode end frame, and the three nuts (6) which connect the studs to the diode end frame.
5. Mark the position of the drive end frame and diode frame with respect to the stator assembly so that the parts can be reassembled in the same position.
6. Detach the diode end frame and field assembly from the stator assembly by removing the attaching screws (13).
7. Separate the field assembly from the diode end frame by removing the four attaching screws (11).
8. Separate the rotor assembly and drive end frame from the stator assembly by removing the attaching screws (25).

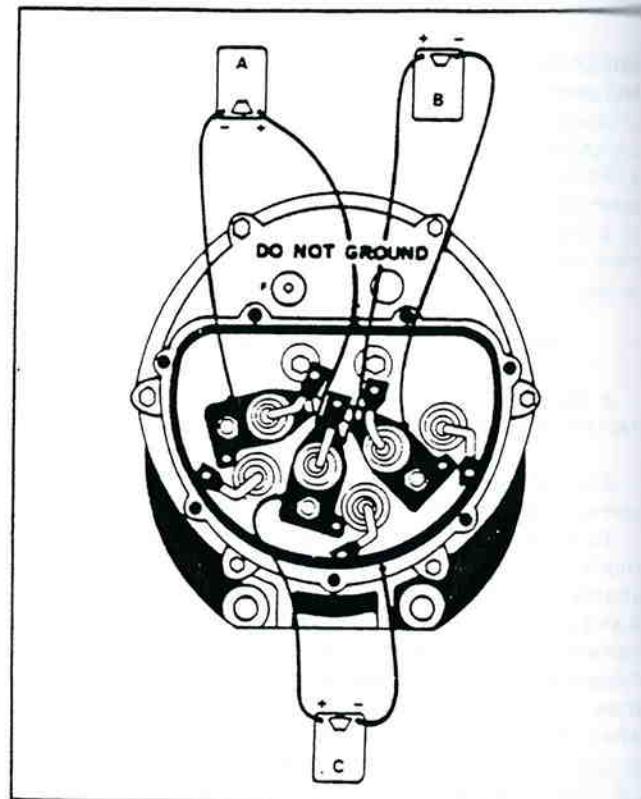


Figure 7-8. Checking Stator Windings for Opens and Grounds.

9. Remove the shaft nut and washer, and the pinion gear. Press the rotor shaft out of the drive end frame.
10. Remove the retainer plate (20) and pull the bearings from the drive end frame.

NOTE: When lightening the outside nut on the DC output terminal, torque the nut to 30-35 ft. lbs. (41-47 Nm). The lower nut should be held secure while tightening the top nut.

REASSEMBLY

Reassembly is the reverse of disassembly. When installing the single row bearing into the drive and frame, press against the outer race only to avoid loading the bearings. Attach the bearing retainer plate, and press against the bearing inner race to force the assembly over the shaft. To avoid pressure on the bronze ring in the rotor, support the inside of the rotor against the shaft, and place the shaft in an upright position to facilitate the assembly procedure. Press against the inner race to force the double row bearing over the shaft. When attaching the field to the diode end frame, make sure the mating surfaces are perfectly clean and tighten the mounting screw securely.

NOTE: When reinstalling diodes, tighten to 9-11 ft. lbs. (12-15 Nm) torque.

