

# SECTION 06: ELECTRICAL

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## 1. GENERAL DESCRIPTION

This vehicle uses a dual voltage system to obtain two different voltages (12 and 24 volts) for various electrical controls and accessories. The main power source incorporates four maintenance-free "Delco" model 1150 batteries connected in a parallel-series configuration. All batteries are kept uniformly charged by means of a 100 amp battery equalizer (standard), giving a maximum possible output supply of 100 amps on the 12 volt system. Both the 12 and 24 volt systems are controlled through individual main battery relays. One or two 24 volt self-rectified alternators are belt driven from the engine, and can be reached through the engine compartment door.

### 1.1 WIRING DIAGRAMS

A master wiring diagram of the electric circuits, covering standard and optional accessories and systems, is located in the technical publications box. Usually, a separate wiring diagram page is provided for each major function or system. In some cases, more than one circuit may appear on one wiring diagram page; when this occurs, each circuit covered in this page is listed in the wiring diagram index. Moreover, a circuit may appear on several pages; in such case, the number(s) at the extremity of the diagram title will indicate the sheet reference number. Refer to the "*Wiring Diagram Index*" to ensure that the correct diagram is being used to trace the circuit in question.

#### 1.1.1 Wiring Diagram Keys

Various symbols are used on the wiring diagrams to depict different types of electrical components. It is essential to become familiar with these symbols in order to understand the diagrams. The major symbols shown on the diagrams are identified under "*Wiring Diagram keys*" (page **K** of wiring diagrams).

#### 1.1.2 Using Wiring Diagrams

Two methods are used to "*work*" with electric wiring diagrams.

**Situation:** You have identified the defective part (breaker, diode, relay, etc.), and you wish to locate its corresponding circuit.

**Problem:** Circuit breaker #56 is released (open circuit) and you don't know which circuit is affected.

- a) Refer to wiring diagram index, and look for "*Circuit breaker code*", pages **F**.
- b) At item CB #56, in the first column, you will find the page on which to find the corresponding diagram, in the second column the breaker ampere rating, and in the third column, the Prévost number. The other columns give you the location and the function of the breaker.
- c) Refer to page 4, keeping in mind the function of the breaker, i.e. emergency exit lights.
- d) When you have located "*emergency exit lights*", follow the wiring until you come across CB #56 and its circuit.

**Situation:** You have a problem with a specific system and you want to find the corresponding diagram.

**Problem:** The last three (3) speakers on the R.H. side of vehicle are inoperative and you must trace the electric circuit.

- a) Refer to wiring diagram index and look for "*Sound system*".
- b) You will find on page 26 the components as well as the electric wiring, thus providing you with a complete understanding of this circuit.

#### 1.1.3 Testing Circuits

A careful study of the wiring diagrams should be made to determine the source and flow of current through each 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 can be tested for continuity or short circuits with a multimeter or a suitable voltmeter.

All electrical connections must always be kept clean and adequately tight. Loose or corroded connections can result in discharged batteries, difficult starting, dim lights and improper functioning of other electric circuits. Inspect all wiring connections at regular intervals. Make sure knurled nuts on all amphenol-type plugs are securely tightened. Knurled nuts on the plastic amphenol-type connectors will click into a detent when properly tightened. Line

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connectors, who have the side locking tabs, must have the locks latched in place to ensure a proper electrical connection.

### 1.2 WIRE SIZES AND COLORS

Each wire in the electrical system has a specific size as designated on the wiring diagram. When replacing a wire, the correct size must be used. Never replace a wire with one of a smaller size.

The vehicle electrical system is provided with different voltages. The insulation on each wire is distinctly colored in order to determine visually the wiring voltage and to assist in making connectors. The wires are color coded as follows:

Red	24 volt system
Yellow	12 volt system
Black	grounded wire
Blue	110 V ac system (live)
White	110 V ac system (neutral)
Green	110 V ac system (ground)
Orange	speakers (+)
Brown	speakers (-)
Grey	spare wire

**Note:** Wires are identified at each 2-4 inch (5-10 cm) intervals by a printed number.

Each wire on a diagram is patterned to assist in tracing and testing circuits. The wire number identifies the voltage rating, the wire identification number and the basic wire gauge as illustrated in figure 1.

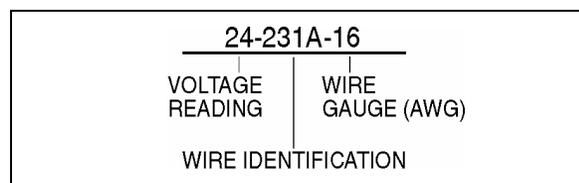


FIGURE 1: WIRE IDENTIFICATION 06048

### 1.3 SPARE WIRES

When the vehicle leaves the factory, and even in the case of a fully-equipped vehicle, an important number of unconnected spare wires are routed between the junction boxes. Consequently, for any connection of an additional accessory, refer to page D "Spare wires" in master wiring diagram to determine the number, the gauge and location of these wires.

**Note:** Spare wires are identified by a wire identification number and by the letters "SP", to designate "spare".

### 1.4 CLEANING CONNECTORS

When the pins and sockets of connectors become dirty, clean them with a good quality solvent containing HFC 134A refrigerant as its active ingredient. HFC 134A has two qualities that recommend it. First, it does not conduct electricity and therefore, will not cause shorting between connector pins and sockets. Second, it evaporates quickly, eliminating the possibility of condensation within the connectors.

Always shake out or gently blow out any excess HFC 134A before assembling a connector to its mating connector or hardware. HFC 134A trapped in the connector can affect the connector seal.

**Warning:** HFC 134A is toxic. HFC 134A bases compounds should always be used in a well-ventilated area, never in a confined space. Use outdoor whenever possible.

### 1.5 CIRCUIT BREAKERS

Most electric circuits are protected by circuit breakers of the "Manual Reset" type. The main circuit breakers, as well as those protecting the A/C system, are located in the main power compartment, on R.H. side of the vehicle, figure 2.

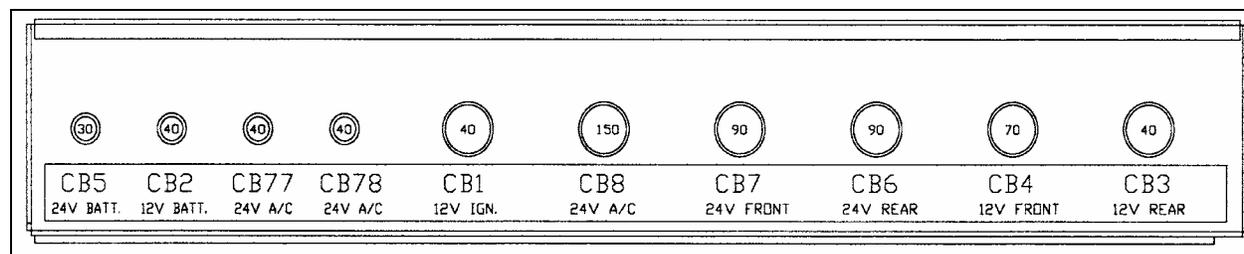


FIGURE 2: MAIN BREAKERS 06473

CIRCUIT BREAKERS			
CB1	Ignition	12 volts	40 amps
CB2	Hot Wire	12 volts	40 amps
CB3	Rear Junction Box	12 volts	40 amps
CB4	Front Junction Box	12 volts	70 amps
CB5	Hot Wire	24 volts	30 amps
CB6	Rear Junction Box & Starter Relay	24 volts	90 amps
CB7	Front Junction Box & Inverter Compartment	24 volts	90 amps
CB8	A/C Junction Box & Evaporator Fan	24 volts	150 amps
CB7 7	Condenser Fan Motor RH	24 volts	40 amps
CB7 8	Condenser Fan Motor LH	24 volts	40 amps

The smaller circuit breakers are either located in front electrical and service compartment or in the main power compartment. This type of circuit breaker deenergizes the circuit without disconnecting any wire. Simply press down the red tab on breaker to open the circuit, repair defective circuit, and afterwards depress black button in center of breaker to close the circuit.

## 1.6 RELAYS

Relays are used to automatically energize or deenergize 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 that pulls a switch arm closed or open, to either energize or deenergize a given component. As the control current required for the coil is very low, the relay allows a remote station to control a high energy circuit without running great lengths of costly high capacity cable, and also eliminates the need for high amperage switches and heavy connectors.

Many systems on this vehicle are provided with control relays, which are all, located in or on the junction boxes, figure 3.

**Note:** Each relay is identified with "12 V" or "24 V" printed on its casing in order to identify the coil operating voltage.

**Caution:** The magnetic relays for the starting motor, evaporator and both condenser motors and condenser speed controls should have the 5/16" stud nuts torqued to  $50 \pm 5$  lbf-in ( $5,5 \pm 0,5$  Nm).

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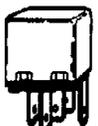
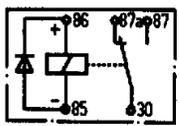
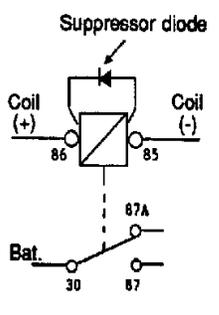
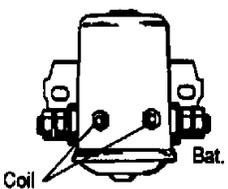
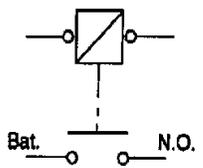
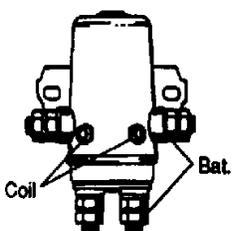
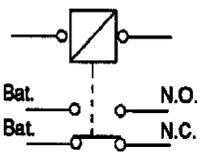
	Configuration on base	Key printed on casing	Key used on wiring diagram	Example
<p>Cubic relay (Steel or plastic casing) Type: S.P.D.T.</p> 				R #5
<p><b>NOTE:</b> This relay is provided with an internal suppressor diode; never reverse wiring terminals #85 and 86 at base as a direct short circuit will result.</p> <p>The relay coils connected to the alternator "relay terminal" should never be provided with a suppressor diode as the output current at this terminal is not rectified, thus rendering relay inoperative.</p>				
<p>Magnetic relay (Round steel casing) Type: S.P.S.T.</p> 	None	None		R #4
<p>Magnetic relay (Round steel casing) Type: D.P.D.T.</p> 	None	None		R #40
<p><b>LEGEND</b></p> <p>Bat. Battery  N.O. Normally Open  N.C. Normally Closed  S.P.D.T. Single Pole Double Throw  S.P.S.T. Single Pole Single Throw  D.P.D.T. Double Pole Double Throw</p>				

FIGURE 3: TYPES OF RELAYS

06050

## 2. H3 SERIES VEHICLES ELECTRICAL COMPARTMENTS AND JUNCTION BOXES

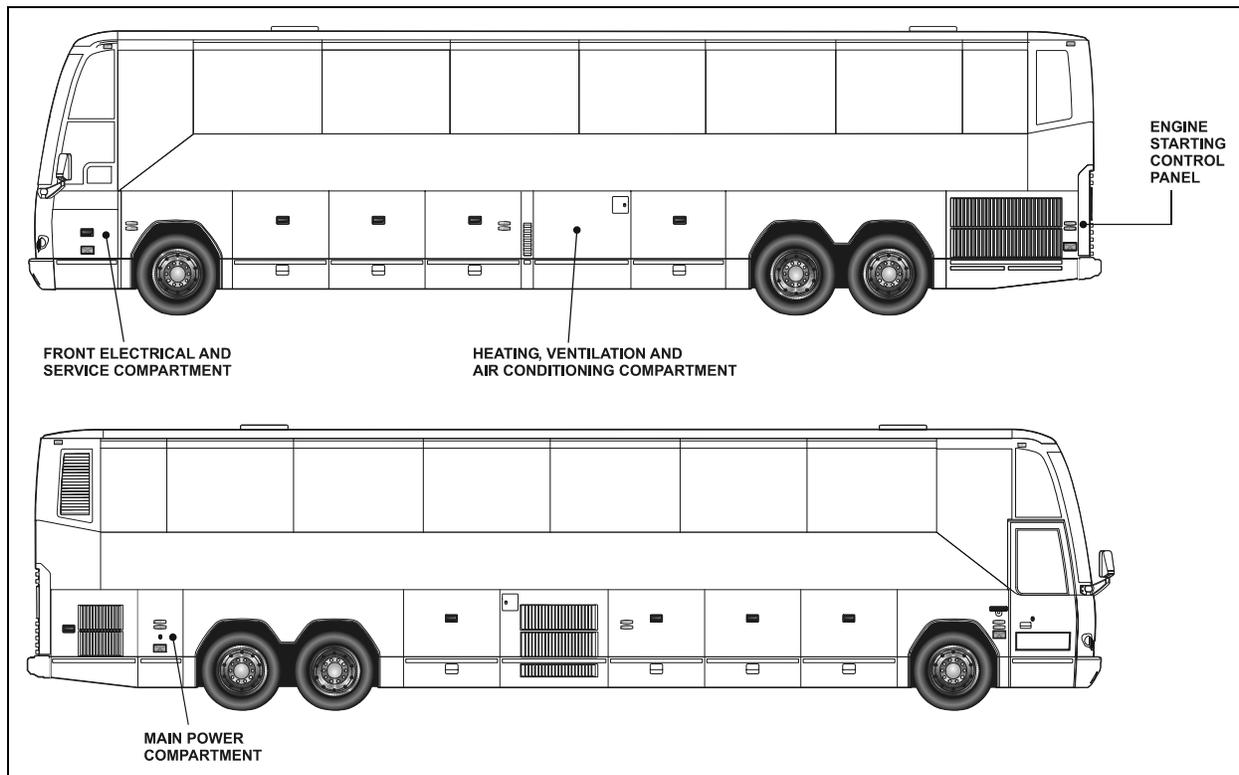


FIGURE 4: ELECTRICAL COMPARTMENTS

06479

### 2.1 MAINTENANCE

A Cortec VCI-238 corrosion inhibitor has been sprayed in all electrical compartments to protect components from corrosion. The life expectancy of this product is five years, so it is recommended to reapply it every five years. It is also recommended to spray it on new components when added or replaced.

**Warning:** Use VIC-238 in a well ventilated area. Do not smoke. Avoid prolonged contact with skin and breathing of spray mist. Harmful or fatal if swallowed. Do not induce vomiting. Call physician immediately.

### 2.2 MAIN POWER COMPARTMENT

The main power compartment is located on rear R.H. side of vehicle aft of the rear wheelhousing. This compartment contains the following components (Fig. 5):

- Four 12 volts batteries;
- Main circuit breakers;
- Voltage regulator (if applicable);
- Battery equalizer;
- Battery Charger (optional);
- Electrical system monitor;
- Alternator Module;
- Main battery relays (safety switch);
- Battery booster block;
- ECU (Electronic Control Unit) for Allison World Transmission;
- Secondary circuit breakers;
- Relays.

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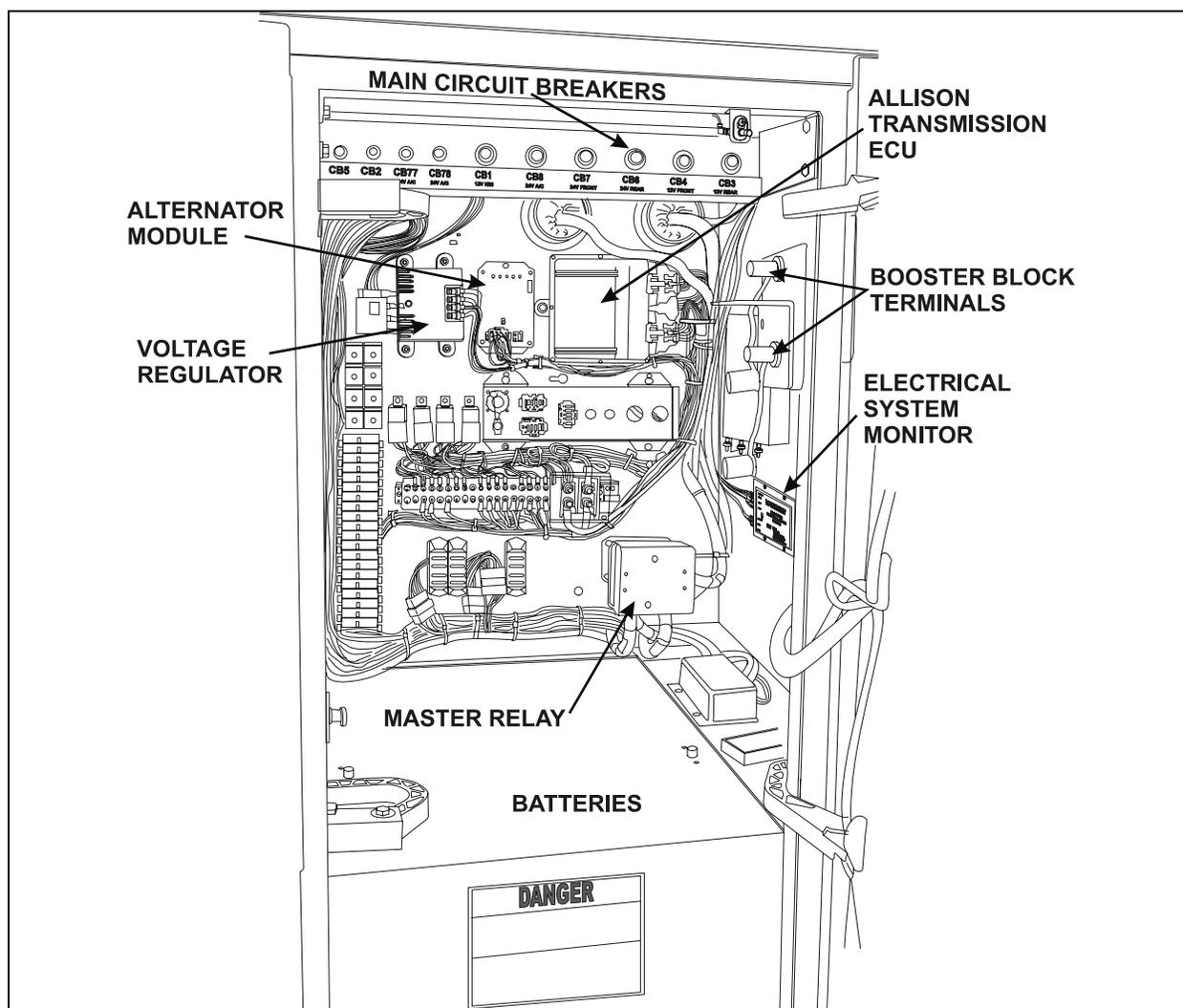


FIGURE 5: MAIN POWER COMPARTMENT

06490

### 2.2.1 Battery Charger or In-Station Lighting Connector

The vehicle may be equipped with a battery charger or in-station lighting connector. When it is connected to an external 110-120 VAC power source, the in-station lighting circuit can be energized without depleting the batteries. The receptacle is usually located on the main power compartment door or engine compartment R.H. side door.

### 2.3 FRONT ELECTRICAL AND SERVICE COMPARTMENT

The front electrical and service compartment is located on front L.H. side of vehicle. It contains the front junction panel with the following components (Fig. 6).

- Circuit breakers
- Resistors
- Pulse regulator (upper wiper)
- Electric flasher
- Fuses
- Relays
- Alarm

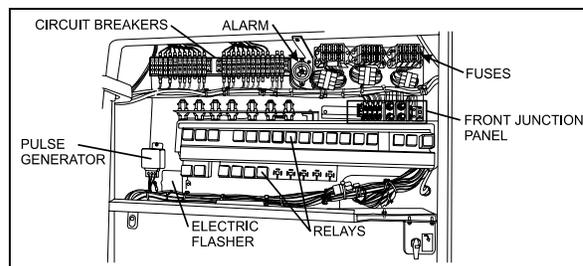


FIGURE 6: FRONT ELECT. & SERVICE COMPARTMENT<sup>06461</sup>

## 2.4 ENGINE STARTING CONTROL PANEL

This control panel is located in the R.H. side of engine compartment near the engine oil reserve tank. This control panel includes the engine starter selector switch, as well as the rear start push button switch to start engine from engine compartment.

