Date 1-1-89

MC-9 MAINTENANCE MANUAL

SECTION 7

ELECTRICAL SYSTEM

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DESCRIPTION

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

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

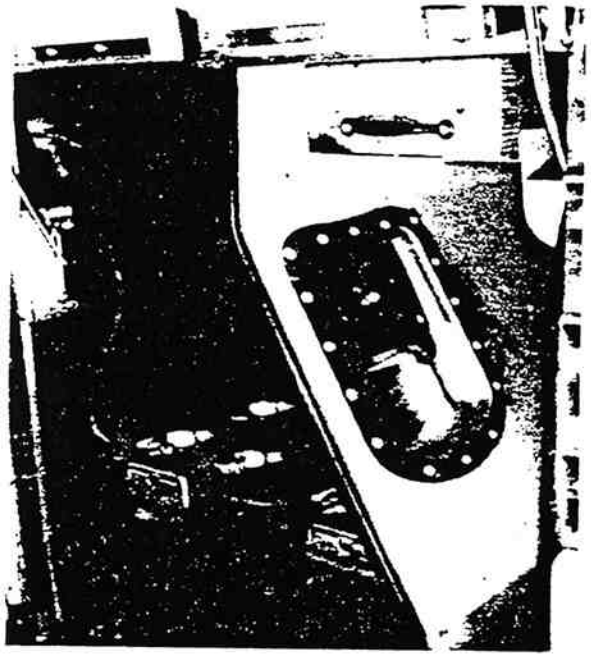

Figure 7-1. Battery Disconnect.

BATTERY DISCONNECT

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

TESTING CIRCUITS

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

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

CIRCUIT BREAKERS

All electrical circuits are protected by circuit breakers. The main circuit breaker and the two circuit breakers protecting the air conditioning system blower motors are located at the front of the baggage compartment and can be reached through the left front baggage door. See figure 7-2.

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

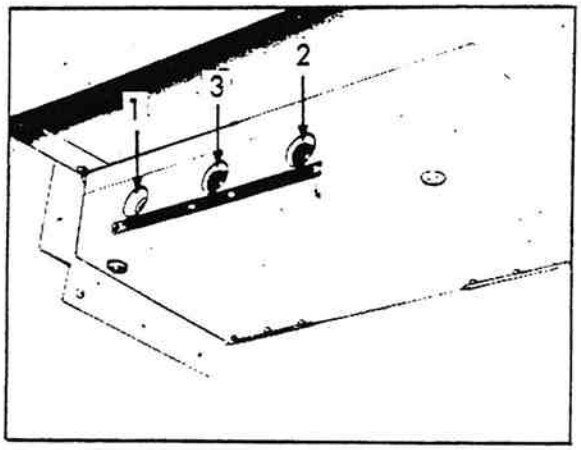

Figure 7-2. A/C Circuit Breaker in Left Front Baggage Compartment.

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

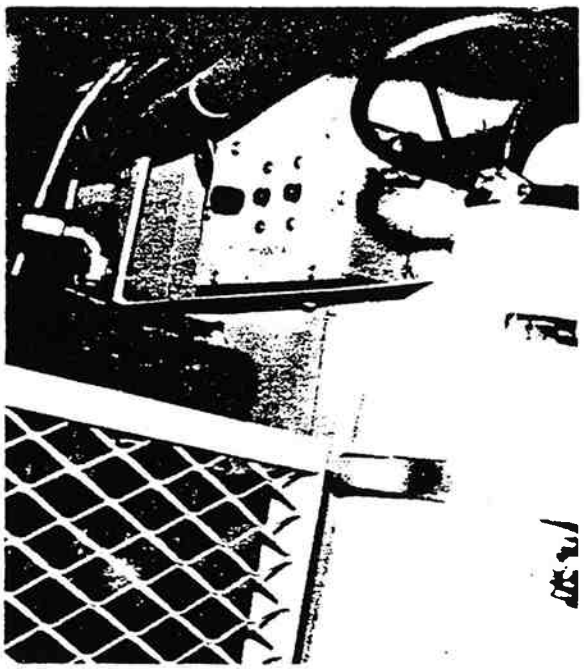

Figure 7-3. 110V In-Station Lighting Circuit Breaker Box in Left Front Service Compartment.