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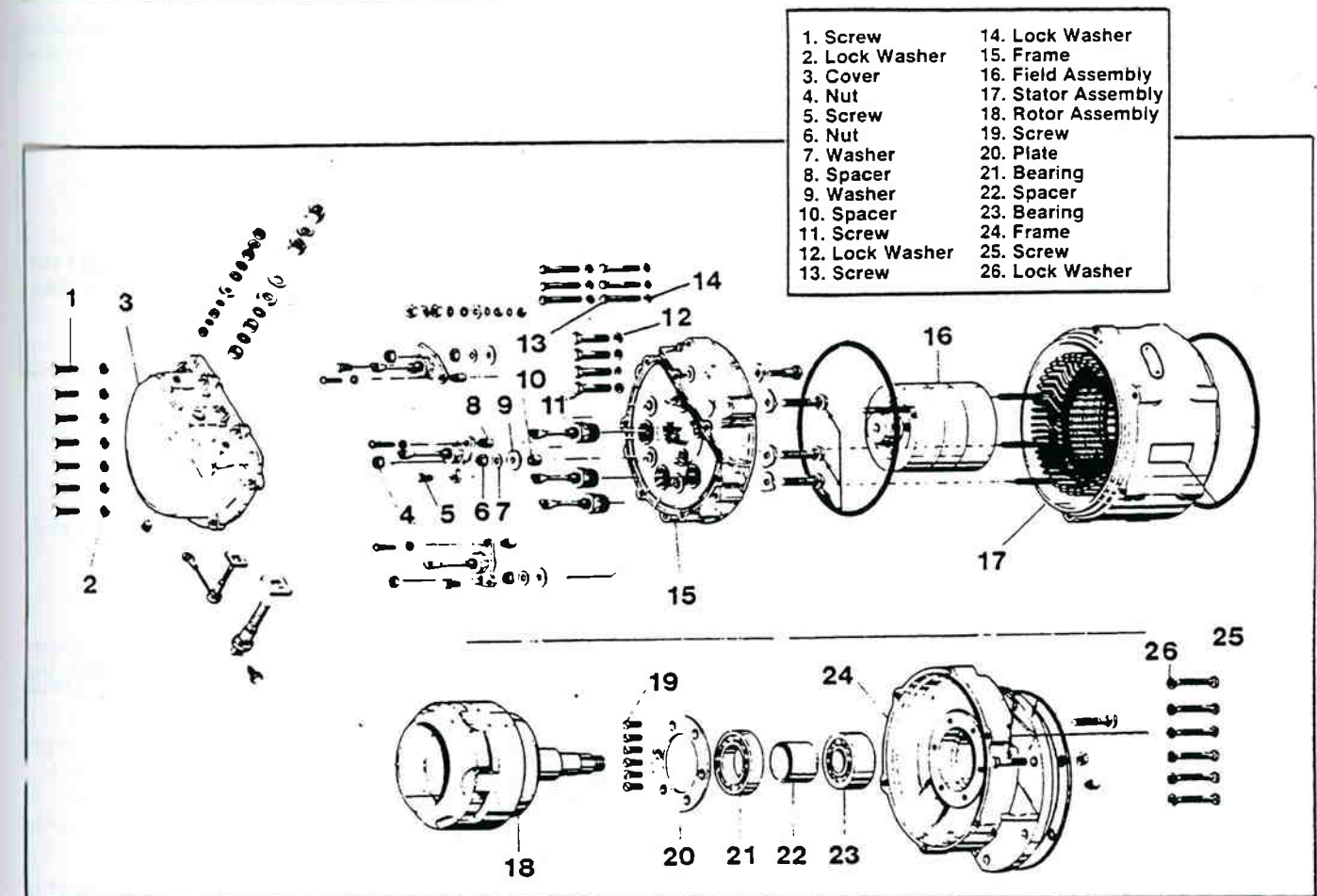


Figure 7-9. Alternator Components.

OUTPUT CHECK

When removed from the engine, the alternator may be checked on a test bench without circulating oil, providing the output is limited to 100 amperes or less. The alternator may be checked without circulating oil at outputs exceeding 100 amperes as long as the period of operation is limited to less than 15 seconds.

CAUTION: Operating the alternator at outputs greater than 100 amperes for periods exceeding 15 seconds will cause the alternator to overheat, resulting in damage to the winding and diodes.

REMOVING ALTERNATOR

1. Disconnect electrical wiring at the diode end frame.
2. Disconnect oil supply lines at the diode end frame. If alternator has an oil drain tube, disconnect it at the engine. Refer to figures 7-10 and 7-11.
3. Remove the nuts and washers from the studs mounting the alternator. Pull alternator straight off mounting studs. To remove the alternator drive gear housing (if so equipped), remove the five allen-head capscrews; if equipped with a "figure-8 adapter," it is removed by removing the four upper adapter mounting bolts.