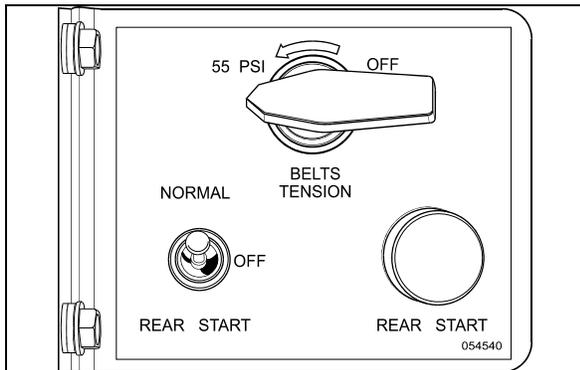


FIGURE 7: ENGINE STARTING CONTROL PANEL 01044

## 2.5 A/C AND HEATING CONTROLS

The following components are located in the main power compartment (see Fig. 5).

- Electronic transmitter (T7067B)
- Relay R35 – Water booster pump
- Relay R36 – A/C compressor clutch
- Relay R38 – A/C liquid solenoid valve
- Diodes

Each component is well identified to facilitate its location.

The following relays and resistors are located in the Heating, Ventilation and Air Conditioning Compartment (HVAC). They are mounted on the control panel located on the R.H. side wall when facing the compartment:

- R39 – Condenser fan motor
- R40 – Condenser speed control HI
- R41 – Condenser speed control HI
- R50 – Evaporator fan LOW & HI speed
- R60 – Evaporator fan HI speed
- R63 – Time Delay
- RS36 – Current limit for relay
- RS37 – Current limit for relay

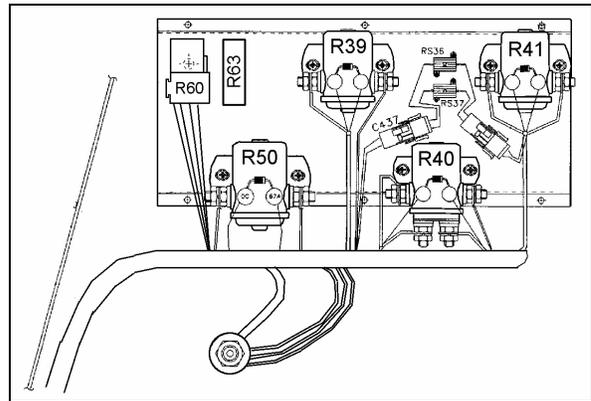


FIGURE 8: CONTROL PANEL IN HVAC COMPARTMENT<sup>06483</sup>

Each relay or resistor is identified to facilitate its location (Fig. 8).

**Note:** It is important when checking the A/C and heating system to keep the condenser compartment door closed in order to avoid faulty readings.

## 3. BATTERIES

The vehicle is provided with four (4) maintenance-free 12 volt heavy-duty batteries connected in series-parallel (Fig. 9). The top-mounted negative and positive terminals are tightly sealed to prevent leaks. Water never needs to be added to this type of battery. There are no filler caps in the cover. The battery is sealed, except for small vent holes in the cover. The vents must not be restricted as they allow small amounts of gases produced in the battery to escape. The special chemical composition inside the battery reduces gassing to a very small amount at normal charging voltages. Besides reducing gassing, the special chemistry greatly reduces the possibility of overcharge damage.

The vents require keeping the battery in an upright position to prevent electrolyte leakage. Tipping the battery beyond a 45° angle in any direction can allow a small amount of electrolyte to leak out of the vent holes.

**Warning:** DO NOT tip battery by more than 45° when carrying or installing the battery.

**Note:** Evidence of electrolyte leakage does not necessarily mean the battery is defective.

## Section 06: ELECTRICAL

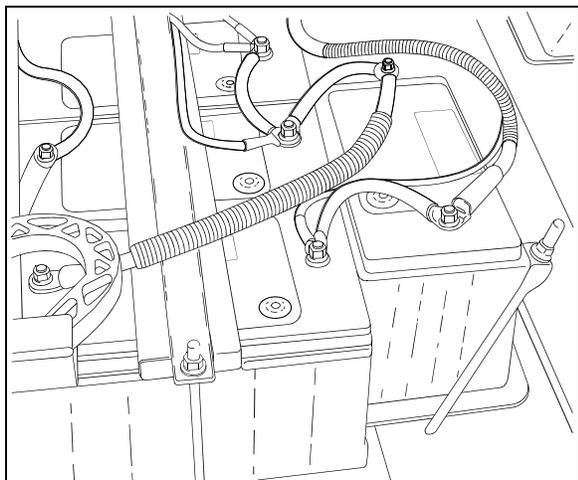


FIGURE 9: BATTERIES

06343

With special cables properly attached to the batteries, the metal surfaces that carry the current are completely sealed from the atmosphere. This prevents terminal oxidation and corrosion that may cause starting and charging problems. If new cables are required, sealed terminal cable replacements should be used to retain the reliability of the original maintenance-free connections.

**Warning:** All lead-acid batteries generate hydrogen gas, which is highly flammable. If ignited by a spark or flame, the gas may explode violently, causing spraying of acid, fragmentation of the battery, which may result in severe personal injuries. Wear safety glasses and do not smoke when working near batteries. In case of contact with acid, flush immediately with water.

The battery has four (4) major functions:

1. Providing a source of current for starting the engine.
2. Stabilizing the voltage in the electrical system.
3. Supplying current for a limited time, when electrical demands of the equipment exceed the power output of the alternator.
4. Providing a limited source of power for connected accessories, when the engine is not running.

### 3.1 MAIN BATTERY RELAYS

Main battery relays (12 V. and 24 V.) are provided for this vehicle. The relays are located

in the main power compartment. The 24 volt battery relay is actuated by a master switch located on the dashboard.

When the main battery relays are turned to the OFF position, all electrical supply from the batteries is cut off, with the exception of the following items.

- Battery equalizer check module;
- ECM;
- ECU power (World transmission);
- Preheater electronic timer;
- Preheater and water recirculating pump;
- Sedan entrance door;
- Radio memory
- Cluster memory.

### 3.2 BATTERY REMOVAL AND INSTALLATION

1. Remove the two screws at the bottom of the plastic protective cover. Unscrew the two quarter turn nuts to remove the protective cover.
2. Remove supports. Unscrew terminal nuts of each defective battery.

**Note:** Main battery relays should be in the "Off" position before disconnecting cables from the batteries.

3. Remove battery cables from the batteries.

**Note:** When the battery cables have been removed from the batteries, wrap the battery terminals and cable ends with electric tape to prevent accidental grounding. The ground cables should always be disconnected first and replaced last.

4. Remove batteries.

5. Installation is the reverse of removal.

**Note:** In replacing batteries, only batteries of the same specification should be used. Refer to "Specifications" at the end of this section for further details.

**Note:** When reinstalling batteries, battery connections must be tightened to 10-15 lbf-ft (13-20 Nm) and the nut on top of sliding tray to 45-55 lbf-in (5-6 Nm). A torque wrench is required to ensure an accurate tightening torque.

**Caution:** Ensure that connections are not reversed when reinstalling batteries, since damage to electrical system components will result.

**Caution:** After reinstalling battery terminals, apply protective coating (Nyogel grease). Do not use Cortec VCI-238.

**Warning:** To prevent possible electric shock or sparking, the main battery relays must be set to the "Off" position before tightening an electrical connection.

**Note:** A protective silicone free, coating should be applied on all connections that have been disconnected. We recommend the use of Cortec VCI-238 (Prévost #682460) on all electrical connections.

### 3.3 BATTERY RATING

Each of the 12 volt batteries used on the vehicle has the following rating:

- Reserve capacity: 195 minutes
- Cold cranking (amps): 950 @ 0°F (-18°C)
- Cold cranking (amps): 745 @ -20°F (-29°C)
- Weight (filled): 59 lb (26,7 kg)

The reserve capacity is defined as the number of minutes a new, fully charged battery at 80°F (26,6°C) can be discharged at 25 amperes and maintain a minimum of 1.75 volts per cell (10.5 volts total for one 12 volts battery). This rating can be used as a basis for determining how long a vehicle might run after an alternator failure.

The cold cranking rating is defined as the minimum discharge current a battery will deliver in amperes for 30 seconds at 0 F (-18 C) while maintaining a minimum of 1.2 volts per cell (7.2 volts total for one 12 volts battery). This rating can be used as a basis for comparing starting performance.

### 3.4 BATTERY TESTING

The maintenance-free battery has a strong ability to withstand the damaging effects of overcharge. The test indicator in the cover is used only to determine if the battery can be tested in case of a cranking problem.

The test indicator in the battery cover is to be used with accepted diagnostic procedures only. It must not be used to determine if the battery is

good or bad, charged or discharged. The test indicator is a built-in hydrometer in one cell that provides visual information for battery testing (Fig. 10).

It is important when observing the test indicator, that the battery be relatively level and has a clean indicator top to see the correct indication. Some lighting may be required in poorly lit areas. Under normal operation, two indications can be observed.

#### Green Dot Visible

Any green appearance is interpreted as a "green dot", and the battery is ready for testing. On rare occasions, following prolonged cranking, the green dot may still be visible when the battery is obviously discharged. Should this occur, charge the battery as described under "Charging Procedure" in "Battery Charging" later in this section.

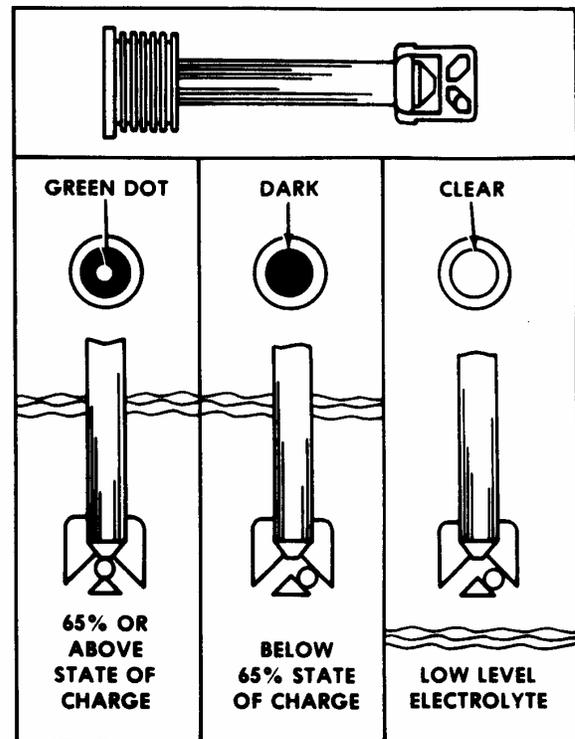


FIGURE 10: TEST INDICATOR

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#### Dark - Green Dot Not Visible

If there is difficulty cranking the engine, the battery should be tested as described in this section. On rare occasions, the test indicator may turn light yellow. In this case, the integral charging system should be checked. Normally, the battery is capable of further service;

## Section 06: ELECTRICAL

however, if difficult start has been reported, replace the battery. **DO NOT CHARGE, TEST, OR JUMP-START.**

### 3.4.1 Visual Inspection

1. Check the outside of the battery for a broken or cracked cover or case that could permit loss of electrolyte. If obvious physical damage is noted, replace the battery.
2. Check for loose terminal posts, cable connections, damaged cables, and for evidence of corrosion. Correct conditions as required before proceeding with tests.

### 3.4.2 Removing Surface Charge

Disconnect cables from the battery and attach alligator clamps to the contact lead pad on the battery as shown in figure 12. Connect a 300 ampere load across the terminal for 15 seconds to remove surface charge from the battery.

### 3.4.3 Load Test

This test is one means of checking the battery to determine its ability to function as required in the vehicle.

To make this test, use test equipment that will withstand a heavy electrical load from the battery, such as a carbon pile resistor or other suitable means.

1. Connect a voltmeter, ammeter, and a variable load resistance as illustrated in figure 11.

**Caution:** Observe polarity of the meters and the battery when making connections, and select the correct meter range.

2. Apply a 290 amperes load to the battery for 15 seconds.
3. With an ammeter reading specified load, read voltage. The voltage should be at least 9.6 volts. Disconnect the load. If the voltmeter indicates 9.6 volts or more, the battery is good. If the voltmeter reading is less than 9.6 volts, replace the battery. This voltage is to be used for battery ambient temperatures of 70°F (21°C) and above. For temperatures below 70°F (21°C), refer to the following "Voltage and Temperature Chart".

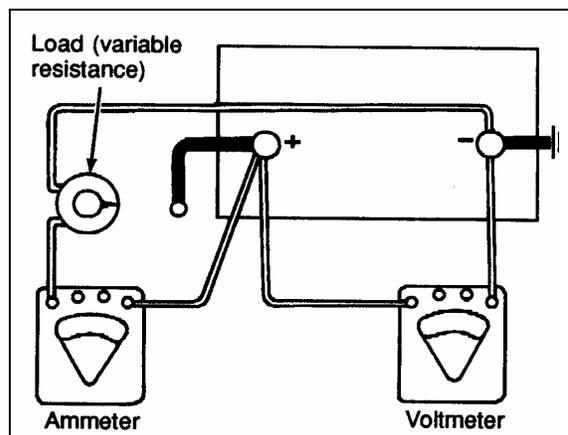


FIGURE 11: LOAD TEST

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**Note:** The accuracy of this test procedure is dependent upon close adherence to the proper load, time and temperature specifications.

### Voltage and Temperature Chart

Ambient Temperature	Minimum Voltage
70°F (21°C) and above	9.6
60°F (16°C)	9.5
50°F (10°C)	9.4
40°F (4°C)	9.3
30°F (-1°C)	9.1
20°F (-7°C)	8.9
10°F (-12°C)	8.7
0°F (-18°C)	8.5

### 3.4.4 Testing Battery Cables

Check all cable ring terminals and connections to determine if they are in good condition. Excessive resistance, generally caused by poor connections, produces an abnormal voltage drop which may lower voltage at the starter to such a low value that normal operation of the starter will not be obtained. An abnormal voltage drop can be detected with a low-reading voltmeter as follows:

**Warning:** To prevent the engine from starting, the DDEC engine circuits, which are protected by breakers; (CB-19, CB-20 and CB-21) located in the main power compartment must be de-energized. Once these tests are completed, depress black button to close circuit.

1. Check voltage drop between grounded (negative) battery terminal and vehicle frame by placing one prod of the voltmeter on the battery terminal and the other on a good ground (unpainted surface) on the vehicle. With the starter cranking the engine at a temperature of 70°F (21°C), voltage reading should be less than 0.3 volt. If the voltage reading exceeds 0.3 volt, there is excessive resistance in this circuit.
2. Check voltage drop between the positive battery terminal and the starter positive terminal stud while the starter motor is operated. If the reading is more than 2.5 volts, there is excessive resistance in this circuit.

**Note:** If it is necessary to extend the voltmeter lead for this test, use a #16 (AWG) or larger wire.

3. Check voltage drop between the starter housing and a good ground on the vehicle. The reading should be less than 0.2 volt.

**Warning:** Any procedure other than the following could cause personal injury or damages to the charging system resulting from battery explosion or electrical burns.

Wear adequate eye protection when working on or near the batteries. Ensure that metal tools or jumper cables do not contact the positive battery terminal (or a metal surface in contact with it) as a short circuit will result. Do not attempt to jump start a vehicle suspected of having a frozen battery because the battery may rupture or explode. Both the booster and discharged batteries must be treated carefully when using jumper cables. Follow exactly the procedure outlined later in this section, being careful not to cause sparks.

### 3.5 BATTERY CHARGING

**Warning:** During charging of the batteries, an explosive gas mixture forms in each cell. Part of this gas escapes through the vent holes and may form an explosive atmosphere around the battery itself if ventilation is poor. This explosive gas may remain in or around the battery for several hours after it has been charged. Sparks or flames can ignite this gas causing an internal explosion, which may shatter the battery.

*Do not smoke near a battery which is being charged or which has been recently charged.*

*Do not break live circuits at battery terminals because a spark usually occurs at the point where a live circuit is broken. Care must always be taken when connecting or disconnecting booster leads or cable clamps on chargers. Poor connections are a common cause of electric arcs, which cause explosions.*

**Caution:** The electrical system on this vehicle is negative ground. Installing the batteries with the positive terminals grounded or incorrect use of the booster battery and jumper cables will result in serious damage to the alternator, batteries and battery cables.

The batteries used on this vehicle can be charged either on or off the vehicle; however, when they are removed from the vehicle, it is recommended that an adapter kit, which is available from any "A/C DELCO" dealer, be used in charging sealed-terminal batteries. Use the booster block to charge the batteries when they are left on vehicle and **make sure that the main battery disconnect switch is set to the "On" position.**

The alligator clamps of the tester or charger must be placed between the terminal nuts and the lead pads of the terminal studs (Fig. 12) after the vehicle cables are detached. The alligator clamps should make firm contact with the lead pads.

**Note:** If this connection cannot be made because of the alligator clamp design, the load value for testing must be reduced from 290 to 260 amperes.

On rare occasions, such as those that occur following prolonged cranking, the green dot in the test indicator may still be visible when the battery is obviously discharged. Should this occur, a boost charge of 20 amperes-hour is recommended. Under normal operating conditions, do not charge the battery if the green dot is visible. The battery should never be charged if the test indicator (hydrometer) is clear or light yellow. If this occurs, replace the battery.

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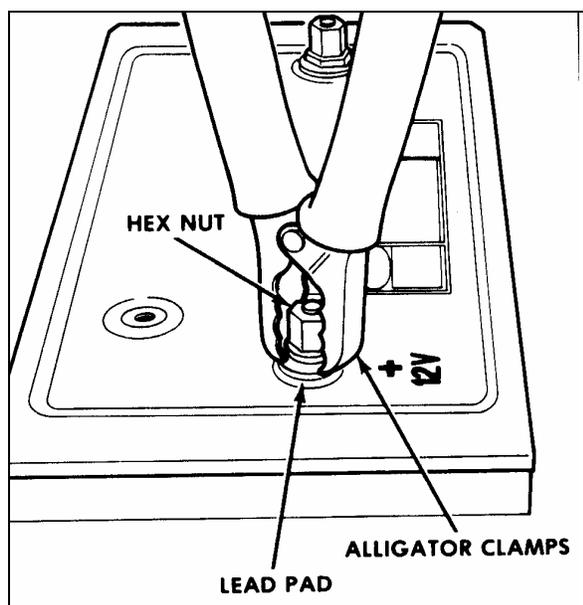


FIGURE 12: ALLIGATOR CLAMPS AND BATTERY 06065

A charge rate between 3 and 50 amperes is generally satisfactory for any maintenance-free battery as long as spewing out of electrolyte does not occur or the battery does not feel excessively hot (over 125°F (52°C)). If spewing out or violent gassing of electrolyte occurs or battery temperature exceeds 125°F (52°C), the charging rate must be reduced or temporarily stopped to allow cooling and to avoid damaging the battery.

Battery temperature can be estimated by touching or feeling the battery case. The battery is sufficiently charged when the green dot in the built-in hydrometer is visible. No further charging is required. Shake or tilt the battery at hourly intervals during charging to mix the electrolyte and see if the green dot appears.

**Warning:** Always turn off the charger before connecting or disconnecting to a battery.

**Note:** The charge rate must be doubled when the batteries are charged by the booster block, because of the series-parallel circuit.

Battery charging consists of a charge current in amperes for a period of time in hours. Thus, a 25 ampere charging rate for 2 hours would be a 50 ampere-hour charge to the battery. Most batteries, whose load test values are greater than 200 amperes, will have the green dot visible after at least a 75 ampere-hour charge. In the event that the green dot does not appear, replace the battery.

### 3.5.1 Battery Charging Guide

#### Fast Charging Rate

20 amps @ 3-3/4 hours

30 amps @ 2-1/2 hours

40 amps @ 2 hours

50 amps @ 1-1/2 hours

#### Slow Charging Rate

5 amps @ 15 hours

10 amps @ 7-1/2 hours

The time required for a charge will vary according to the following factors:

#### Size of Battery

For example, a completely discharged large heavy-duty battery requires more than twice the recharging time of a completely discharged small passenger car battery.

#### Temperature

For example, a longer time will be needed to charge any battery at 0°F (-18°C) than at 80 °F (27°C). When a fast charger is connected to a cold battery, the current accepted by the battery will be very low at first, and then in time, the battery will accept a higher rate as it warms.