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

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

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

RELAYS

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

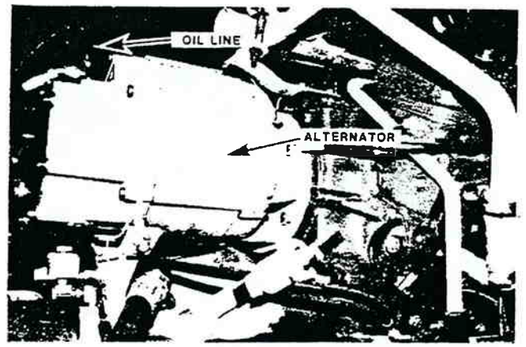

Figure 7-4. Alternator.

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

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

GEAR DRIVEN ALTERNATOR — OIL COOLED

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

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

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

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

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

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

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

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

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

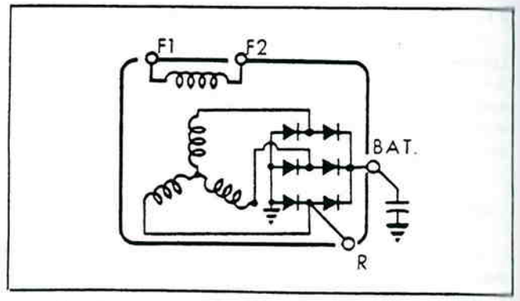

Figure 7-5. Alternator Wiring Diagram (Typical).

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

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

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

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

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

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

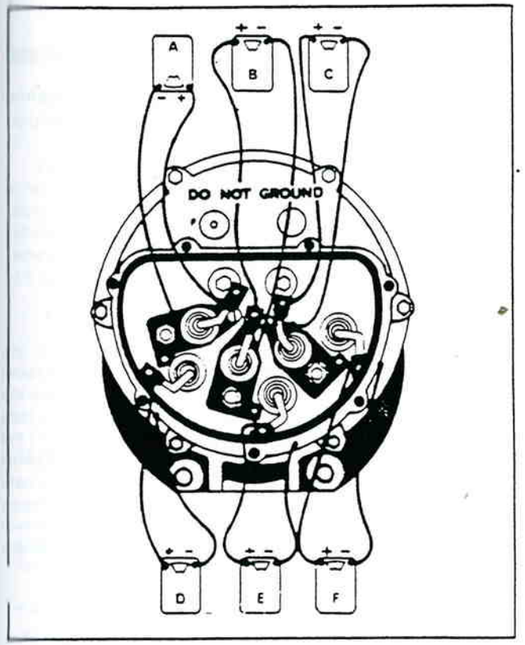

Figure 7-6. Checking Diodes for Opens Using Ohmmeter.

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

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

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

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

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

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

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

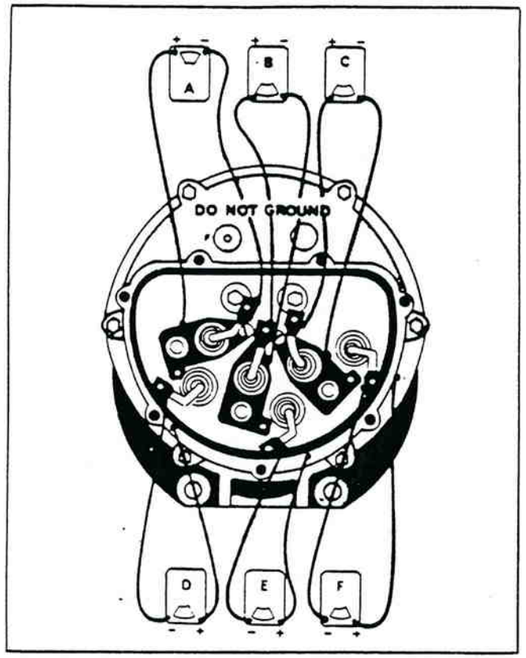

Figure 7-7. Checking Diodes for Shorts Using Ohmmeter.

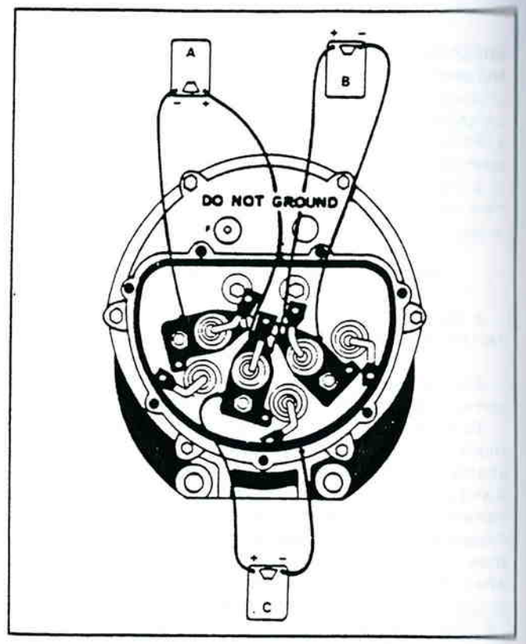

Figure 7-8. Checking Stator Windings for Opens and Grounds.