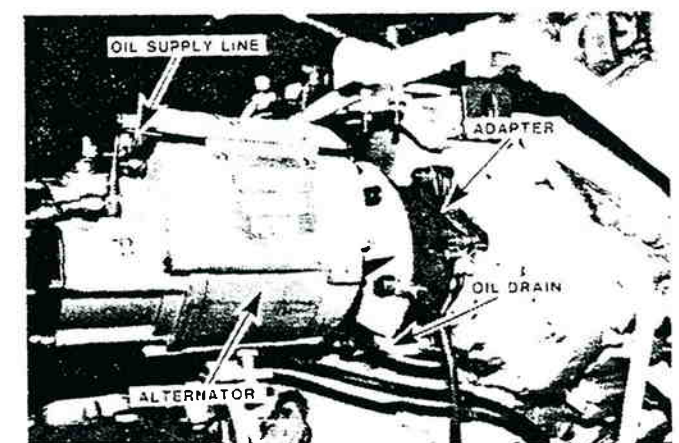


Figure 7-10. Alternator With Adapter.

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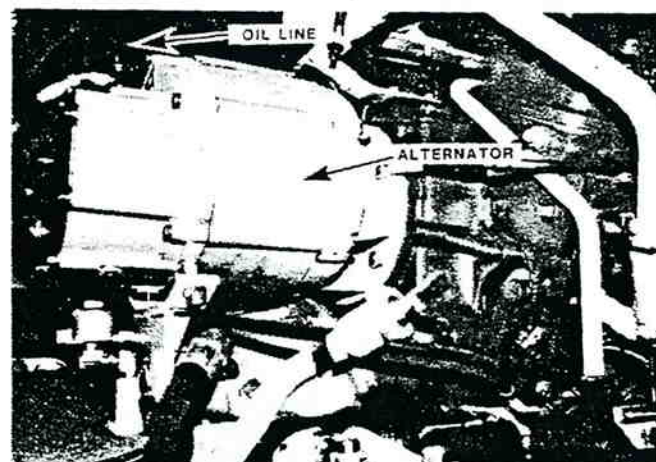
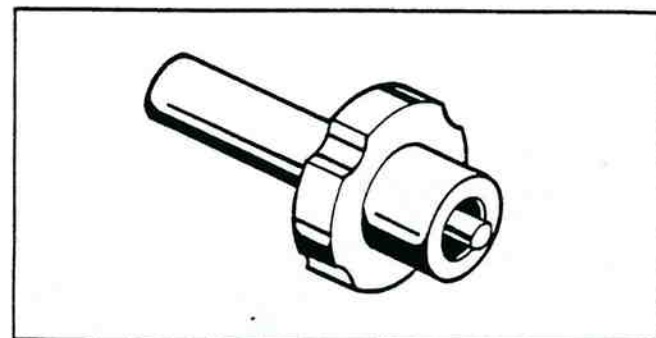


Figure 7-11. Alternator Without Adapter.

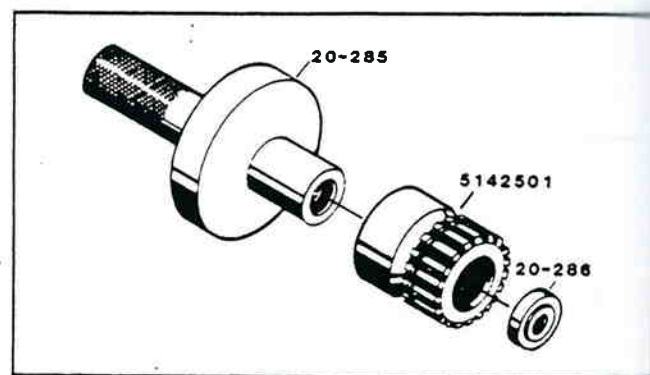
ALIGNMENT OF 21-TOOTH DRIVE PLATE
(NUT MOUNTED CAM GEAR)

1. Check the concentricity of drive plate by placing pin of tool 20-157 (figure 7-12) into pilot hole in camshaft. If shoulder of 20-157 will fit inside the teeth of the 21-tooth drive plate proceed to Alignment of Adapter Plate (1).

2. Mount drive plate loosely on camshaft gear (or loosen capscrews if plate is already mounted). Place tool 20-157 into center bore of camshaft to center the drive plate. See figure 7-12. Tighten capscrews to 40-45 lb. ft. (54-61 Nm) torque. Capscrews are accessed through notches in 20-157 alignment tool. Remove alignment tool.