#### State of Charge

For example, a completely discharged battery requires more than twice as much charge than a half-charged battery. Since the electrolyte is nearly pure water and a poor conductor in a completely discharged battery, the current accepted is very low at first. Later, as the charging current causes the electrolyte acid content to increase, the charging current will likewise increase.

#### Charger Capacity

For example, a charger which can supply only 5 amperes will require a much longer period of charging than a charger that can supply 30 amperes or more.

### 3.5.2 Emergency Jump Starting With Auxiliary (Booster) Battery

**Warning:** Do not jump start vehicles equipped with maintenance-free batteries if the test indicator is light yellow.

Both booster and discharged batteries should be treated carefully when using jumper cables. A vehicle with a discharged battery may be started by using energy from a booster battery or the battery from another vehicle.

**Warning:** *Jump starting may be dangerous and should be attempted only if the following conditions are met:*

The booster battery or the battery in the other vehicle must be of the same voltage as the battery in the vehicle being started, and must be negative grounded.

If the booster battery is a sealed-type battery without filler openings or caps, its test indicator must be dark or a green dot must be visible. Do not attempt jump starting if the test indicator of the booster battery or the discharged battery has a light or bright center.

**Warning:** *Follow the procedure exactly as outlined hereafter. Avoid making sparks.*

Wear eye protection and remove rings, watches with metal bands and other metal jewelry.

Apply parking brake and place the transmission shift lever or push-button pads in Neutral (N) position in both vehicles. Turn off lights, heater and other electrical loads. Observe the charge indicator. If the indicator in the discharged battery is illuminated, replace the battery. **Do not** attempt jump starting when indicator is illuminated. If the test indicator is dark and has a green dot in the center, failure to start is not due to a discharged battery and the cranking system should be checked. If charge indicator is dark but the green dot does not appear in center, proceed as follows:

1. Connect one end of one red jumper cable to the positive (+) terminal of the booster power source and the other end to the positive (+) post of the booster power block, located in the main power compartment (refer to fig. 5).
2. Connect one end of the remaining negative jumper cable (black) to the negative (-) terminal of the booster power source, and the other end of the black jumper cable to the negative (-) post of the booster power block.
3. Make sure the clips from one cable do not inadvertently touch the clips on the other cable. Do not lean over the battery when

making connections. The ground connection must provide good electrical conductivity and current carrying capacity.

4. Start the engine in the vehicle that is providing the jump start. Let the engine run for a few minutes, then start the engine in the vehicle that has the discharged batteries.
5. When removing the jumper cables, perform the above procedure exactly in reverse order, and replace protective caps on booster block terminals.

**Warning:** *Any procedure other than the above could result in personal injury, property damage due to battery explosion, or damage to the charging system of the booster vehicle or of the boosted vehicle*

**Note:** *Jumper cables must withstand 500 cranking amperes. If cable length is 20 feet (6m) or less, use 2/0 (AWG) gauge wires. If cable length is between 20-30 feet (6-9m), use 3/0 (AWG) wires.*

### 3.6 CLEANING AND INSPECTION

The external condition of the battery and the battery cables should be checked periodically. The top of the battery should be kept clean and the battery hold-down clamp bolts should be kept properly tightened. For best results when cleaning the battery, wash first with a diluted solution of ammonia or soda to neutralize any acid present, then wash out with clean water. The battery hold-down bolts should be kept tight enough to prevent the batteries from moving, but they should not be tightened to the point that excessive strain is placed on the battery hold-down cover (proper tightening torque: 45-55 lbf-in (5-6 Nm).

To insure good contact, the battery cable ring terminals should be tight on the battery posts. If the posts or cable ring terminals are corroded, the cables should be disconnected and the posts and clamps cleaned separately with a soda solution and a wire brush. Install cable ring terminals on battery posts and tighten to a torque of 10-15 lbf-ft (13-20 Nm). Replace protective caps to prevent corrosion and sparks.

### 3.7 COMMON CAUSES OF BATTERY FAILURE

When a battery fails, the cause of failure may be related to something other than the battery. For this reason, when a battery failure occurs, do not be satisfied with merely recharging or replacing

## Section 06: ELECTRICAL

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the battery. Locate and correct the cause of the failure to prevent recurrence. Some common external causes of battery failure are as follows:

1. A defect in charging system such as high resistance or a faulty alternator or regulator.
2. A malfunction within the 12 volts system (equalizer).
3. Overloads caused by a defective starter or excessive use of accessories.
4. Dirt and electrolyte on top of the batteries causing a constant drain.
5. Hardened battery plates, due to battery being in a low state of charge over a long period of time.
6. Shorted cells, loss of active material from plates.
7. Driving conditions or requirements under which the vehicle is driven for short periods of time.
8. A constant drain caused by a shorted circuit such as an exposed wire or water infiltration in junction boxes causing ground fault.
9. Extended operation of preheating system with engine not running.
10. Failing to close disconnect switches during the night.

### 3.8 TROUBLESHOOTING

If a battery is known to be good and then has not performed satisfactorily in service for no apparent reason, the following factors may reveal the cause of trouble:

1. Vehicle accessories and disconnect switches inadvertently left on overnight.
2. Defects in the charging system, such as high wiring resistance, faulty alternator, regulator or battery equalizer.
3. A vehicle electrical load exceeding the alternator (or battery equalizer) capacity, with the addition of electrical devices, such as CB radio equipment, a cellular phone or additional lighting systems.
4. Defects in the electrical system, such as shorted or pinched wires.

5. Extended driving at slow speed while using many accessories.
6. Loose or poor battery cable-to-post connections, previous improper charging of a run-down battery or loose hold-down clamp bolts.
7. High-resistance connections or defects in the cranking system.

### 4. ELECTRICAL SYSTEM MONITOR

This vehicle is equipped with an electronic device that monitors and detects abnormal alternator, voltage regulator, battery banks or battery equalizers conditions. The monitor is installed on R.H. side wall of the main power compartment (refer to fig. 5). The "Battery balance" and "Battery Hi/Lo" warning lamps connected to this module are mounted in the dashboard (refer to "Operator's Manual" for location). If a malfunction should occur, the monitor sends a signal to the driver through the warning light of the malfunctioning component. If the "Battery Hi/Lo" warning light is illuminated, check the 24 volt voltmeter to determine if the battery voltage is too high or too low.

**Note:** According to the battery charging condition, it is normal that "Battery Hi/Lo" warning light illuminates upon starting the engine and stays illuminated for a few seconds. This is caused by the normal voltage drop of the battery during starting.

#### 4.1 TELLTALE LIGHT DEFINITIONS

Battery Hi/Lo

Voltmeter drops below 24 V dc

- Check alternator output.
- Check voltage regulator.
- Check battery connections.
- Check battery cells.
- Check battery equalizer connections.

Voltmeter exceeds 30 V dc

- Check alternator output.
- Check voltage regulator.
- Check battery connections.

Battery Balance

**Note:** Allow at least 15 minutes to balance batteries after any corrective measure has been taken.

1. Batteries out of balance (difference greater than 1.5 volts between the two battery banks).
  - ◆ Check battery equalizer connections.
  - ◆ Check equalizer cables for proper gauge.
  - ◆ Check battery connections.
2. Demand for 12 volt power exceeding rated amperage output of battery equalizers causing batteries to go out of balance.
  - ◆ Reduce 12 volt load or install additional battery equalizer(s).

#### "Battery" Warning Light

This warning light is not controlled by the electronic monitor, but by the "R" terminal of the alternator using the normally-closed contact of relay R-33. If a voltage drop should occur in the charging system, the "Battery" telltale light will immediately illuminate to warn the driver. The "Battery Hi/Lo" telltale light will illuminate if voltage drops below 24 V dc.

Refer to heading "Diagnosis of Charging System Problems" later in this section, to determine whether the alternator or the voltage regulator is defective. Should the "Battery" telltale light illuminate while the 24 volt voltmeter keeps on giving a normal reading and the "Battery Hi/Lo" telltale light does not illuminate, the relay R-33 or its wiring is probably defective.

**Caution:** The relay R-33 should never be replaced with a relay provided with a suppressor diode on its coil as the output current (between 12 and 14 volts) at the alternator "R" terminal is not rectified, thus rendering the relay inoperative.

**Note:** When the "Battery" warning light illuminates, the "A/C & Heating" system shuts off in order to prevent battery discharge.

## 5. BOSCH ALTERNATOR

One or two 24 volt 140 amp., self regulated, belt driven, air-cooled BOSCH alternators may be used in the 24 volt electrical system (instead of the DELCO 24 volt 270 amp. alternator).

Change the brushes and the voltage regulator as per "Repair and Testing Instructions for T1 Alternator 0120 69 552" every 100,000 miles (160 000 km) or once every two years, whichever comes first.

Replace bearings as per "Repair and Testing Instructions for T1 Alternator 0120 69 552" every 200,000 miles (320 000 km) or once every four years, whichever comes first.

Refer to Bosh T1 Alternator Maintenance Manual Annexed at the end of this section.

### 5.1 TWIN BOSCH ALTERNATORS INSTALLATION

If the alternators needed to be removed, reinstall as follows. Refer to figure 13 for installation and to figure 14 for tightening specifications:

1. Install alternator mounting bracket (1, figure 13) to the gear case. Use the four flanged phosphor alloy bolts on the pulley end of the bracket and the flanged nuts at the transmission end of the bracket;
  2. Bolt the alternators to the bracket using the three inch bolt at the top of the upper alternator (2, fig 13) and flanged bolts at the other mounting bosses (3 and 4, figure 13). Tighten the bolts in the sliding sleeves (4, figure 13) last as they will adjust to prevent breaking the alternator mounting bosses upon final tightening. Repeat for the second alternator;
  3. On the drive shafts of both alternators, install key, pulley, spring washer and nut. Tighten to 220 Lbf-ft (300 Nm);
- Note:** Final tightening of the pulleys can be performed once the belt is installed. This will help keep the pulley from turning when tightening.
4. Install the snubber bracket (5, fig. 13) using three flanged bolts. Do not tighten the adjustment bolts on the snubber until after final tightening;
  5. Install the compressor belt idler pulley (6, fig. 13) as shown. A stud inserts into one of the mounting holes of the pulley assembly. Fasten this one using a nut and bolts for the other two.

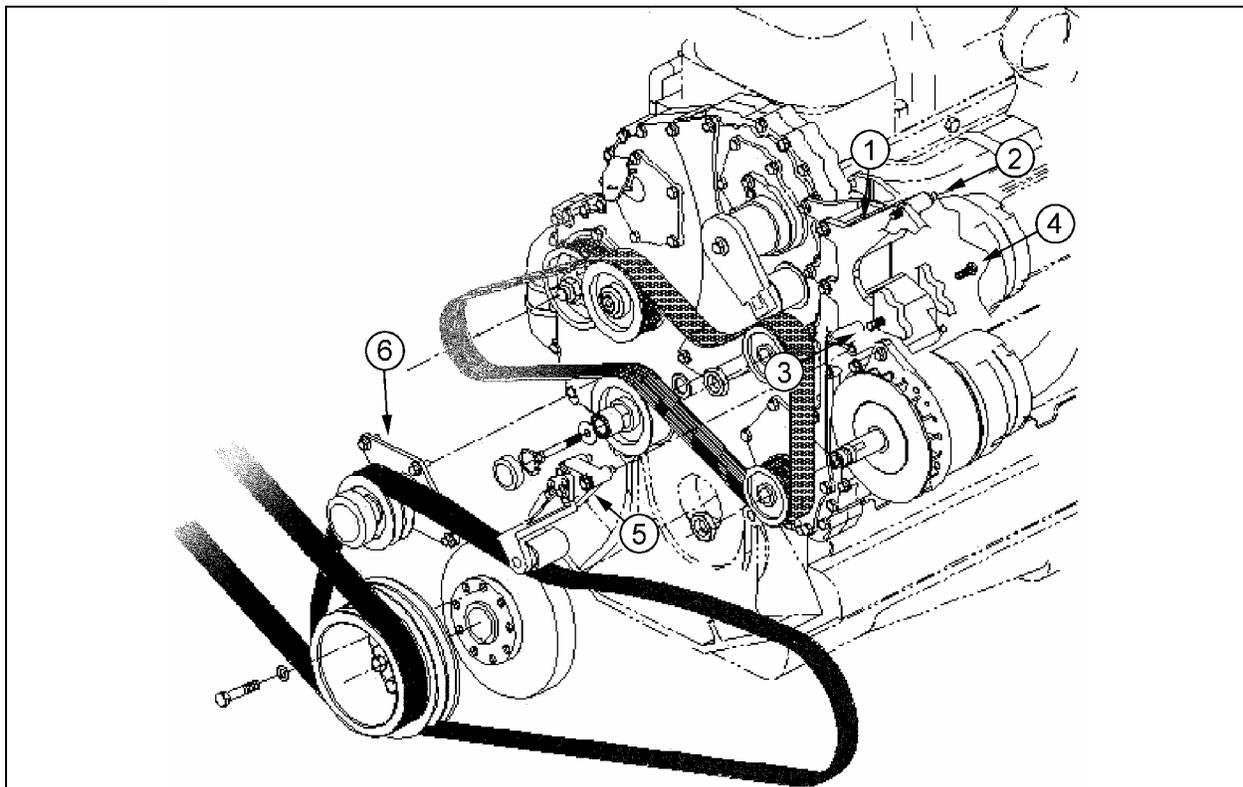


FIGURE 13: TWIN BOSCH ALTERNATORS INSTALLATION

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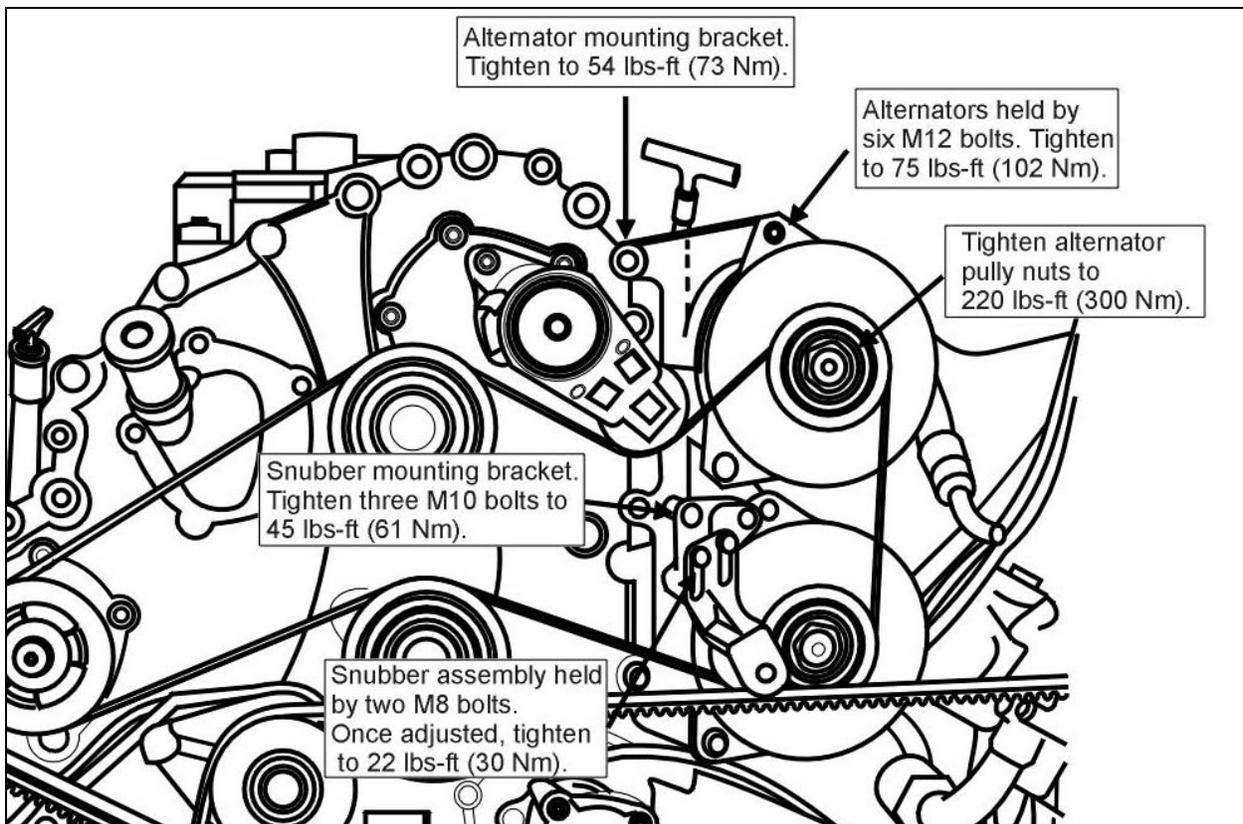


FIGURE 14: ALTERNATORS AND ACCESSORIES MOUNTING TORQUES

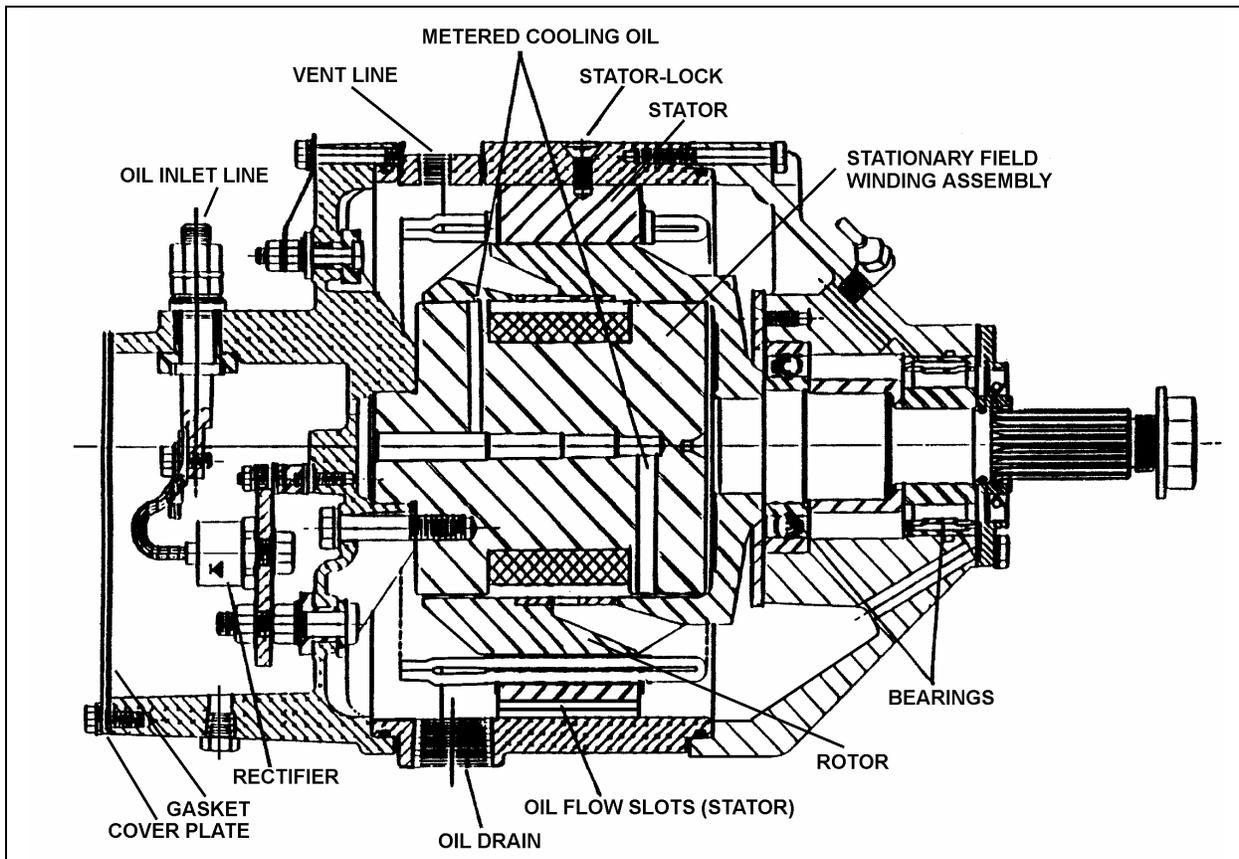


FIGURE 15: 50DN DELCO ALTERNATOR SECTIONAL VIEW

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## 6. DELCO ALTERNATOR

The 24 volt charging system consists of a belt driven, oil-cooled, brushless alternator, a 24 volt voltage regulator, an alternator relay and a 12 volt system that includes a 12 volt, 100 amp equalizer. The components used in this system are described under the applicable headings hereafter.