DISASSEMBLY

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

1. Remove nuts and washers from DC terminal on diode end frame.
2. Separate the diode cover plate (3) from the diode end frame by removing mounting screws (1).
3. Remove the washer, nut and lock washer attaching the diode supports to the end frame, the three screws (5) connecting the diode leads to the diode supports, and the three nuts (4) which attach the stator studs to the diode supports.
4. Separate the diode support assemblies from the diode end frame, and the three nuts (6) which connect the studs to the diode end frame.
5. Mark the position of the drive end frame and diode frame with respect to the stator assembly so that the parts can be reassembled in the same position.
6. Detach the diode end frame and field assembly from the stator assembly by removing the attaching screws (13).
7. Separate the field assembly from the diode end frame by removing the four attaching screws (11).
8. Separate the rotor assembly and drive end frame from the stator assembly by removing the attaching screws (25).
9. Remove the shaft nut and washer, and the pinion gear Press the rotor shaft out of the drive end frame.
10. Remove the retainer plate (20) and pull the bearings from the drive end frame.

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

REASSEMBLY

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

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

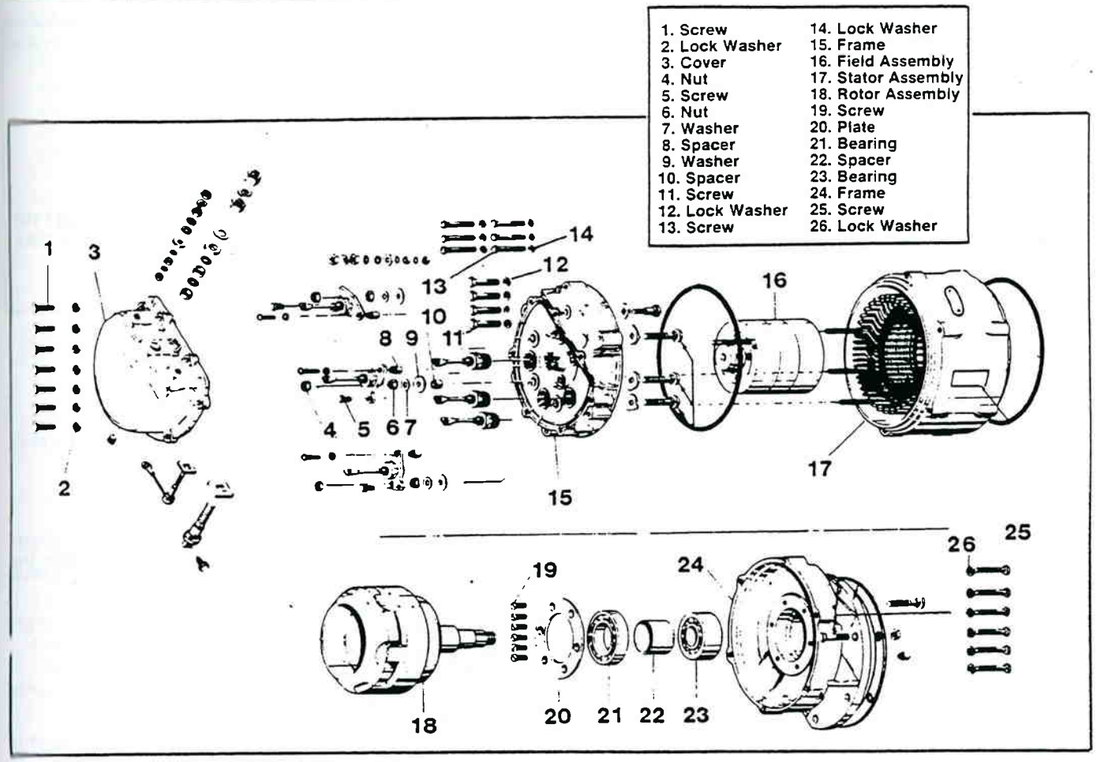

Figure 7-9. Alternator Components.