Figure 7-12. Alignment Tool 20-157
(Nut-Mounted Cam Gear).ALIGNMENT OF 21-TOOTH DRIVE PLATE
(CAPSCREW MOUNT CAM GEAR)

1. Remove capscrew and washer that mount cam gear to camshaft. Install alignment washer (20-286), 5142501 coupling gear and capscrew inside 21-tooth drive plate. Refer to figure 7-13. Shoulder on washer fits inside bore of cam gear. Snug up capscrew tightly.

Figure 7-13. Alignment Tool
(Capscrew-Mounted Cam Gear).

ALIGNMENT OF ADAPTER PLATE (1)

NOTE: This procedure (1) is followed when the 21-tooth drive plate is mounted with a lock washer and nut. If a capscrew is used to mount the drive plate, go to the next procedure (2).

1. Mount the gasket and adapter plate on the flywheel housing loosely, using the five allen head capscrews. Loosen the screws if plate is already mounted.

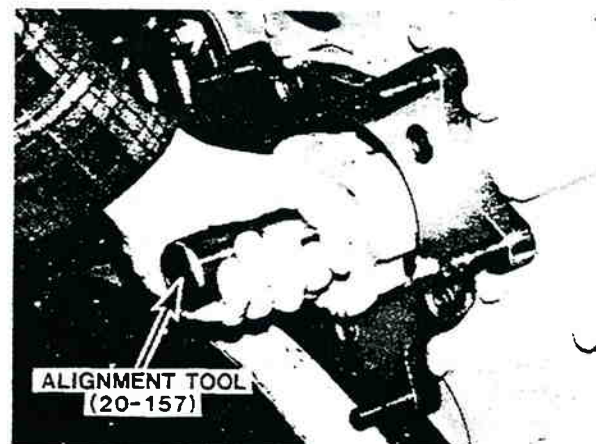


Figure 7-14. Aligning Adapter Plate.

2. Place tool 20-157 into center bore of camshaft to center adapter plate. See figure 7-14. Tighten the four 1/2" allen head capscrews to 78-80 lb. ft. (105-108 Nm) torque. Tighten the one 7/16" allen head capscrew to 55-60 lb. ft. (75-81 Nm) torque. Remove tool 20-157.

ALIGNMENT OF ADAPTER PLATE (2)

NOTE: This procedure (2) is followed when the cam gear is mounted with a capscrew and washer.

1. Mount gasket and adapter plate on flywheel housing loosely, using the five allen-head capscrews.

2. Remove capscrew and washer mounting cam gear to camshaft. Install alignment washer 20-286, DDA coupling 5142501, and original capscrew. The shoulder on the washer 20-286 fits inside the bore of the cam gear. Coupling 5142501 fits between the washer 20-286 and the 21-tooth plate. Install capscrew and snug up tightly.

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3. Insert alignment tool 20-285 inside coupling until the tapered shoulder touches the alternator adapter plate.

4. With adapter plate located properly using tool 20-285 tighten the four 1/2" allen-head capscrews to 78-80 lb-ft torque (105-108 Nm). Tighten the one 7/16" capscrew to 50-55 lb-ft torque (68-74 Nm). Remove tooling group 20-285 20-286, 5142501.

5. Replace the original washer and capscrew, tighten capscrew to 180-190 lb-ft (244-258 Nm).

INSTALLATION OF ADAPTER HOUSING
AND ALTERNATOR

NOTE: This procedure is followed when a geared adapter housing is used to drive the alternator. If the alternator is mounted to the engine without the geared adapter housing, refer to Installation of Alternator without Geared Adapter Housing.

1. Place the adapter housing and gasket over the adapter studs and tighten nuts to 70-75 lb. ft. (95-102 Nm) torque.

NOTE: Coat gasket with Permatex before installation.

2. Mount the alternator and gasket onto the adapter housing studs and tighten to 70-75 lb. ft. (95-102 Nm) torque.

3. Install the oil feed lines and tighten the oil drain tube at the engine.

4. Install the electrical connections at the diode end frame.
5. Run the engine and check alternator output and for oil leaks.

ALTERNATOR WITH "FIGURE 8" ADAPTER PLATE

Later production coaches do not have the alternator adapter; the alternator is a direct mount type. A "figure 8" adapter plate is used with this later installation.