This oil-cooled alternator is self rectifying. All current carrying members, windings, built-in diodes, and field coils are stationary. The only moving component is the rotor. The 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 through the drive end frame and drive

adapter housing. This alternator should never be operated with the oil supply line disconnected. A continuous flow of engine oil through the alternator lubricates the bearings and cools the assembly. Four terminals are used on this alternator: the DC output terminal, two field terminals, and a 12 volt relay terminal. The alternator output voltage is regulated by a separate 24 volt regulator that controls the alternator field current (Fig. 15 and 16).

**Note:** The relay coils connected to the alternator "relay terminal" SHOULD NEVER BE PROVIDED WITH A SUPPRESSOR DIODE as the output current at this terminal is not rectified, thus rendering relay inoperative.

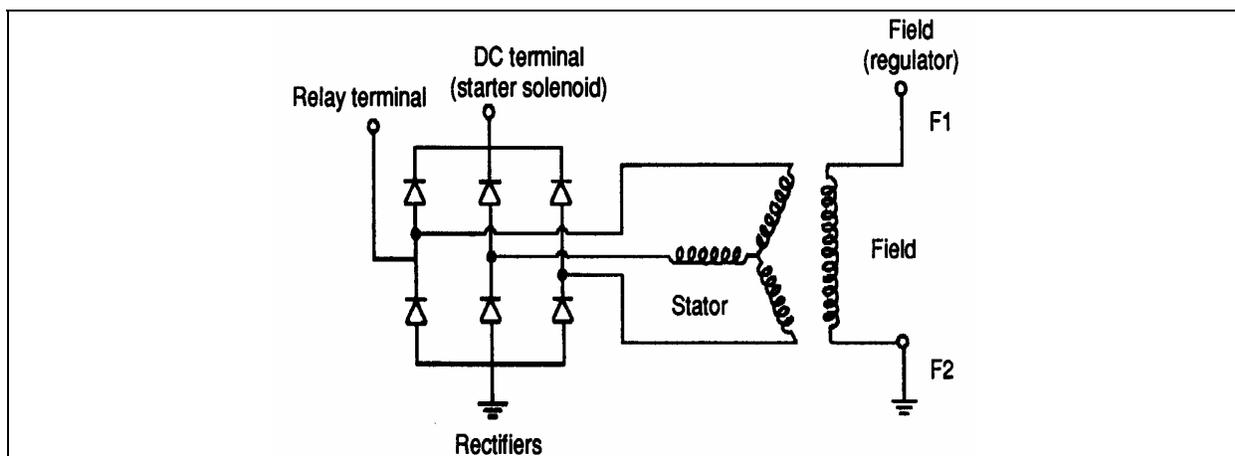


FIGURE 16: ALTERNATOR WIRING DIAGRAM (DELCO)

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**Caution:** The electrical system is **NE GATIVE GROUNDED**. Connecting the batteries or a battery charger with the positive terminal grounded will endanger the alternator diodes and vehicle wiring by a high current flow. Burned wiring harnesses and burned “open” diodes will result. Always ensure that the alternator and battery polarities are matched prior to installation. **THE ALTERNATOR WILL NOT REVERSE TO ACCEPT INVERSE POLARITY.** Also, do not ground or short across any of the alternator or regulator terminals.

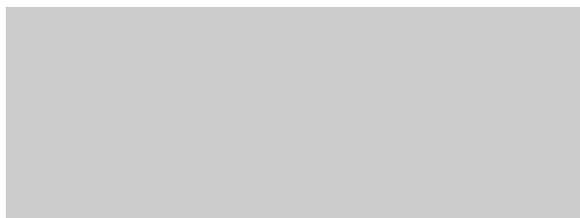
Since there are no brushes, slip rings, or rubbing seals, the alternator requires no periodic maintenance other than the following:

1. Check alternator-to-engine mounting bolts for looseness and tighten to the proper torque.
2. Check all electrical connections for tightness and corrosion. Clean and tighten connections as necessary. Be sure wiring insulation is in good condition and that all wiring is securely clipped to prevent chafing of the insulation.
3. With the engine running, listen for noise and check the alternator for vibration. If the alternator is noisy or vibrates excessively, it should be removed for inspection and repair.
4. Ensure that battery terminals are clean and tight.

## 7. CHARGING SYSTEM TROUBLESHOOTING

The troubleshooting of the charging system is made easier by the use of a 12 and a 24 volt voltmeter, “Battery”, “Battery balance” and “Battery Hi/Lo” telltale lights mounted in the dashboard (for location refer to the “Operator’s Manual”). The definition of each warning light is explained under the “ELECTRICAL SYSTEM MONITOR”

### 7.1 ALTERNATOR OR VOLTAGE REGULATOR



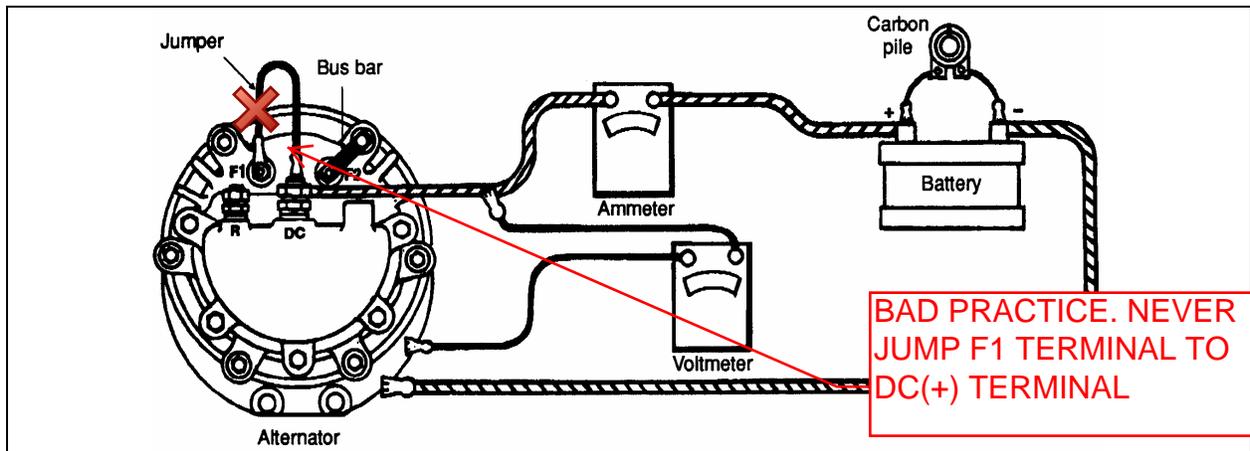


FIGURE 17:

## 7.2 ALTERNATOR DIAGNOSIS

**Caution:** Before checking the alternator, set to "OFF" the battery main disconnect switch.

It is not necessary to disassemble completely the alternator to make electrical checks. All electrical checks are made at the diode end of the assembly without having to remove the rotor, drive end frame or bearing. If the electrical components are not defective but bearing replacement is necessary, this can be done at the drive end without having to disassemble the diode end of the unit.

The components in the alternator that require electrical checks are the field winding, the six diodes, and the stator winding.

### 7.2.1 Diode Checks

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

1. Ensure the battery main disconnect switch is set to the "OFF" position.
2. Remove the pipe plug from underneath the end housing to drain the oil in the rectifier engine oil supply.
3. Remove the cap screws (7) and lock washers that attach the diode end cover to

the end housing. Remove the end cover from the end housing.

**Note:** Do not operate the alternator unless this unit is completely reassembled.

4. Remove seal from the end housing, detach and remove "DC" and relay terminals, stud, insulating sleeves and O-rings.
5. Disconnect all diode flexible leads; i.e. three from the output terminal stud and three from the diode supports. See figure 18 for more details.

Each diode may be checked for short or open circuits with an ohmmeter.

**Note:** The ohm meter polarity may be determined by connecting its leads to the voltmeter leads. The voltmeter will read up-scale when the negative leads are connected together and the positive leads are connected together. The polarity of the voltmeter leads may be determined by connecting the leads to the identified terminals on a battery.

**Note:** Use an ohm meter with a single 1.5 volts cell. Most accurate reading will be determined when the 300 ohms value is calibrated to the center one-third of the scale. DO NOT USE high voltage, such as a 110 volts test lamp to check diodes.

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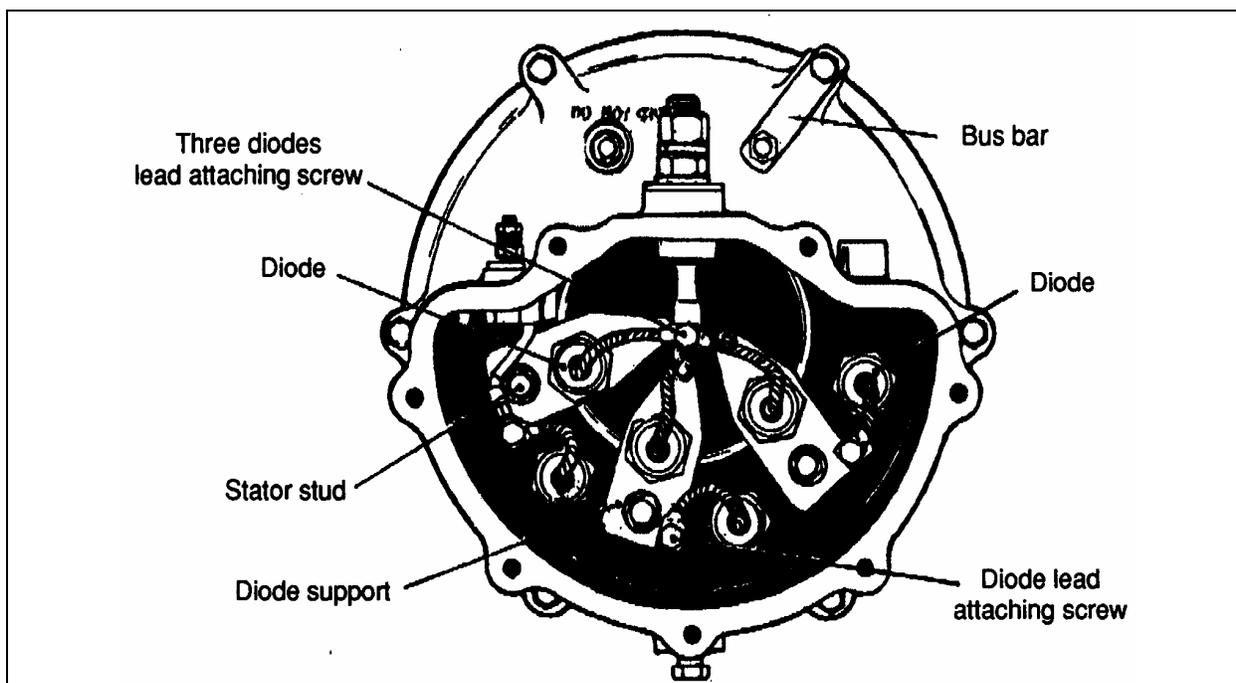


FIGURE 18: VIEW OF RECTIFIER END FRAME WITH COVER REMOVED

06069

To check diodes mounted in the supports for short fields, connect the positive ohmmeter lead to each diode lead and the ohmmeter negative lead to each support as shown in "A", "B", and "C" of figure 19. To check 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 parts "D", "E", "F". The ohmmeter readings may vary considerably when checking diodes for shorts, but if the reading is 300 ohms or less, the diode is probably defective and should be replaced. A diode that reads 300 ohms or less will allow excessive reverse current from the battery. Replace defective diodes as explained later in this section.

To check the diodes mounted in the diode supports for open fields, connect the ohmmeter negative lead to each diode lead and the ohmmeter positive lead to each support as shown in parts "A", "B", and "C" of figure 20. To check the diodes mounted in 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 parts "D", "E" and "F". An infinite resistance reading indicates an open diode. Diodes can be replaced by following the procedure outlined under DIODE REPLACEMENT".

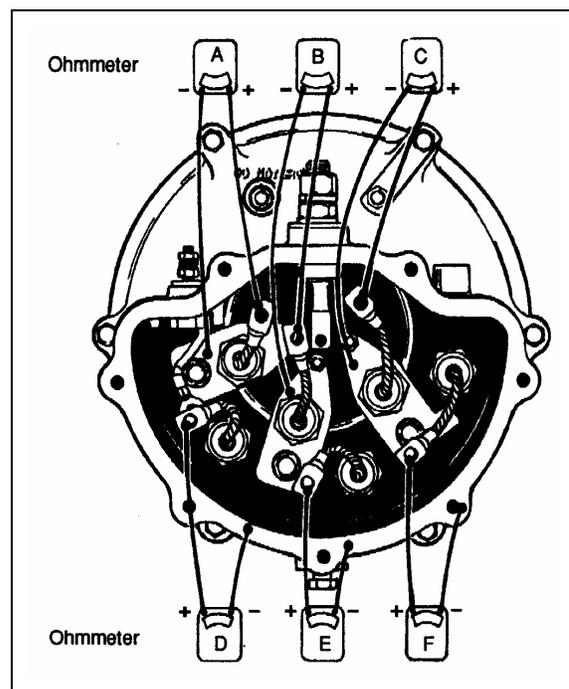


FIGURE 19: CHECKING DIODES WITH OHMMETER ON A TYPICAL OIL COOLED ALTERNATOR (END COVER REMOVED)

06070

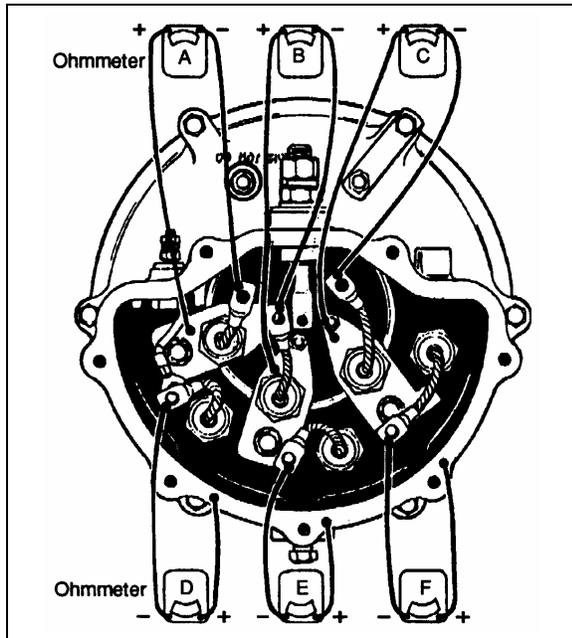


FIGURE 20: CHECKING DIODES WITH OHMMETER ON A TYPICAL OIL COOLED ALTERNATOR (END COVER REMOVED)

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When reinstalling diodes, torque to 9-11 lbf-ft (12-15 Nm). Re-stake next to the threads in an arbor press with an 1/8 inch (3,2 mm) round punch. Press the punch with gradual pressure. Do not strike as the shock may damage the diodes.

### 7.2.2 Field Winding Check

The field winding may be checked for shorts and opens with an ohmmeter. To check the field winding, connect the ohmmeter to field terminal and to ground. A resistance reading above normal indicates an open, and a reading less than normal indicates a short field. The normal resistance value is 3.0 to 3.3 ohms at 80 °F (27°C). 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. Coil resistance is approximately 3.1 ohms. Amperage readings, other than the above, indicate an open, grounded, or shorted field. A defective field coil 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 "FIELD REPLACEMENT" for a detailed procedure.

### 7.2.3 Stator Winding Check

The stator winding may be checked for open and short fields with an ohmmeter as follows:

#### Open Fields

Connect the ohmmeter leads to two pairs of diode supports as shown in parts "A", "B", and "C" of figure 21. Correct polarity of the leads must be observed. The ohmmeter should indicate a low resistance. If an infinite or a high resistance is measured in either one or both checks, the stator windings are open.

#### Ground

To check the stator windings for ground, connect an ohmmeter to the diode support and diode end frame as shown in part "C" of figure 21. The ohmmeter should indicate a very high or infinite resistance. If zero, or a very low resistance is measured, the windings are grounded.

#### Shorts

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 probable.

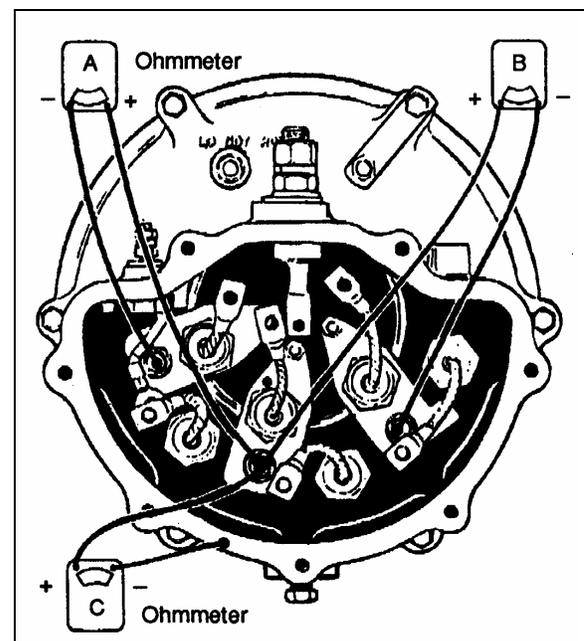


FIGURE 21: CHECKING STATOR WINDING FOR "OPEN" AND GROUND

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### 7.3 DIODE REPLACEMENT

The following replacement procedures are based on the assumption that the diode end cover is still off and diode leads were disconnected as explained earlier in this section.

**Note:** *When replacing a diode, make sure it is designed for a negative ground system. The diode can be identified by the symbol stamped on the diode case. The arrow must point toward the diode flexible lead.*

To replace the three diodes that are mounted in the supports attached to the stator lead studs, it is necessary to remove the diode and support assembly. The two outer diode and support assemblies are identical and can be installed on either side. The center unit has a different support, with 2 inches (50,8 mm) between the mounting hole centers.

**Note:** *The outer supports are provided with 2¼ inch (57,15 mm) center holes.*

#### 7.3.1 Diode Replacement (in Support)

1. Remove nut with lock washer attaching the diode support to the stator lead stud.
2. Remove nut, lock washer, and flat washer attaching support to the small stud in the end frame.
3. Remove the diode and support assembly. Then remove insert from small hole in support or from small stud in the end frame.
4. Remove nut and flat washer from diode mounting stud, then remove diode from the support.
5. Place a new diode in the support and install a flat washer and nut on the diode mounting stud. Hold the diode with a wrench placed over flats on the diode, while tightening nut on the mounting stud to a torque of 160-180 lbf-in (18-20 Nm).
6. Place diode and support assembly over the stator lead stud and the small mounting stud. Place insert over small stud inside the hole in the support. Install flat washer, lock washer, and nut on the small stud, and tighten to a torque of 22-25 lbf-in (2-3 Nm). Install nut with lock washer on stator lead stud and tighten firmly.

#### 7.3.2 Diode Replacement (in End Frame)

To remove diode, use a thin 1 inch open end wrench on flats of the diode case to unscrew diode from the end frame. Thread the new diode into the end frame and tighten to a torque of 160-180 lbf-in (18-20 Nm). If no other parts are to be replaced, refer to "DIODE END COVER INSTALLATION" in this section.

### 7.4 FIELD REMOVAL

1. Remove three diode and support assemblies from the end frame to provide access to the two lower field to end frame bolts.
2. Remove nut with lock washer and flat washer from three stator lead studs.
3. Remove the six bolts and lock washers attaching the diode end frame to the stator frame.
4. Separate the end frame from the stator frame, and remove the end frame and field assembly from the rotor while pushing the stator lead studs out of the end frame.
5. Remove nut, lock washer, flat washer, and insulating washer which secure the field lead terminal stud in the end frame. Push the stud out of the end frame.
6. Remove field terminal stud insulating bushing and seal from the end frame. Remove insulating sleeve from the field terminal stud.
7. Remove the four bolts and lock washers attaching the field to the end frame.
8. To separate the field from the end frame, install four 3/8-24 x 3 inch bolts in place of the 3/8-24 x 2 inch bolts removed in step 7. Thread bolts in to even heights. Support the end frame in an arbor press. Then, using a suitable press plate to exert pressure on all four bolt heads, press the field out of the end frame.