OUTPUT CHECK

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

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

REMOVING ALTERNATOR

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

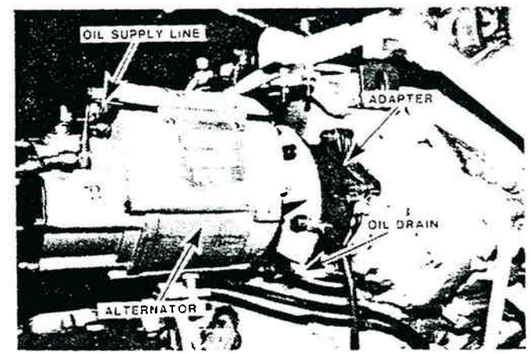

Figure 7-10. Alternator With Adapter.

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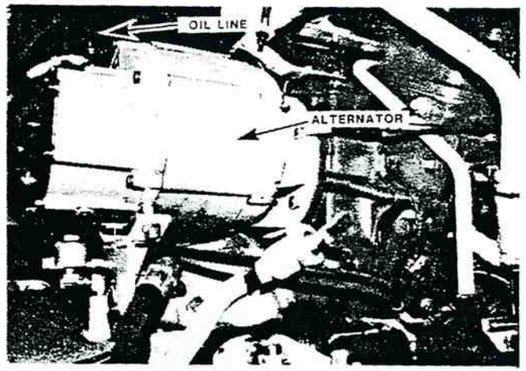

Figure 7-11. Alternator Without Adapter.

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

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

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

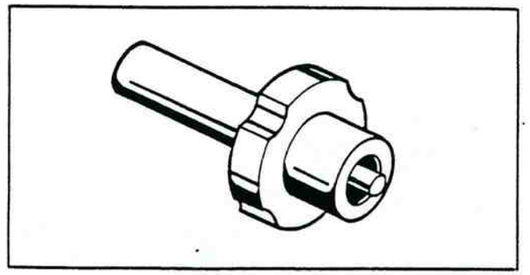

Figure 7-12. Alignment Tool 20-157 (Nut-Mounted Cam Gear).

ALIGNMENT OF 21-TOOTH DRIVE PLATE (CAPSCREW MOUNT CAM GEAR)

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

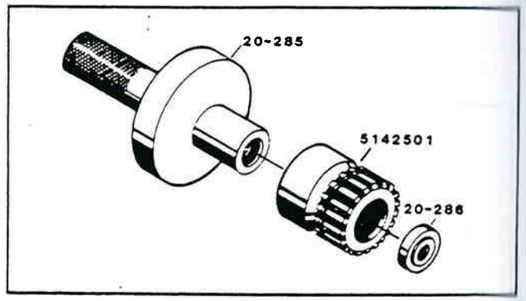

Figure 7-13. Alignment Tool (Capscrew-Mounted Cam Gear).

ALIGNMENT OF ADAPTER PLATE (1)

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

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

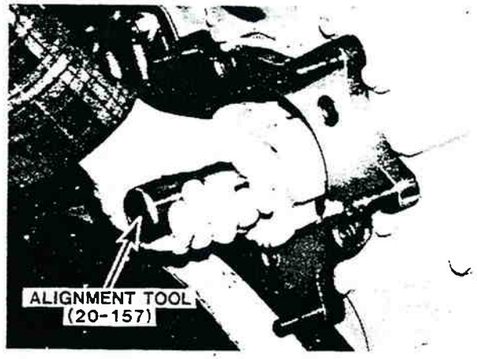

Figure 7-14. Aligning Adapter Plate.

2. Place tool 20-157 into center bore of camshaft to center adapter plate. See figure 7-14. Tighten the four ½" allen head capscrews to 78-80 lb. ft. (105-108 Nm) torque. Tighten the one 7/16" allen head capscrew to 55-60 lb. ft. (75-81 Nm) torque. Remove tool 20-157.

ALIGNMENT OF ADAPTER PLATE (2)

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

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

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

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

4 With adapter plate located properly using tool 20-285 tighten the four ½" allen-head capscrews to 78-80 lb-ft torque (105-108 Nm) Tighten the one 7/16" capscrew to 50-55 lb-ft torque (68-74 Nm) Remove tooling group 20-285 20-286, 5142501

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

INSTALLATION OF ADAPTER HOUSING AND ALTERNATOR

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

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

NOTE: Coat gasket with Permatex before installation.