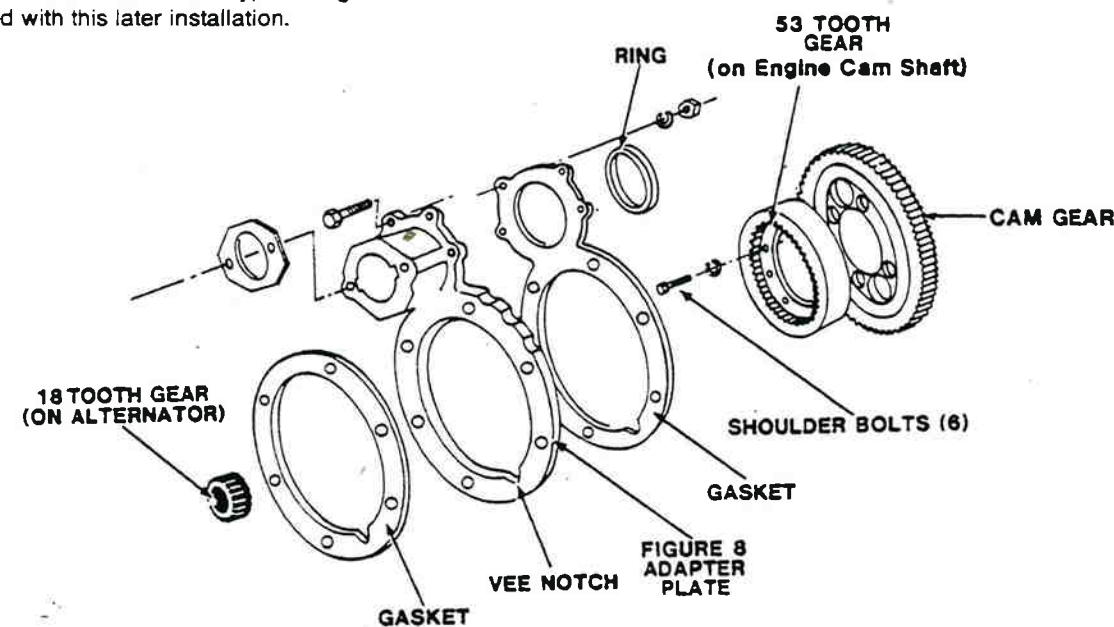


Figure 7-14A. Alternator Mounting Adapter.

REMOVING ALTERNATOR

1. Disconnect electrical wiring at the diode end frame.
2. Disconnect oil supply lines at the diode end frame.
3. Remove the nuts and washers from the studs mounting the alternator. Pull alternator straight off mounting studs. Remove the "figure-8 adapter" by removing the four upper adapter mounting bolts.

INSTALLING AND ALIGNING
OF ALTERNATOR ADAPTER (FIGURE-8 ADAPTER)

The alternator is attached to the engine by the use of an adapter which has a figure "8" shape. The adapter is installed and aligned prior to installation of the alternator.

1. Position gasket and "figure-8 adapter" on flywheel housing. See Fig. 7-14A.

NOTE: Gasket must have notch at inside edge of large circle for proper internal oil drainage.

2. Center the figure-8 adapter over cam gear using feeler gauge or other means. Install and tighten the four upper adapter bolts to 45-50 lb. ft. (54-61 Nm) torque. Adjust the two set screws to contact flywheel housing.

3. Place magnetic base (for dial indicator) on the hex-head capscrew mounting cam gear to camshaft. Install dial indicator on base and set stylus to contact inside edge of figure-8 adapter bore. Set dial indicator to zero. See Fig. 7-14B.

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NOTE: A tool is available which quickly mounts a dial indicator on the 53-tooth alternator drive gear for alignment of figure-8 adapter. This tool is available from Kent-Moore Corporation Service Tool Division or through a Detroit Diesel Allison distributor. The Kent-Moore tool number is J29893. See Fig. 7-14C.

CAUTION: Engine must always be rotated in a clockwise direction when viewed from engine front. Barring the engine in the wrong direction will loosen the crankshaft end bolt. Engine damage will result when engine is started. An assistant is necessary to bar engine over while dial indicator is read.

4. Bar engine over. Dial indicator must rotate clockwise at least 180° of one revolution. The figure-8 adapter is centered if dial indicator reads within $\pm .002$ TIR. If satisfactory, proceed to step 6.