### 7.5 FIELD INSTALLATION

1. Position the field assembly on the end frame. Insert four 3/8-24 x 3 inch bolts through the end frame and thread into the field to keep holes aligned.
2. Support the end frame on an arbor press bed so that the diodes will not be damaged,

and press the field into the end frame. Press in until shoulder on field coil bottoms against the end frame.

3. Remove the four guide bolts. Install four 3/8-24 x 2 inch bolts, using new lock washers to attach the field to the end frame. Tighten bolts securely.
4. Place insulating sleeve in inner side of the field terminal stud hole in the end frame, and insert the terminal stud through the sleeve. Place two O-rings and insulating bushing over the terminal stud and push into hole in the end frame. Install insulating washer, flat washer, toothed lock washer, and nut on terminal stud. Tighten firmly.
5. Install each stator lead stud in the end frame as follows: Place insulating washer over the stud and insert the stud through the end frame. Place the insulating bushing over the stud and position in end frame hole. Install flat washer, lock washer, and nut on the stud. Tighten firmly.
6. Install three diode and support assemblies on the end frame as previously directed under "DIODE REPLACEMENT".
7. Install a new seal in notch around end of the stator frame. Insert field into the rotor and position the end frame against the stator frame. Attach end frame to the stator frame with six bolts and lock washers. Tighten bolts firmly.
8. If no other parts require replacement, refer to "DIODE END COVER INSTALLATION" in this section to complete the assembly.

### 7.6 STATOR REPLACEMENT

If tests performed under "Stator Winding Checks" earlier in this section indicated an open circuit or short in the stator, the stator and frame assembly must be replaced.

#### 7.6.1 Removal

1. Remove diode end frame and field assembly as previously directed in steps 1 through 4 under "Field Removal".
2. Remove the six bolts and lock washers attaching the stator frame to the drive end frame.

3. Separate the stator frame from the drive end frame and remove the stator frame from the end frame and rotor.

#### 7.6.2 Soldering Stator Terminal Leads

1. Using a wire brush, thoroughly clean the wire and terminal.
2. Silver solder the stat or lead to the terminal using a torch.
3. Thoroughly clean the silver solder connection with a wire brush.
4. Using a high grade energized rosin flux, coat the silver soldered connection with a 80-20 tin-lead solder or pure tin solder to prevent deterioration of the silver solder by engine oil.

**Note:** *The silver solder will provide the required mechanical strength, which will not be affected by temperature. The tin-lead solder will protect the silver solder connection from deterioration by engine oil.*

#### 7.6.3 Installation

1. Position new seal in notch around the drive end of the stator frame.
2. Position the stator and frame assembly over the rotor against the drive end frame. Attach the stator frame to the drive end frame with six bolts and lock washers. Tighten bolts firmly.
3. Install diode end frame and field assembly as directed in steps 5, 6 and 7 under "installation".
4. Install rectifier end cover as directed later.

#### 7.7 DIODE END COVER INSTALLATION

1. Make sure all diodes are properly installed and securely tightened. Leads from diodes threaded into the end frame must be securely attached to the diode supports. The relay terminal lead must also be attached to the left diode support.
2. Connect leads from the three diodes mounted in supports to the output terminal stud. Tighten the attachment screw firmly. Place insulating bushing over relay terminal stud.

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3. Place a new seal in the diode end frame.
4. With the end cover in place against the end frame, install the cap screws and lock washers. Tighten the cap screws evenly and firmly.
5. Make sure the drain plug is installed in bottom of the end cover and securely tightened.

### 7.8 ALTERNATOR REMOVAL (DELCO)

1. Place "Starter Selector Switch" in engine compartment to the "OFF" position.
2. Place the battery main disconnect switch to the "OFF" position.
3. Remove alternator drive belt (see "7.9 ALTERNATOR DRIVE BELT").

**Note:** When reinstalling drive belt, it is important to set the belt tension correctly. (refer to the appropriate heading later in this section).

4. Scratch off protective sealer from electrical connections (relay, field and positive terminals). Refer to figure 22.

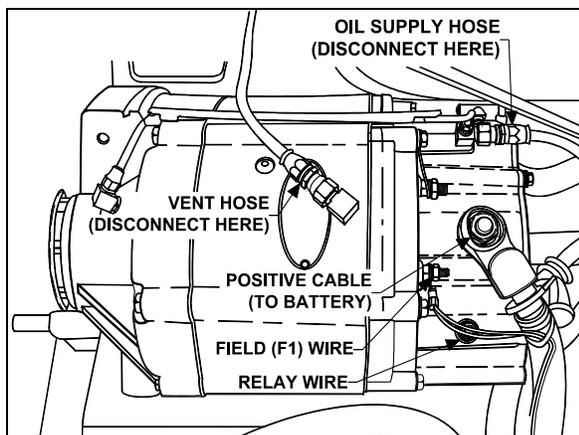


FIGURE 22: ALTERNATOR (HOSES AND WIRES) 06073

**Note:** After reconnecting electrical wires, it is important to cover terminals with protective sealer (Prévost #680745).

5. Disconnect wire #25 from the relay terminal, wire #107 from the field "F1" terminal and disconnect battery cable from the positive "+" terminal on the diode end cover. Tag wires removed to ease identification at time of installation. Refer to figure 22.
6. Disconnect oil supply line and vent hose from top of alternator (Fig. 22) and tape

lines to prevent entry of foreign matter. Disconnect oil drain hose from bottom of alternator (Fig. 23) and tape line to prevent entry of foreign matter.

7. Remove the four bolts and lock washer retaining alternator (refer to fig. 23).

**Warning:** Alternator weights approximately 154 lbs (70 kg). Another person is required to take the alternator out of engine compartment.

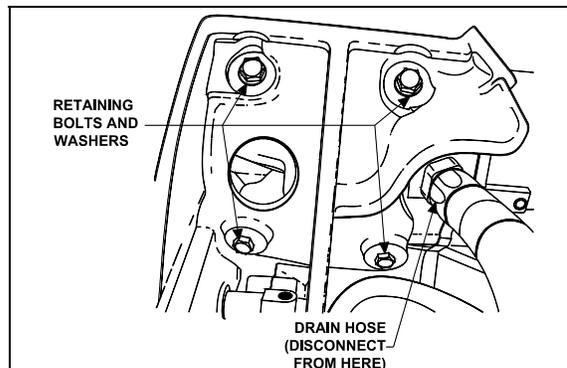


FIGURE 23: ALTERNATOR RETAINING BOLTS AND WASHERS 06350

#### 7.8.1 Disassembly of Alternator

After diode, field and stator winding checks, the alternator can be disassembled to repair a faulty component, such as field or stator, or to proceed with bearing or rotor replacement. Perform the following steps to disassemble the alternator:

1. Remove nuts and washers from "DC" terminal on diode end frame.
2. Separate the diode cover plate from the diode end frame by removing the mounting screws.
3. Remove the washer, nut and lock washer attaching the diode supports to the end frame, the three screws connecting the diode leads to the diode supports, and the three nuts which attach the stator studs to the diode supports.
4. Separate the diode support assemblies from the diode end frame, and the three nuts that 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 attachment screws.
7. Separate the field assembly from the diode end frame by removing the four attachment screws.
8. Separate the rotor assembly and drive end frame from the stator assembly by removing the attaching screws.
9. Remove the shaft nut and washer, and the pulley. Press the rotor shaft out of the drive end frame.
10. Remove the retainer plate and pull the bearings from the drive end frame.

#### 7.8.2 Alternator Cleaning and Inspection

Whenever the alternator is disassembled, it should be cleaned and inspected.

##### **Cleaning**

If sludge has accumulated on the stator, a light mineral oil should be used to clean it.

##### **Inspection**

When the alternator has been disassembled to the extent that the stator is exposed, the stator should be checked for the following:

- a) Adequate varnish.
- b) Proper spacing of conductors so that "near shorts" do not exist.
- c) Proper phase lead placement.
- d) Strong conductor and cross-over welds.

#### 7.8.3 Bearing or Rotor Replacement

Whenever the rotor and drive end frame are disassembled for any reason, the single-row ball bearing must be replaced with a new one due to the probability of damage during disassembly.

##### **Removal and Disassembly**

1. If the pulley was not removed from the rotor shaft at time of alternator removal, remove the nut and flat washer from the shaft and pull the pulley off the shaft.
2. Remove the six bolts and lock washers attaching the drive end frame to the stator

frame. Separate the drive end frame from the stator frame. Remove the drive end frame and support assembly.

3. Support the drive end frame in an arbor press so that the rotor can be pressed down out of the end frame. Using a suitable adapter against the end of the rotor shaft that will pass through the inner race of the double-row ball bearing, press the rotor down out of the end frame and bearings. Since the single-row bearing outer race is held in the end frame by the retainer plate, and the inner race is a press fit onto the rotor shaft, the bearing will probably be damaged when the shaft is pressed out and need to be replaced with a new part.
4. Remove the six screws attaching the bearing retainer plate to the drive end frame. Remove the retainer plate, the single-row bearing and the bearing spacer from the end frame.
5. Support the drive end frame in an arbor press with the double-row bearing down, so that the bearing can be pressed down out of the end frame. Using a suitable driver that will exert a force on the bearing outer race, press the bearing out of the end frame.
6. Remove the rubber bearing clamp from groove in the end frame.

##### **Assembly and Installation**

1. Install a new single-row ball bearing into inner side of the drive end frame. Install the bearing retainer plate and attach with six screws. Stake screws in place after tightening.
2. Position the rubber bearing clamp in the groove in bearing bore of the drive end frame. Lubricate the clamp to permit the bearing to be pressed in without dislodging or damaging the clamp.
3. Position the rotor in an arbor press with the shaft end up. Install the drive end frame and single-row bearing assembly over the rotor shaft. Using a driver over the rotor shaft, which will exert a force on the bearing inner race, press the bearing onto the shaft until it bottoms against the rotor.

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4. Install bearing spacer over the rotor shaft. Position the double-row bearing over the rotor shaft at end frame bore. Using an adapter that will exert a force on both the inner and outer races of the bearing, press the bearing onto the shaft and into the end frame until the inner race bottoms against the bearing spacer.
5. Place a new seal around the drive end of the stator frame.
6. Insert the rotor between the stator and field, and position the drive end frame against the stator frame. Attach the end frame to the stator frame with six bolts and lock washers. Tighten the bolts to a torque of 5 to 5.4 lbf-ft (6-7 Nm).

**Caution:** When replacing the alternator on the vehicle, ensure that an alternator with the proper drive ratio is used. Installation of an alternator with any other drive ratio will result in severe and costly damage to the alternator and engine.

### 7.8.4 Alternator Reassembly

Reassembly is the reverse of disassembly.

**Note:** When tightening the outside nut on the "DC" output terminal, torque the nut to 30-35 lbf-ft (41-47 Nm). The lower nut should be supported while doing so.

When reinstalling diodes, tighten to a torque of 9-11 lbf-ft (12-15 Nm).

### 7.8.5 Output check

When removed from the engine, the alternator may be checked without circulating oil on a test bench, providing the output is limited to 100 amperes or less. The alternator may be bench tested 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 without adequate oil circulation for periods exceeding 15 seconds, will cause the alternator to overheat, resulting in damage to the winding and diodes.

If the alternator is to be operated at an output greater than 100 amperes for longer than 15 seconds, circulating oil must be provided. SAE 30 engine oil must be applied to the connection on the diode end cover at a pressure of 35 psi

and at a temperature of 60 °F to 220 °F (16°C to 104°C). This will provide an oil flow of about one gallon per minute.

To check the alternator on a test bench, make electrical connections as shown in figure 20. Make sure the negative battery terminal is connected to the alternator frame.

## 7.9 ALTERNATOR DRIVE BELT

### Removal

1. Insert a ¾ inch socket drive into one of the tensioning arm opening (Fig. 24).

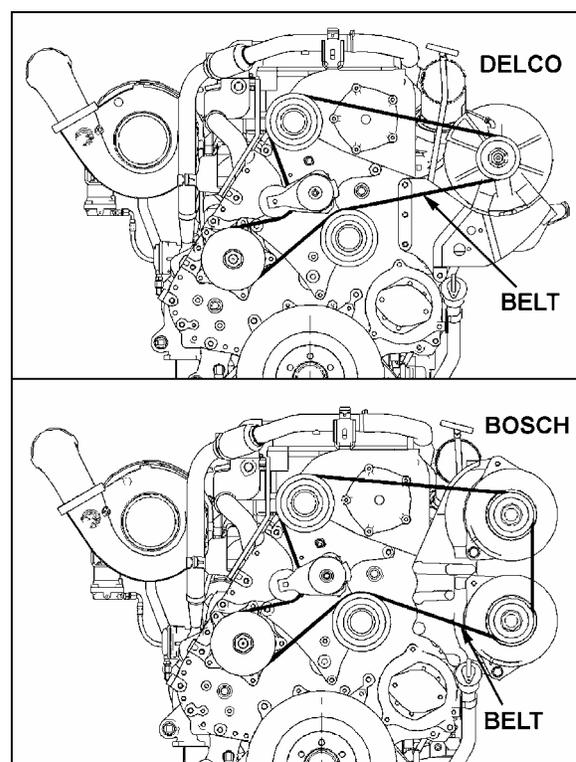


FIGURE 24: ALTERNATOR DRIVE BELT

06342

2. Twist the tensioning arm to slacken belt.
3. Remove belt.

### Installation

Installation of the alternator drive belt is the reverse of removal.

### 7.9.1 Adjustment

Correct belt tension is required to maximize belt life. The tensioning arm maintains proper belt tension, no adjustment is required.

Check for wear and proper tension every 6,250 miles (10 000 km) or twice a year, whichever comes first.

## 8. VOLTAGE REGULATOR (DELCO)

The 24 volt regulator (Delco) is located in the main power compartment.

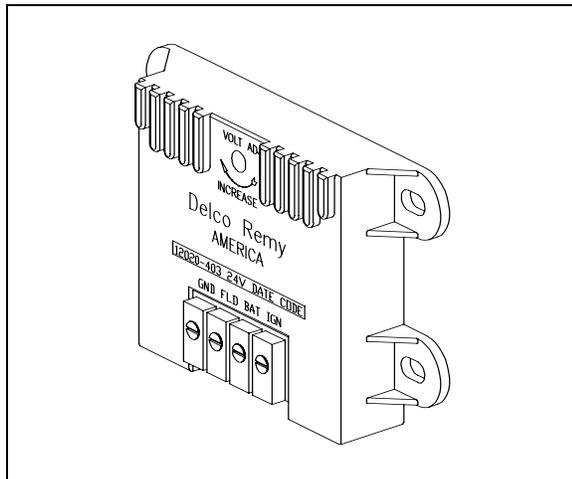


FIGURE 25: VOLT REGULATOR

06408

The transistor regulator illustrated in figure 25 is an assembly mainly consisting of diodes, capacitors, resistors and transistors. These components are mounted on a printed circuit panel board to form a completely static unit containing no moving parts. Regulators of this type have only four terminals which are identified "GND." (ground), "FLD" (field) "BAT" (battery) and "IGN" (ignition).

The regulator components work together to limit the alternator voltage to the preset value by controlling the alternator field current. This is the only function that the regulator performs in the charging system.

The voltage at which the alternator operates is determined by the regulator adjustment. Once adjusted, the alternator voltage remains constant. The regulator is unaffected by length of service, changes in temperature, or changes in alternator output and speed.

A typical wiring diagram of a negative ground system is illustrated in figure 26. This diagram shows only the basic charging system components. It does not show any components such as the control relays. Refer to "Charging system" wiring diagram, in "Wiring diagrams" for the electric circuits and connections.

## Voltage regulator maintenance

The voltage regulator is a service-free electronic unit. When it fails, it should be replaced. The following procedure must be used:

- Open the main power compartment door in order to get access to the voltage regulator;
- Unscrew the electrical cable connectors;
- Unscrew the voltage regulator unit;
- Install a new voltage regulator by reversing the procedure.

**Caution:** Place the battery main disconnect switch to "OFF" position.

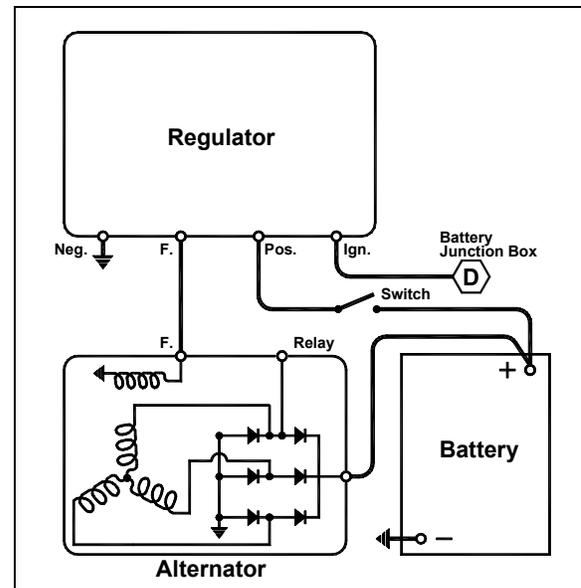


FIGURE 26: TYPICAL WIRING DIAGRAM OF A NEGATIVE GROUND SYSTEM

06415

**Note:** For information about BOSCH alternator and voltage regulator, refer to technical publication "Repair and Testing Instructions for T1 Alternator 0120 689 552".

## 8.1 TROUBLESHOOTING PROCEDURES

Trouble in the electrical system will usually be indicated by one of two conditions: an undercharged or an overcharged battery. Either condition can result from an improper voltage regulator setting:

### Checking Battery Voltage

The absence of gas production during the continuous appearance of the green dot in the battery's built-in hydrometer indicates that the

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voltage setting is satisfactory. Check the following conditions:

### Checking Voltage Regulator Setting

1. To check the voltage setting, connect a voltmeter across the "POS" and "NEG" terminals on the regulator, and an ammeter to the "C" terminal on the alternator. Refer to figure 27.

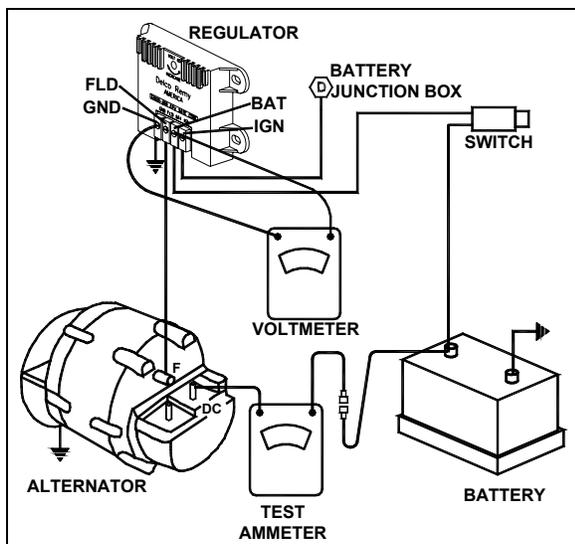


FIGURE 27: REGULATOR VOLTAGE TEST 06416

2. Operate the engine at approximately 1000 rpm (about 2300 alternator rpm), with accessories on, to obtain an alternator output of 20-200 amperes.
3. Note the voltage setting. It should be steady at 27.5 volts.
4. If not, the desired setting can be obtained by removing the plug from the voltage regulator cover and slightly turning the adjusting screw inside the regulator. Turn the adjusting screw clockwise to increase the voltage setting or counterclockwise to decrease it. See figure 28 for details.

**Note:** If regulator voltage cannot be adjusted to the specified setting, remove the regulator and repair or replace it as necessary.

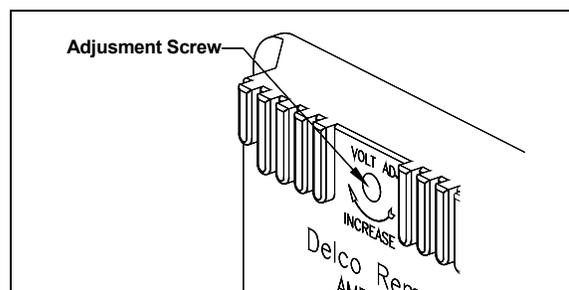


FIGURE 28: ADJUSTING REGULATOR VOLTAGE SETTING

06418

### 8.1.1 Undercharged Battery

If the voltage setting is steady and reasonably close to the specified value and the battery is undercharged, raise the setting by 0.3 volt, then check for an improved battery condition over a minimum service period of 48 hours. If the voltage cannot be adjusted to the desired value, the alternator should be checked as follows:

1. Stop alternator, turn off all accessories and disconnect battery ground cable.
2. Disconnect all leads from the regulator and from the alternator field. **Do not allow leads to touch ground.**
3. Connect a voltmeter and an ammeter in the circuit at the alternator "DC" terminal.
4. Connect a jumper lead from the alternator "DC" terminal to the alternator field terminal.
5. Connect a carbon pile resistor load across the battery. Turn to the "Off" position.
6. See figure 29 for wiring connections.

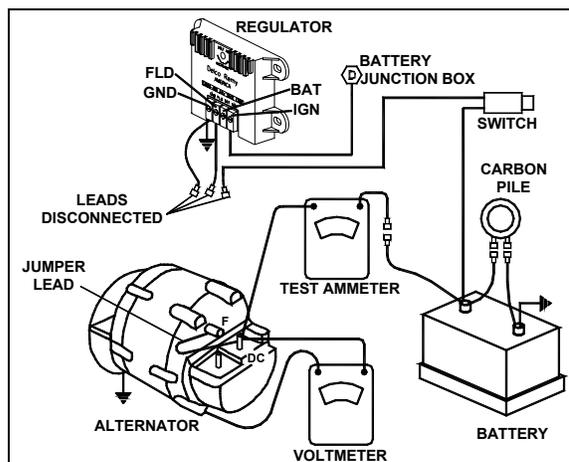


FIGURE 29: REGULATOR VOLTAGE TEST (UNDERCHARGED BATTERY)

06417

7. Reconnect battery ground cable
8. Turn on all vehicle accessories.

9. Operate alternator and adjust carbon pile resistor load as required to check for rated output as given in Delco-Remy Service Bulletin 1G-187 or 1G-188.
10. Check the alternator field winding as follows: Disconnect the lead from the field terminal and connect an ohmmeter from the field terminal to ground. A resistance reading above normal indicates an open field, and a resistance reading less than normal indicates a shorted or grounded field. The normal resistance can be calculated by dividing the voltage by the field current published in Delco-Remy Service Bulletin 1G-186, 1G-187, or 1G-188. The normal resistance value should be at or near midscale on the ohmmeter for accuracy. An alternate method of checking is to connect a battery of specified voltage and an ammeter in series with the field winding, and compare readings with published specifications in Delco-Remy Service Bulletin 1G-186, 1G-187, or 1G-188. An alternator is defective if it does not produce rated output or if field windings are faulty. If the alternator provides rated output, and field windings check satisfactorily, the regulator should be checked as covered under "Regulator Checks".

#### 8.1.2 Overcharged Battery

If the voltage setting as checked above is steady and reasonably close to the specified value, lower the setting by 0.3 volt and check for an improved battery condition over a minimum service period of 48 hours. If the voltage cannot be adjusted to the desired value, proceed as follows: where the alternator field is grounded internally in the alternator as shown in figure 26 a shorted or grounded field or a defective regulator can cause an overcharged battery. The field winding can be checked as covered in paragraph "Undercharged Battery". If the field winding is found to be correct, the alternator is not defective, and the regulator should be checked as covered under "Regulator Checks".

#### 8.2 REGULATOR CHECKS

Separate the cover from the base, and remove the panel assembly from the cover. Carefully note the location of all washers and lock washers.

The component parts are keyed to figure 26. Before making electrical checks, visually inspect the components and make sure all soldered

connections are secure. Various electrical checks with an ohmmeter can be made to determine which components are defective.

The ohmmeter **must** be accurate, and should be a scale-type meter with a 1.5 or 3 volt cell. Most digital ohmmeters cannot be used to check semiconductors. However, some digital ohmmeters are specially designed to test semiconductors and can be used to test components in the regulator. Consult the ohmmeter's manufacturer for specifications concerning the capabilities of the ohmmeter.

It is important that all of the following checks be made. If a defective part is found, replace it before proceeding with the remaining checks. Be sure to make all the checks since more than one component may be defective.

A defective regulator can be repaired according to the following methods:

- A) By changing the printed circuit board in the regulator. Unscrew the retaining screws on the printed circuit and remove it. Install a new printed circuit board. This method is the most commonly used.
- B) By removing any retaining screws involved and unsoldering the connections. When resoldering, limit solder time to a minimum as excessive heat may damage the printed circuit board and component parts. However good soldered connections are essential for satisfactory operation. A resin core 63% tin 37% lead solder with a 360 °F (182°C) melting point is recommended along with a soldering iron rated at 50 watts or less. Use extreme care to avoid overheating. Before checking the printed circuit board, remove transistor TR1, which must be checked separately. Connect the ohmmeter as shown in figure 29, and then reverse the ohmmeter leads to obtain two readings on the same component. Use the middle scale on scale-type meters on which the 300 ohm value should be within, or nearly within, the middle third of scale.

**Capacitors C1 and C2 =** The ohmmeter should read high and low on each capacitor. If not, replace capacitor.

**Diodes D1, D2 and D3 =** Each diode should give one high and one low reading. If not, replace diode.

## Section 6: ELECTRICAL

**Resistor R2 =** Turn voltage adjustment screw (identified in figure 28) with ohmmeter connecting each way. Reading should change as slotted screw is turned. If not, replace R2.

**Transistor TR1 =** See figure 30. Use the low scale. Each of the three checks should read low and high. If not, replace TR1.

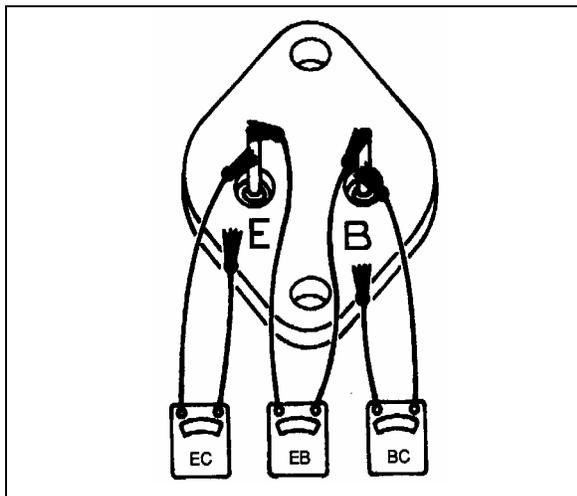


FIGURE 30: CHECKING TRANSISTORS TR1 06081

**Transistor TR2 =** Change the ohmmeter to use the low scale. EB should read low and high. BC should read low and high. EC should both read high. If not, replace TR2. See figure 31.

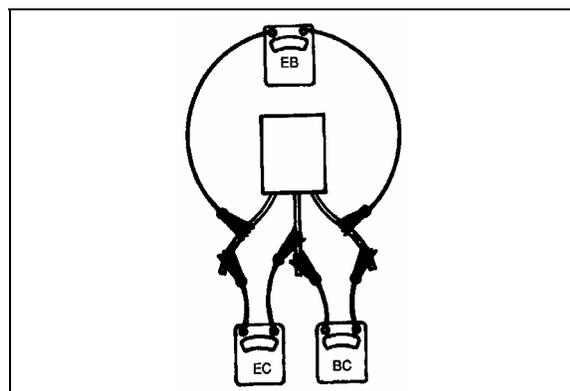


FIGURE 31: CHECKING TRANSISTORS TR2 06082

### 8.3 ADJUSTING VOLTAGE

After repair, the regulator must be adjusted to the desired voltage setting. Follow the procedure under "Checking Voltage Regulator Setting". Slowly turn the adjusting screw full range and observe the voltmeter to ensure that the voltage is being controlled, then, while still turning, slowly adjust to the desired setting.

## 9. BATTERY EQUALIZER

VoltMaster Battery equalizer owner's manual (100 amps) is annexed at the end of this section.

Battery equalizer is located in the main power compartment.

## 10. STARTER

Refer to Mitsubishi Electric Corporation (MELCO) Service bulletin ME003-P annexed at the end of this section for information and maintenance instruction on MELCO 105P70 starter.

## 11. ENGINE BLOCK HEATER

The vehicle may be equipped with an engine immersion-type electric block heater to assist cold weather starting. The heater male electric plug is located on the engine compartment door (Fig. 32) or on the engine compartment R.H. side door. To use it, connect the female plug of an electrical extension cord to the heater plug. Some converted vehicles may have the heater connected to the coach AC power system. The extension cord must be plugged into a 110-120 V AC power source only. The engine block heater should be used whenever the vehicle is parked for an extended period of time in cold weather and a suitable power source is available.

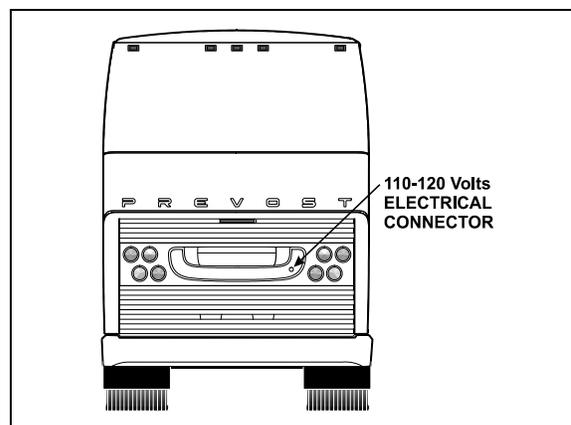


FIGURE 32: ELECTRIC HEATER PLUG LOCATION 06481

### 11.1 MAINTENANCE

This heater is non-serviceable except for the cord, and if faulty, must be replaced as a unit.

## 12. EXTERIOR LIGHTING

The circuit for exterior lights, as well as their control switches, relays and circuit breakers are shown on the applicable wiring diagrams. Wiring diagrams are located in the technical publication box.

### 12.1 HEADLIGHTS

Each headlight assembly consists of two headlamp module 90 mm (3½ inch) equipped with a 12-volt halogen bulb and one 100 mm (4 inch) 12-volt LED turn/signal lamp. Outer lamps have a double function (both low and high beam). Inner lamps are used for high beam or daytime running light. The inner or outer lamp uses the same single filament halogen bulb part number.

**Note:** If vehicle is equipped with optional Xenon headlamps, refer to paragraph 12.1.6.

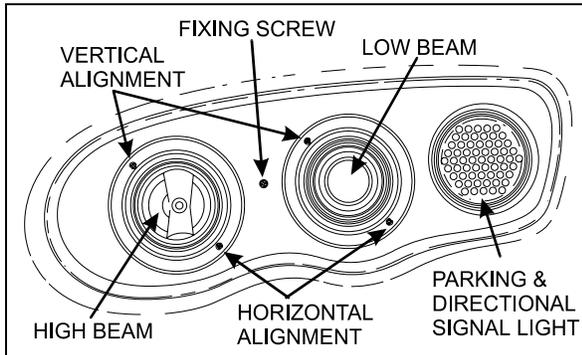


FIGURE 33: HEADLIGHT ASSEMBLY 06481

#### 12.1.1 Headlight Beam Toggle Switch

The multifunction lever located on the steering column is used to select proper lighting. High beams or low beams can be selected by pulling the lever rearward. A high beam indicator on the central dashboard panel is illuminated when the high beam circuit is energized.

**Note:** Pulling the lever rearward while the lights are off will flash the headlights.

#### 12.1.2 Maintenance

Clean headlights with soap and water and a good glass cleaner whenever dirty. For maximum illumination, headlight connections must be coated with a dielectric grease to prevent oxidation and proper voltage must be maintained. Low battery voltage, loose or dirty contacts in wiring system and poor ground contribute to a decrease in voltage. Check wiring and connections regularly and keep battery properly charged. When a headlight

burns out, a new bulb must be installed. Headlights must be properly aimed to provide maximum allowable road illumination. When using mechanical aiming devices, follow manufacturer's instructions.

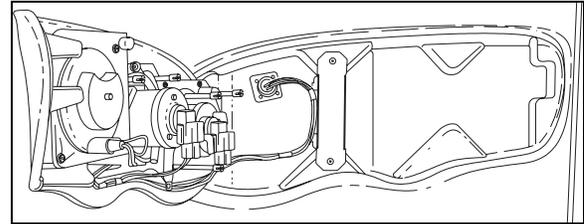


FIGURE 34: OPENING HEADLIGHT ASSEMBLY 06482

Headlight aim should be checked after installing a new bulb. Aiming can be performed without opening headlight assembly. Horizontal and vertical aiming of each module is provided by two adjusting screws that pivot the module in the housing for proper alignment (fig. 33). There is no adjustment for focus since the module is set for proper focus during manufacturing assembly.

**Note:** Make sure headlight assembly is properly positioned into its housing before securing using fixing screw.

**Caution:** Use a soft cloth to clean the parking and front turn signal lamp.

#### 12.1.3 Headlight Adjustment

The following is a general procedure for headlight adjustment using a mechanical equipment, such as a "Hoopy 100" Aligner. If your mechanical equipment is different, refer to the manufacturer's instruction manual.

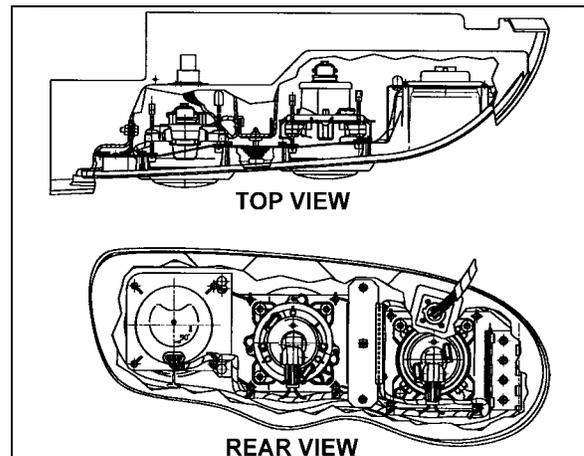


FIGURE 35: HEADLIGHT ASSEMBLY TOP & REAR VIEW 06495

Setting aligner according to slope

## Section 6: ELECTRICAL

1. Park vehicle on a level floor.
2. Set the support rail (Prévost #29261) down (Fig. 36). Using shims, adjust its level to stabilize it.

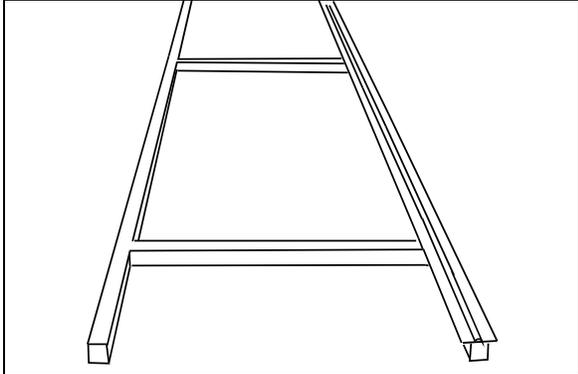


FIGURE 36: SUPPORT RAIL INSTALLATION 06501

3. Install jigs #29263 and #29262 onto the support rail. Position the support rail so that both stops are centered between the two beams (Fig. 37). Mark the position for future reference.

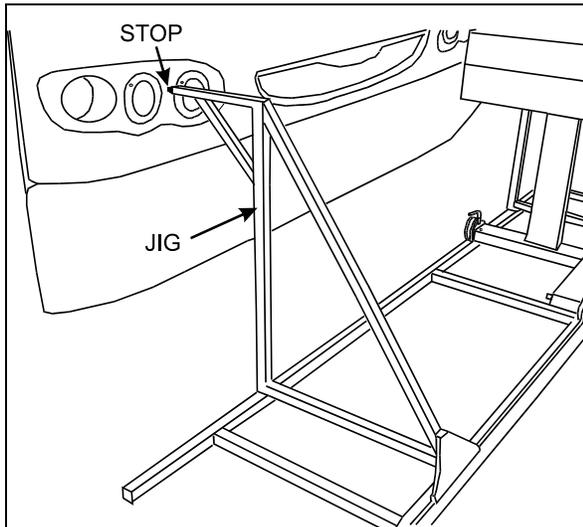


FIGURE 37: INSTALLATION OF JIGS 06499

**Note:** The stops will position the support rail between 16-24 inches of vehicle.

4. Remove the jigs.
5. Install "Hoopy 100" Aligner onto support rail (Fig. 38).
6. Using an Allen key on the front wheel, level Hoopy 100 aligner until spirit level bubble is centered (Fig. 39 and 40).

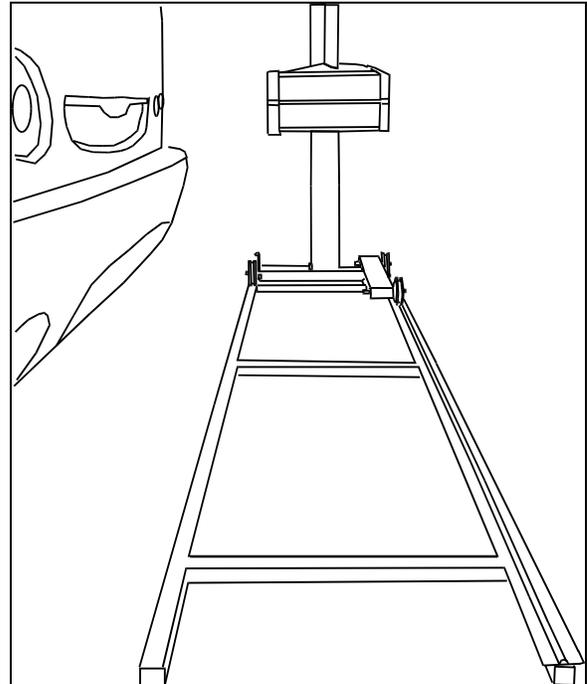


FIGURE 38: INSTALLATION OF HOOPY 100 ALIGNER 06496

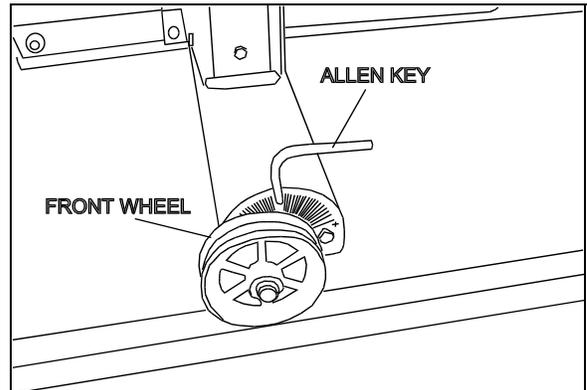


FIGURE 39: ADJUSTING HOOPY 100 LEVEL 06498

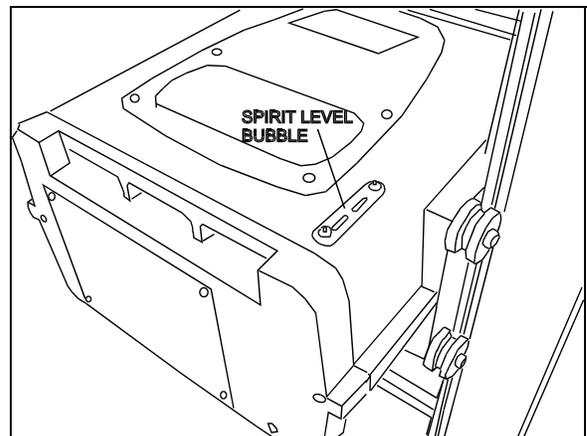


FIGURE 40: SPIRIT LEVEL 06500

7. Install a calibration fixture in the axis of front axle wheel and one in the axis of rear axle wheel (Fig. 41).

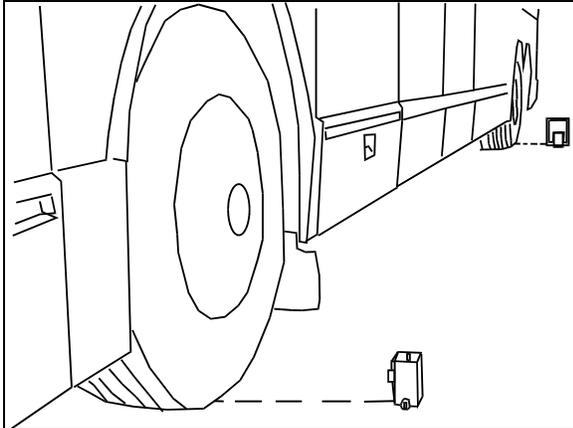


FIGURE 41: INSTALLING CALIBRATION FIXTURES 06497

8. Adjust mirrors so that lines are perfectly aligned.
9. Record reading.

**Note:** The floor level reading must be added to the aligner reading to ensure a precise alignment.

10. Transfer positive (+) or negative (-) reading of calibration fixtures to the front wheel of Hoopy 100 aligner. Add this reading to Hoopy 100 aligner level reading.