5. If runout is more than $\pm .002$ TIR, loosen the four upper adapter bolts. Back off the two set screws and readjust them until dial indicator reads within tolerance when engine is barred over. Repeat the procedure until the required reading is attained, or until it is determined that the figure-8 housing is out-of-round or otherwise defective. Replace as necessary.

6. Remove dial indicator and magnetic base. Tighten the four upper mounting bolts to 40-45 lb. ft. (54-61 Nm) torque.

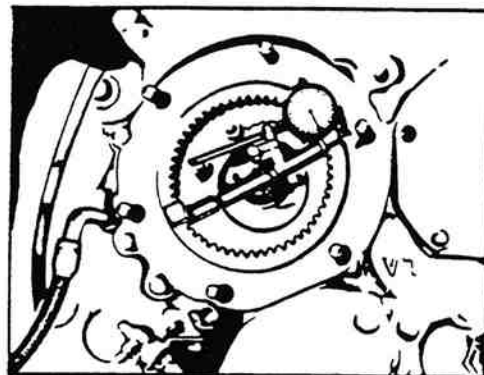


Figure 7-14B. Dial Indicator Installed.

INSTALLATION OF ALTERNATOR ON FIGURE-8 ADAPTER

1. Position the alternator and gasket on the mounting studs.

NOTE: Gasket must have a notch at inside edge of large circle for proper internal oil drainage. Coat gasket with a thin coat of Permatex before installation. Use sparingly, especially in area of notch at bottom.

2. Install nuts on studs and tighten to 70-75 lb. ft. (95-102 Nm) torque.

3. Install oil feed line and electrical connections at the diode end frame.

4. Run the engine and check alternator output and for oil leaks.

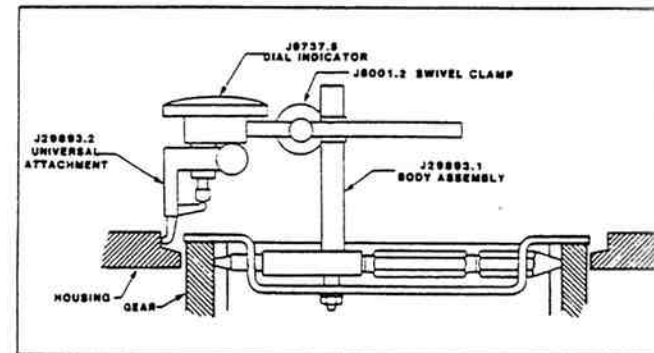


Figure 7-14C. Dial Indicator and Mounting Tool.

SAFEGUARDING OF ALTERNATOR AND COACH ELECTRICAL SYSTEMS

The following general procedures are important in protecting the alternator, voltage regulator and other electrical or electronic systems on the coach.

1. After installing a new or rebuilt alternator, make certain that all wiring to the alternator and to the voltage regulator is completely installed before attempting engine start-up.

2. Do not remove any wires or cables from the alternator or from the voltage regulator while the battery disconnect switch is "ON".

3. Do not perform welding operations on the coach without following the steps listed in the "WELDING CAUTION" in the Introduction to this manual.

A further series of steps to be taken to protect the alternator from damage when initially starting a newly installed engine are listed below. When a new or rebuilt engine is first started, it may stall due to lack of prime in the fuel system. When the engine stalls, built-up compression may induce roll back in the engine causing the alternator to reverse direction and thereby produce a negative voltage spike. This negative spike could burn out a transistor in the voltage regulator making it ineffective in protecting the alternator.

Initial Engine Start-up Procedures

1. Make sure field relay is removed (refer to rear junction box decals in the later pages of this section for the field relay location).

2. Turn all dash switches off.

3. Turn battery disconnect switch "ON".

4. Turn master switch "ON".

5. Fuel prime and start engine.

6. Run engine for five minutes.

7. Stop engine.

8. Turn master switch "OFF".

9. Turn battery disconnect switch "OFF".

10. Install field relay in rear junction box.

11. Turn battery disconnect switch "ON".

12. Turn master switch "ON".

13. Restart engine using normal start-up procedures.

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SERVICING ALTERNATOR GEARED DRIVE ADAPTER

The alternator drive adapter should be inspected every time the alternator is removed, or when its condition is suspect:

1. Remove the alternator.
2. Remove the five nuts and washers that secure the adapter housing to the adapter plate.
3. Pull housing straight off studs.