● eg – level: 0.2, mirrors: 0.1 = 0.3

● eg – level: -0.2, mirrors: 0.1 = 0.1

**Note:** If vehicle remains stationary during the headlight alignment procedure, it is not necessary to check floor slope each time.

### Headlight Alignment

**Caution:** This mechanical equipment must be calibrated by metrology before initial set-up or after major overhaul. Calibration must be performed annually.

1. Set the support rail (Prévost #29261) down (Fig. 36). Using shims, adjust its level to stabilize it. Use previous reference marks to ensure proper positioning.
2. Make sure that headlight assembly fixing screw is properly fastened (Fig. 33).

**Note:** Make sure that vehicle is at proper height (suspension) and that air pressure is above 90 psi.

3. Install “Hoopy 100” Aligner onto support rail (Fig. 38). Turn aligner ON.

**Caution:** Vehicle must be parked at the same location each time. If location is changed for any reason, floor slope alignment and aligner leveling must be redone. Refer to “Setting aligner according to slope”.

**Note:** If aligner indicates LOW BATT, battery must be charged for 12 hours.

### Low beam adjustment

1. Turn ON low beam lights.
2. Press ALIGN TO LAMP and move aligner in front of first beam.

**Note:** If beam is offset, a LOW CANDLES message will appear. Using vertical and horizontal alignment screws, adjust beam as needed (fig. 33).

3. Adjust aligner height (move aligner sideways if needed) so that XX appears in the aligner sight. Lock aligner side handle.
4. Open Hoopy 100 aligner door.
5. Press AIM LAMP down, press a second time so that LOW ADJUST appears in the sight. Arrows indicate in which direction to adjust the beam using the vertical and horizontal adjustment screws. Perform this adjustment until XX appears in the sight.
6. Aligner will reset after 5 minutes.
7. Repeat for other low beam light.

### High beam adjustment

1. Turn ON high beam lights.
2. Press ALIGN TO LAMP and move aligner in front of first beam.
3. Adjust aligner height (move aligner sideways if needed) so that XX appears in the aligner sight. Lock aligner side handle.
4. Open Hoopy 100 aligner door.
5. Press AIM LAMP down, press a second time so that HIGH ADJUST appears in the sight. Arrows indicate in which direction to adjust the beam using the vertical and horizontal adjustment screws. Perform this adjustment until XX appears in the sight.
6. Aligner will reset after 5 minutes.

## Section 6: ELECTRICAL

7. Repeat for other high beam light.
8. Store equipment away in a safe place.

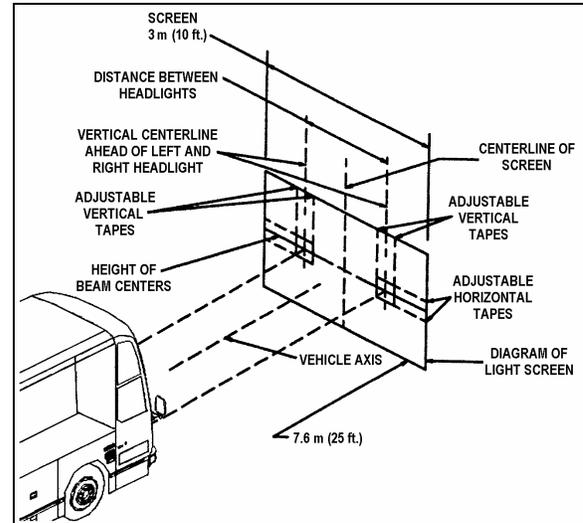
If proper mechanical equipment is not available, perform adjustments as described below:

1. Headlight aiming and inspection can be accomplished by visual means. This is done on a screen located at a distance of 25 feet (7,6 m) of the headlights. It should be of adequate size with a matte-white surface well shaded from extraneous light and properly adjusted to the floor area on which the vehicle stands. Provisions should be made for moving the screen or its vertical centerline so that it can be aligned with the vehicle axis. In addition to the vertical centerline, the screen should be provided with four laterally adjustable vertical tapes and two vertically adjustable horizontal tapes.
2. The four movable vertical tapes should be located on the screen at the left and right limits called for in the specification with reference to centerlines ahead of each headlight assembly.
3. The headlight centerlines shall be spaced either side of the fixed centerline on the screen by  $\frac{1}{2}$  the lateral distance between the light source centers of the pertinent headlights. The horizontal tapes should be located on the screen at the upper and lower limits called for in the specification with reference to the height of beam centers and the plane on which the vehicle rests, not the floor on which the screen rests (Fig. 42).
4. The nominal vertical aim position on lower beam headlights shall be adjusted based on the headlight mounting height, from the ground to the light source center of the headlight, according to table 1.

**TABLE 1 – VERTICAL BEAM AIM GUIDELINES**

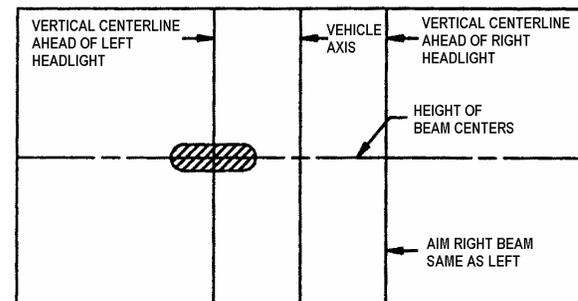
Headlight (centerline) Mounting Height	Nominal Vertical Aim	Aim Inspection Limits for Vertical Aim
56 to 90 cm (22 to 36 inch)	0 Vertical	10 cm (4 inch) up to 10 cm (4 inch) down
90 to 120 cm (36 to 48 inch)	5 cm (2 inch) down	5 cm (2 inch) up to 15 cm (6 inch) down
120 to 140 cm (48 to 54 inch)	6.4 cm (4 inch) down	4 cm (1.5 inch) up to 16.5 cm (6.5 inch) down

5. High beam headlights are aimed so that the center of the high-intensity zone is located at the horizontal and straight ahead vertically (Fig. 43).
6. Low beam headlights are aimed so that the top edge (the cutoff) of the high-intensity zone is at the vertical location as per Table 1 and the left edge of the high-intensity zone is at the vertical centerline of the headlight (Fig. 44).



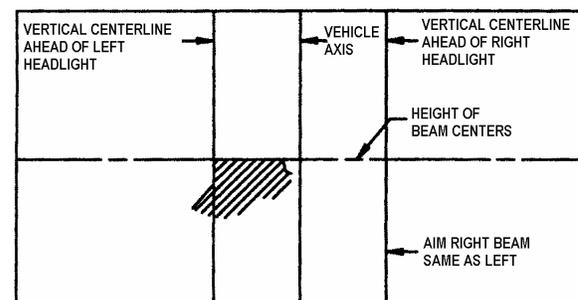
**FIGURE 42: A LIGNMENT OF HEADLIGHT AIMING SCREEN**

06502



**FIGURE 43: HIGH-INTENSITY ZONE (SHADED AREA) OF A PROPERLY AIMED UPPER BEAM ON THE AIMING SCREEN 7.6 M (25FT) IN FRONT OF VEHICLE**

06503



**FIGURE 44: HIGH-INTENSITY ZONE (SHADED AREA) OF A PROPERLY AIMED LOWER BEAM ON THE AIMING SCREEN 7.6 M (25 FT) IN FRONT OF VEHICLE**

06504

- The inspection limits for high-beam headlights shall be with the center of the high-intensity zone from 10 cm (4 inch) up to 10 cm (4 inch) down; and, from 10 cm (4 inch) left to 10 cm (4 inch) right on a screen at 7.6 m (25 ft.) (Fig. 45).

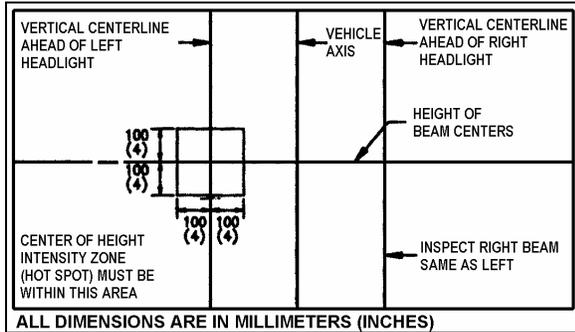


FIGURE 45: AIM INSPECTION LIMITS FOR UPPER-BEAM HEADLIGHTS 06505

- The inspection limits in the vertical direction for low-beam headlights or the low beam of a dual-beam headlight, shall be as described in Table 1. In the horizontal direction, the left edge of the high-intensity zone shall be located from 10 cm (4 inch) left to 10 cm (4 inch) right of the vertical centerline of the beam. The viewing screen shall be located 7.6 m (25 ft.) in front of the vehicle (Fig. 46).

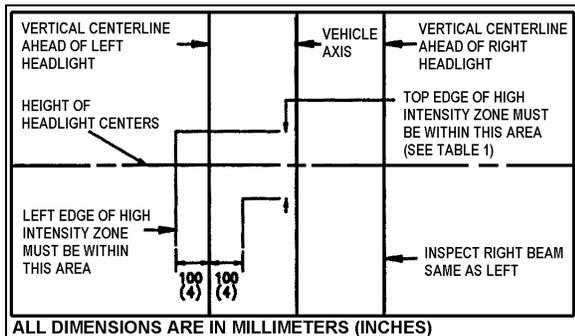


FIGURE 46: AIM INSPECTION LIMITS FOR LOWER-BEAM HEADLIGHTS 06506

#### 12.1.4 Sealed-Beam Unit

##### Bulb Removal and Replacement

- Remove the headlight screw fixing the headlight assembly, then pivot headlight assembly out (Fig. 33 and 34).
- Remove connector from headlight bulb.
- Remove the bulb by pushing and rotating it out of the socket.

- Install the new bulb by reversing the previous procedure.

**Caution:** During this step, avoid contacting the bulb with the fingers not to alter the bulb life.

**Note:** Do not disrupt headlight adjustment screws.

##### Module Replacement

- Remove screw fixing headlight assembly to its housing (Fig. 33) and pivot assembly out.
- Remove connector from headlight bulb.
- Unfasten three metal clips attaching headlight unit to support.
- Install new module and fasten metal clips.
- Install wiring connector on back of new sealed beam unit.
- Pivot headlight assembly back into its housing then secure using fixing screw.

**Note:** Make sure headlight assembly is properly positioned into its housing before securing using fixing screw.

- Perform alignment procedure.

**Note:** The headlight aim must be checked and adjusted even if it was properly adjusted before the sealed beam unit was replaced.

#### 12.1.5 Front Turn Signal

The front turn signal is part of the front headlight assembly. The turn signal is a sealed unit (LED) located on each front corner and should be replaced as an assembly. Turn signal is visible from both front and side.

##### Removal and Replacement

- Remove screw fixing headlight assembly to its housing (Fig. 33) and pivot assembly out.
- Partially unfasten back plate fixing screws, then remove signal lamp.
- Remove socket from signal lamp.
- Install wiring connector on back of new signal lamp then install signal lamp.
- Fasten back plate fixing screws then pivot headlight assembly back into its housing then secure using fixing screw.

**Note:** Make sure headlight assembly is properly positioned into its housing before securing using fixing screw.

## Section 6: ELECTRICAL

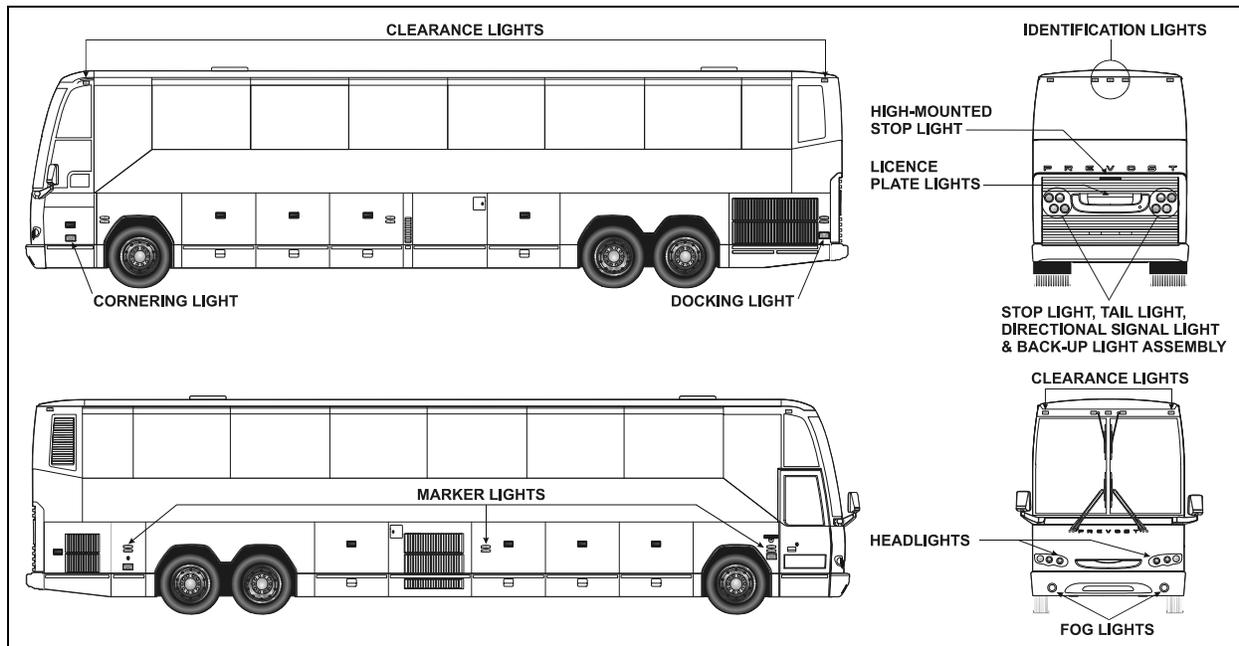


FIGURE 47: VARIOUS LIGHTS LOCATION

06480

### 12.1.6 Optional Xenon Headlamp

The outer lamps of each headlight assembly may be equipped with the optional Xenon lamps. These lamps improve visibility and provide better lifespan.

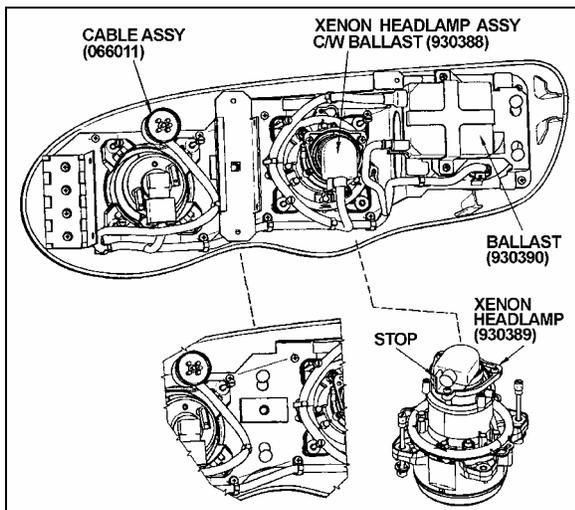


FIGURE 48: XENON HEADLAMP LOCATION

06540

### Bulb Removal and Replacement

1. Remove the headlight screw fixing the headlight assembly, then pivot headlight assembly out (Fig. 33 and 48).
2. Remove main cable connector (066011).

3. Remove connector from headlamp bulb by turning counterclockwise.
4. Unscrew the three Phillips head screws, pull the retainer and bulb out.

**Caution:** To avoid breaking the bulb, make sure the socket is in proper position against the stop.

5. Install the new bulb by reversing the previous procedure.

**Caution:** During this step, avoid contacting the bulb with the fingers not to alter the bulb life.

**Caution:** Never connect a voltmeter or V.O.M. to measure bulb voltage as instrument will be destroyed.

**Note:** Do not disrupt headlight adjustment screws.

### 12.2 STOP, TAIL, DIRECTIONAL, BACK-UP, AND HAZARD WARNING LIGHTS

A combination stoplight, taillight, directional signal light and back-up light assembly is mounted at the rear, on each side of the vehicle. Furthermore, when braking, a high-mounted stoplight will illuminate simultaneously with the stoplights on the sides for increased safety.

The stop and tail lights are combined in the same 6-LED lamp. The directional signal and license plate lights consist of individual LED lights mounted on the engine rear door, and

each light is serviced individually as a complete unit. The back-up light sealed unit uses a regular tungsten bulb.

The hazard warning flashing system uses the front, side and rear directional lights simultaneously. This system is energized by a switch on the L.H. dashboard.

#### 12.2.1 Lamp Removal and Replacement

1. Open engine compartment rear door.
2. Unscrew the lamp support retaining screws (2), and then from the outside, remove the lamp and its support.
3. From the outside, install the new lamp with its support then fasten the retaining screws.

#### 12.2.2 High-Mounted Stop Light Removal and Replacement

This vehicle is equipped with a high-mounted stop light (LED). This light is a sealed unit and should be replaced as an assembly in accordance with the following procedure:

1. Unscrew both "Phillips" light screws, then remove the light assembly.
2. Position the new light assembly and install the "Phillips" screws.

#### 12.3 LICENCE PLATE LIGHT

Two LED units are mounted above the rear license plate(s) of vehicle. In case of burn out, the LED unit must be changed according to the following procedure.

1. Pry out the rubber seal with a small screwdriver. Pull on the LED unit and disconnect it.
2. Reconnect new LED unit, place rubber seal, and press on it until it is seated in position.

#### 12.4 CLEARANCE, IDENTIFICATION AND MARKER LIGHTS

The vehicle is equipped with marker, identification and clearance lights (LED). The clearance lights are mounted at each corner of the coach near the top and the identification lights are in the upper center of rear and front sections. The rear clearance and identification lights are red and the front ones are amber.

The amber marker lights are mounted along the sides of vehicle.

#### 12.4.1 Marker Light Removal and Replacement

The side marker light is a sealed unit (LED) and should be replaced as an assembly in accordance with the following procedure:

1. Unscrew both "Phillips" light screws, disconnect and remove the light assembly.
2. Connect and position the new light assembly and install the "Phillips" screws.

#### 12.4.2 Clearance and Identification Light Removal and Replacement

The clearance and identification lights are sealed units (LED) and should be replaced as an assembly in accordance with the following procedure:

1. Unscrew both "Phillips" light screws, disconnect and remove the light assembly.
2. Connect and position the new light assembly, then install the "Phillips" screws.

#### 12.5 DOCKING AND CORNERING LIGHTS

This vehicle is provided with two halogen sealed-beam units that serve as cornering lights. They are mounted on the vehicle as follows: one is mounted on the front L.H. side service compartment door, while the other is located between the front wheel and the entrance door on the R.H. side. The main function of these lights is to increase lateral visibility when turning a corner. These lights are energized simultaneously with the directional lights. On the V.I.P. model, a dashboard-mounted rocker switch may be actuated to cancel this system in special situations.

Two additional halogen sealed-beam units are installed on rear electrical compartment door (R.H.) and radiator door. These lights are used as docking lights and both will illuminate automatically when reverse range is selected to facilitate back-up or docking procedure.

On the V.I.P. model, these lights do not operate automatically when the reverse range is selected, but by means of a dashboard-mounted rocker switch. When actuated, the docking as well as the cornering lights illuminate. Furthermore, a "Low docking" switch, also located on dashboard, allows the use of the docking and cornering lights at a lower intensity when the docking switch is actuated.

#### 12.5.1 Lamp Removal and Replacement

## Section 6: ELECTRICAL

Both docking and cornering sealed-beam units can be changed in accordance with the following procedure:

1. Remove the two “Phillips” screws attaching the retaining ring.
2. Disconnect the light unit connection.
3. Remove the lamp.
4. Position new lamp.
5. Connect and position the light unit.
6. Finally, install the retaining ring and screw.

### 12.6 FOG LIGHTS

Optional halogen fog lights can be mounted on this vehicle to give the driver better visibility in foggy weather, or to improve the range of vision just ahead of the coach.

#### 12.6.1 Bulb Removal and Replacement

1. To access the spare wheel compartment, pull on the release handle located in the front electrical and service compartment, near the door lower hinge. The bumper will lower gradually.
2. Unscrew the wing nut and pivot assembly upwards.
3. Unscrew the outer ring. Disconnect the light unit connection and remove the bulb.

**Caution:** During this step, avoid contacting the bulb with your fingers. This could alter the bulb life.

4. Install the new bulb, reconnect the light unit and replace in its proper position.
5. Reinstall the outer ring, pivot the assembly downwards.
6. Fasten the wing nut and securely close the bumper.

## 13. INTERIOR LIGHTING EQUIPEMENT

### 13.1 CONTROL PANEL LIGHTING

The instrument gauges and switches mounted on all control panels are energized whenever the exterior light switch is pushed to the first position. A control dimmer located on the dashboard is used to vary the brightness of the panel gauges, switches and indicator lights.

The gauge lights, panel lights, switch lights and indicator lights have a different bulb arrangement. Thus, the procedure to change a defective bulb can vary according to the application.

#### 13.1.1 Switch Lighting

1. Slightly pull the switch with a defective LED away from the control panel.
2. Disconnect the electric cable from the switch.
3. To install a new switch, reverse the procedure (Fig. 49).

**Note:** Switches are lighted by the use of LED. When lighting on a switch fails, replace defective switch as a unit.

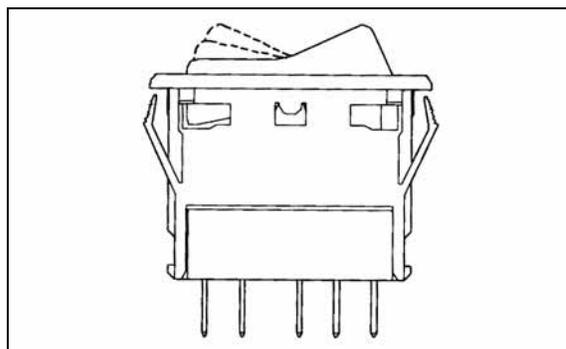


FIGURE 49: SWITCH

#### 13.1.2 Telltale Light Replacement

Telltale module is non-serviceable and must be replaced as a unit.

1. Unscrew and remove the top dashboard panel.
2. Remove the telltale back wire electric connectors.
3. Unscrew and remove the telltale module.
4. To replace the telltale module, reverse the procedure.

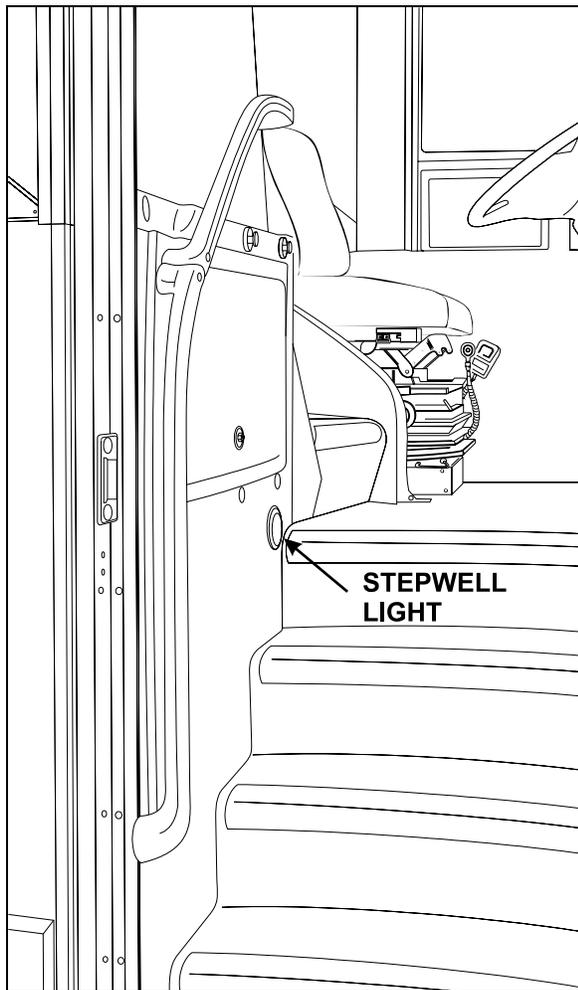
#### 13.1.3 Gauge Light Bulb Replacement

1. For any gauge light bulb replacement, the dashboard panel must be removed in order to have access to the rear of gauges.
2. Remove bulb socket from the gauge, turn the defective bulb counterclockwise and pull it out of the gauge.

3. Push a new bulb and socket ASM and turn clockwise to lock in place.
4. Replace the rear dashboard housing.

## 13.2 STEPWELL LIGHTS

### 13.2.1 Coach Entrance



**FIGURE 50: COACH ENTRANCE STEPWELL** 06492

The three stepwell lights are illuminated when the door opening system is activated (Fig. 50).

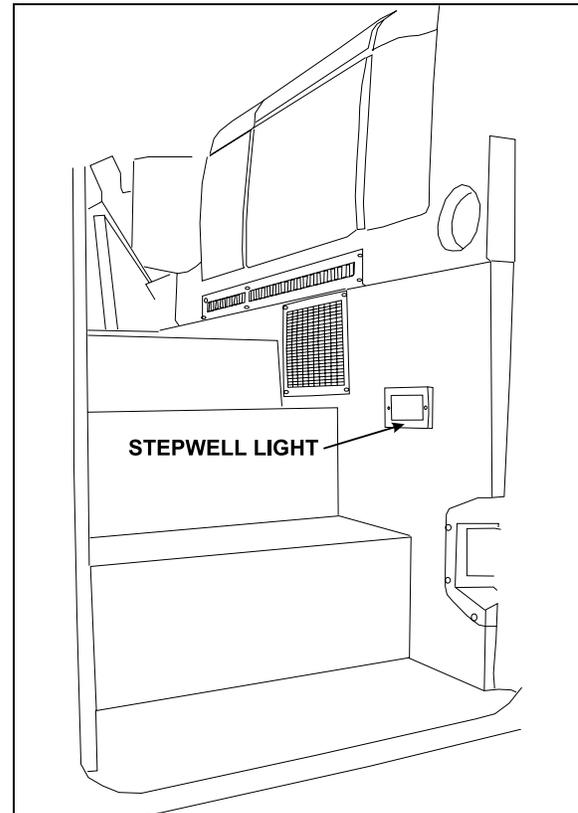
#### Light Removal and Replacement

1. Unsnap the lamp outer ring with a flat head screwdriver and remove it.
2. Unfasten the three fixing screws, remove and disconnect LED light assembly.
3. Connect and install the new LED assembly in position.

4. Fasten the three fixing screws and replace the lamp outer ring by snapping it back in place.

### 13.2.2 VIP Entrance and Bus Entrance Door

The stepwell light is illuminated when the door opening system is activated (Fig. 51).



**FIGURE 51: VIP ENTRANCE STEPWELL** 06507

### 13.2.3 Bulb Removal and Replacement

Proceed as follows to replace defective bulb:

1. Unscrew the two Phillips-head screws retaining the lens to the wall, and remove it.
2. With the light lens removed, pull bulb from the lamp while applying lateral pressure.
3. Install the new bulb into the lamp.
4. Position the light lens and install it.

## 13.3 LAVATORY NIGHT-LIGHT

The lavatory night-light is illuminated as soon as the ignition switch is set to the "ON" position.

### 13.3.1 Bulb Removal and Replacement

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Proceed as follows to replace defective bulb:

1. Unscrew the two Phillips-head screws retaining the lens to the lavatory wall, and remove it.
2. With the light lens removed, pull bulb from the lamp while applying lateral pressure.
3. Install the new bulb into the lamp.
4. Position the light lens and install it.

### 13.4 DRIVER'S AREA LIGHTS

One halogen ceiling light is installed over the stepwell and another one over the driver's area. These lights are frequently used for nighttime operation when passengers board or leave coach.

#### 13.4.1 Bulb Removal and Replacement

1. Unsnap the lamp with a flat head screwdriver and remove it.
2. Pull the defective bulb out of the socket.
3. Install the new bulb by pushing it in position.
4. Replace the lamp by snapping it back in place.

**Caution:** Do not touch halogen bulbs with bare hands as natural oils on skin will shorten bulb life span.

### 13.5 PASSENGER SECTION LIGHTING

The passenger section of coach is lit by two types of fluorescent tube lamps installed on the parcel racks.

The aisle or indirect lights are located on front of parcel racks, and provide soft, indirect cabin lighting and parcel rack interior lighting. More

powerful lighting for general and in-station applications is provided by fluorescent tubes located under the parcel racks, close to the windows. A dual power system is available for this lighting either from the 24 volt vehicle power supply or from a 110 volt outlet supply. In order to save batteries during extended periods of in-station lighting, no current is drawn from the batteries as soon as the 110 volt circuit is connected.

Moreover, adjustable reading lamps are installed under the parcel racks for passenger accommodation.

#### 13.5.1 Fluorescent Tube Replacement

##### Indirect Fluorescent Light

1. Open the parcel rack access door, if so equipped, unscrew the two Phillips screws (one each end). Let the hinged cover down.
2. Remove fluorescent tube from light socket.
3. Install a new fluorescent tube.
4. Lift the hinged cover and replace the two retaining screws (Fig. 52).

##### Parcel Rack Interior Lighting

1. Open the parcel rack access door, if so equipped, unscrew the two Phillips screws (one each end). Pull the hinged cover down.
2. Push on the bulb, turn and then, pull it from the socket.
3. Install a new bulb.
4. Lift the hinged cover and replace the two retaining screws.

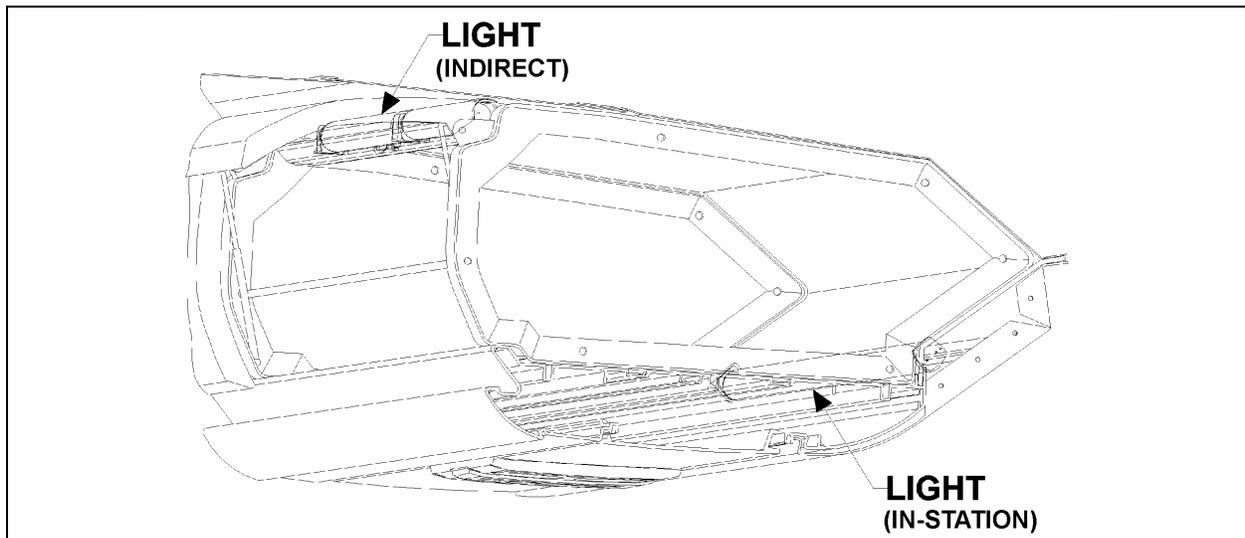


FIGURE 52: PARCEL RACK

06419

### 13.5.2 Removal and Replacement of In-Station Fluorescent Tubes

1. Start by pulling out the corner of the lens then delicately peeling it out of its seat.

**Caution:** *The lens is fragile. Be very careful when removing and handling.*

2. Rotate and pull the fluorescent tube from its sockets.
3. Install a new fluorescent tube, rotating the tube to secure it in the sockets.
4. Replace the screen lens by first inserting one side in the seat, then push the other side in and snap it in place by running it in from one corner to the next.

### 13.5.3 Removal and Replacement of Reading Lamp Bulb

1. Engage the tool (#830164) over the lamp and turn one quarter turn counterclockwise. Then, remove the tool slowly.
2. Pull the bulb socket off the reading lamp unit.
3. Push and turn bulb counterclockwise, then pull it out of the socket.
4. Install new bulb in the socket, then push and turn clockwise to lock bulb in position.
5. Push the bulb socket in the reading lamp unit.
6. Position the reading lamp with the tool (#830164), turn one quarter turn clockwise.

### 13.6 ENGINE COMPARTMENT LIGHTING

Two lights illuminate the engine compartment upon opening of the engine door (Fig. 53).

Each light is sealed and can be replaced as follows:

1. Disconnect the light unit connection.
2. Remove the lamp.
3. Position new lamp.
4. Connect the light unit.
5. Make sure the retaining ring is installed properly.

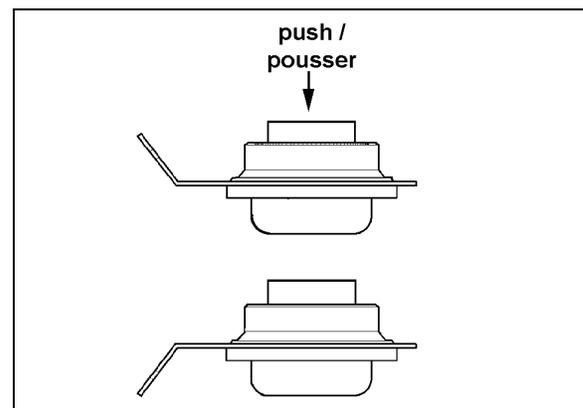


FIGURE 53: ENGINE COMPARTMENT LIGHT

### 13.7 LAVATORY LIGHT

The lavatory halogen lights are installed on ceiling. A microswitch, mounted in the door

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exterior frame, is activated by the door lock mechanism upon locking to energize the circuit. This switch is readily serviced by removing the two Phillips-head screws securing the mounting plate to the door exterior frame.

Proceed as follows to replace the bulb:

1. Unsnap the lamp with a flat head screwdriver and remove it.
2. Pull the defective bulb out of the socket.
3. Install the new bulb by pushing it in position.
4. Replace the lamp by snapping it back in place.

**Caution:** Do not touch halogen bulbs with bare hands as natural oils on skin will shorten bulb life span.

### 14. LIGHT BULB DATA

When replacing a light bulb, special attention must be paid to the voltage rating (refer to light bulb date hereafter).

**Note:** Exterior and interior lights can be 12 volts or 24 volts.

Application	Prévost part no.	Trade or SAE number	Watts or Candle Power	Volts	Qty
<b>EXTERIOR LIGHTING</b>					
Hi-beam	930359	H9	65 W	12	2
Low-beam	930360	H9	65 W	12	2
Low-beam Xenon (optional)	930388	D2S	35 W	12	2
Docking & cornering	930319	H9415	37.5 W	12	4
Fog	930361	H3	55 W	12	2
License plate (sealed)	930368	Led	.05 A	12	2
Side marker (red)	930340	Led	.06 A	12	2
Side marker (amber)	930341	Led	.06 A	12	10
Identification (red)	930334	Led	0.10 A	12	3
Identification (amber)	930337	Led	0.10 A	12	3
Clearance (red)	930334	Led	0.10 A	12	4
Clearance (amber)	930337	Led	0.10 A	12	4
Front directional (hazard and marker)	930364	Led	0.75 / 0.10 A	12	2
Rear directional	930365	Led	0.55 A	12	2
Stop	930366	Led	0.3 A	12	4
Back-up	930367	Sealed Unit	2.1 A	12	2
Center stop (high-mounted)	930330	Led	---	12	1
Tail	930366	Led	0.03 A	12	4
Exterior compartment (except engine)	562278	6429 (78207)	10 W	24	A R
Engine compartment	930383	Sealed Unit	2.1 A	12	2

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Application	Prévost part no.	Trade or SAE number	Watts or Candle Power	Volts	Qty
<b>INTERIOR LIGHTING</b>					
Speedometer	560145	2721 M OSRAM	1 cp	24	2
Tachometer	560145	2721 M	1 cp	24	2
Turbo boost	561167	2721 M	3 W	24	1
Other instruments (1/unit)	560144	2721 MFX OSRAM	1.6 cp	24	A R
Step (VIP)	562278	6429	10 W	24	1
Step (Coaches)	830173	LED	0.7 W	12	3
Lavatory	561009	6423	5 W	24	1
Parcel rack	561553	313	1.6 cp	24	A R
Driver's area	830176	Q20MR16	20 W	12	2
"EMERGENCY EXIT" decal	560601	456	2 cp	24	20
"LAVATORY OCCUPIED"	561166	1820	1.6 cp	24	2
"WATCH YOUR STEP"	561166	1820	1.6 cp	24	2
Aisle	560141	1251	3 cp	24	6
Reading	563073	623	.37 A	24	A R
Fluorescent (In-Station)	830153	F32T8/SP41	32 W	---	A R
Lavatory	830176	Q20MR16	20 W	12	1
Destination sign fluorescent	830080	F30T8CW4	30 W	---	1
Fluorescent (Indirect)	830152	F13T5/CW	13 W	---	---

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### 15. SPECIFICATIONS

#### Battery

Make..... Volvo  
Model..... 20359831  
Type ..... Maintenance-free  
Terminal type ..... Top Stud  
Group size..... 31  
Volts ..... 12  
Load test amperage ..... 290  
Reserve capacity (minutes) ..... 195  
Cold cranking (in amps)  
-At 0°F (-18°C).....950 (each battery)  
Maximum dimensions (inches/mm)  
-Length (including flange) ..... 13.0/330,2  
-Width..... 6.7/169,3  
-Height (including top posts) ..... 9.3/237,0  
-Approximate weight (lbs/kg) ..... 59/26,7

\* *Battery tester cable clamps should be between terminal nuts and lead pads of terminals. If not possible, load value should be 210 amperes.*

#### Torque specifications

Battery cable to post ..... 10-15 ft-lbf (13-20 N·m)  
Battery cover ..... 45-50 ft-lbf (5-6 N·m)

#### Electrical system monitor

Make..... Vanner  
Model..... EM-70  
Input ..... 24 V dc  
System high ..... Greater than 30 V dc  
System low ..... Less than 24 V dc  
Trip level..... + 0.75 V dc  
Prévost Number ..... 562058

#### Alternator

Make..... Delco Remy  
Model Number..... 1117702  
Series ..... 50DN  
Type ..... 600

Field current at 80°F (27°C)

-Amperes ..... 7.2 – 8.0

-Volts ..... 24

Hot output

-Amperes ..... 270 at 80°F (27°C) ambient

-Volts ..... 28

-Approximate rpm ..... 3000

Ground ..... negative

Prévost number ..... 561723

**Alternator**

Make ..... BOSCH

Model Number ..... 0120689552

Series ..... T1

Hot output

-Amperes ..... 140 at 25°C (AMBIENT)

-Volts ..... 28

-Approximate rpm ..... 6000

Ground ..... negative

Prevost Number ..... 562752

**Regulator**

Make ..... Delco-Remy

Model Number .....

Type ..... Transistor

Voltage adjustment ..... External screw

Prévost number ..... 562775

**Battery equalizer**

Make ..... Vanner

Model ..... 60-100D

Amperes ..... 100 amps

Prévost Number ..... 562542

**Starter**

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Make.....Mitsubishi Electric Corporation (MELCO)  
Model Number.....M009T82479  
Type .....105P70  
Voltage ..... 24  
Prévost Number ..... 510752

**No-load test**

-Volts ..... 23.5  
-Max. current draw ..... 125 amperes  
-Min. rpm ..... 3000 rpm

**Starter solenoid**

Make.....Mitsubishi Electric Corporation (MELCO)  
Model Number..... 1115557  
Pull In Voltage ..... 16 volts max.