Once the housing is removed, rotate and check the end play of the shaft to check condition of bearings. Inspect drive gear for worn or chipped teeth. If condition of bearings, shaft, or gear is questionable, replacement is necessary.

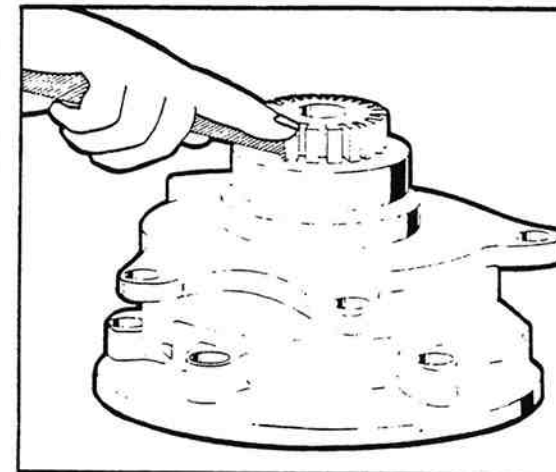


Figure 7-15. Retaining Ring Removal.

DISASSEMBLY

1. Remove self-locking nut from drive gear shaft.
2. Remove bearing retaining ring from the adapter housing. (Do not remove retaining ring from shaft.) (Figure 7-15).
3. Support the adapter housing on steel blocks on the bed of a hydraulic press and press the drive shaft out of the drive gear bore (figures 7-16 and 7-17).
4. Remove the Woodruff key from the drive shaft.
5. Install a bearing separator between the lower bearing and the drive spline and retaining ring (figure 7-18).
6. Support the bearing separator on steel blocks on the bed of a hydraulic press. Press the drive shaft out of the bearing races.
7. Thoroughly clean all parts before reassembly. See figure 7-19.

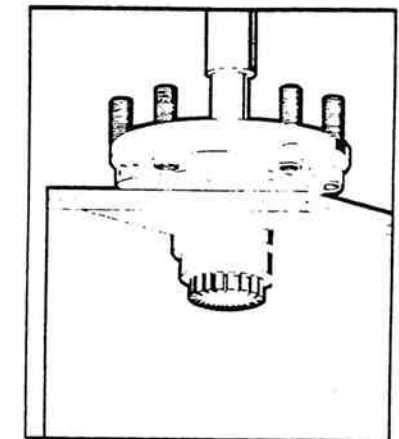


Figure 7-16. Adapter Housing Support.

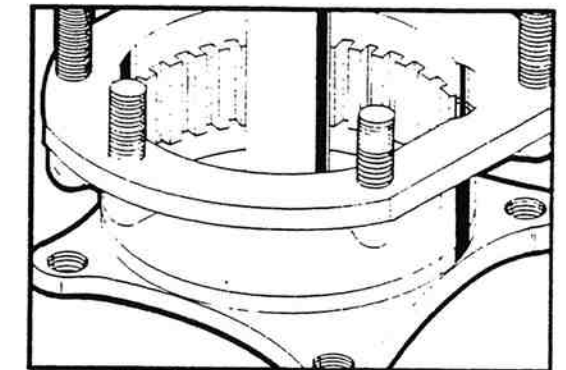


Figure 7-17. Drive Gear Removal from Drive Gear Bore.

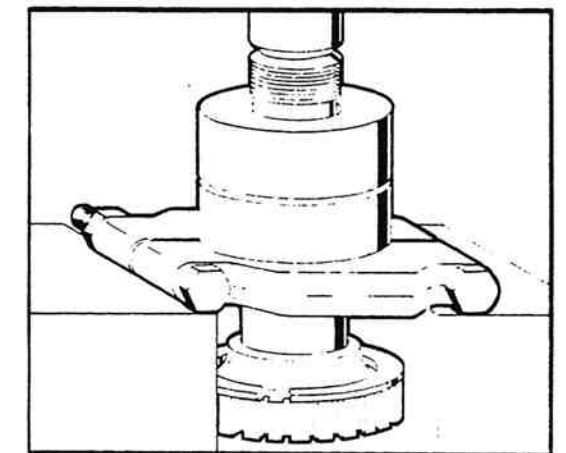


Figure 7-18. Drive Shaft Removal.