2 Mount the alternator and gasket onto the adapter housing studs and tighten to 70-7b lb. ft. (95-102 Nm) torque.

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

4 Install the electrical connections at the diode end frame.

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

ALTERNATOR WITH "FIGURE 8" ADAPTER PLATE

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

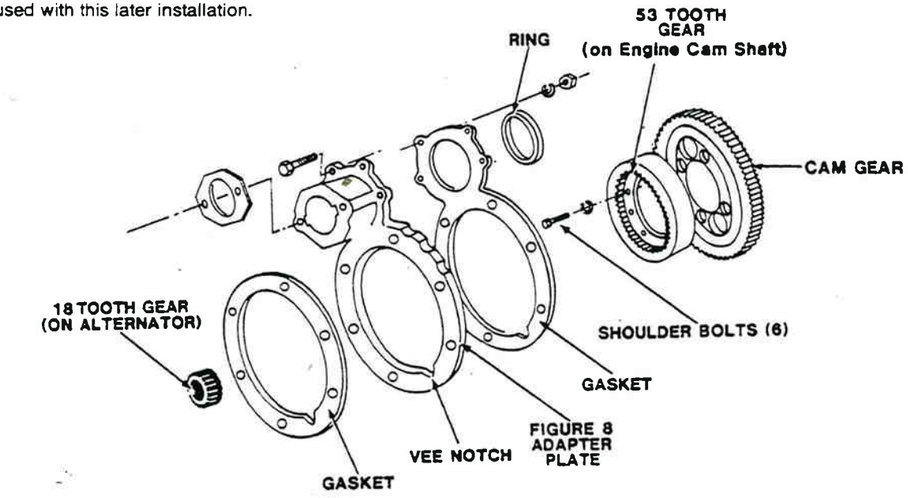

Figure 7-14A. Alternator Mounting Adapter.

REMOVING ALTERNATOR

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

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

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

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

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

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

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

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

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

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

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

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

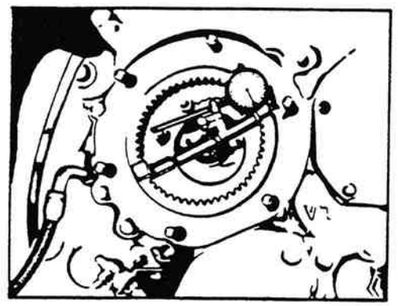

Figure 7-14B. Dial Indicator Installed.

INSTALLATION OF ALTERNATOR ON FIGURE-8 ADAPTER

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

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

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

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

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

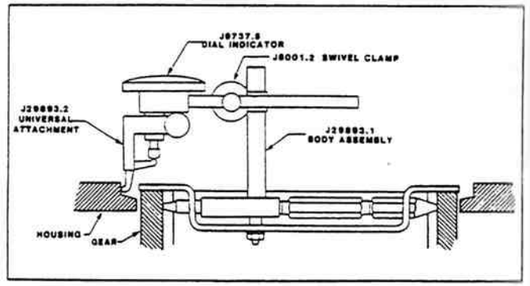

Figure 7-14C. Dial Indicator and Mounting Tool.

SAFEGUARDING OF ALTERNATOR AND COACH ELECTRICAL SYSTEMS

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

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

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

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

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

Initial Engine Start-up Procedures

1. Make sure field relay is removed (refer to rear junction box decals in the later pages of this section for the field relay location).
2. Turn **all** dash switches off.
3. Turn battery disconnect switch "ON".
4. Turn master switch "ON".
5. Fuel prime and start engine.
6. Run engine for five minutes.
7. Stop engine.
8. Turn master switch "OFF".
9. Turn battery disconnect switch "OFF".
10. Install field relay in rear junction box.
11. Turn battery disconnect switch "ON".
12. Turn master switch "ON".
13. Restart engine using normal start-up procedures.

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SERVICING ALTERNATOR GEARED DRIVE ADAPTER

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

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

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

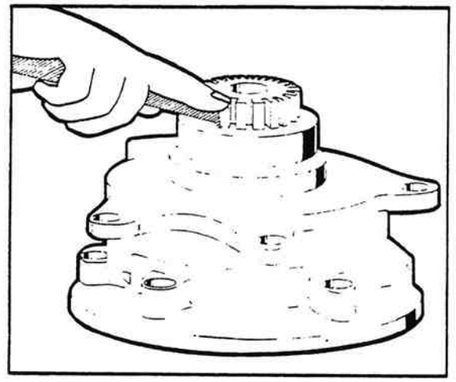

Figure 7-15. Retaining Ring Removal.

DISASSEMBLY

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

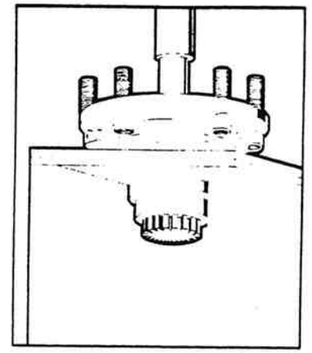

Figure 7-16. Adapter Housing Support.

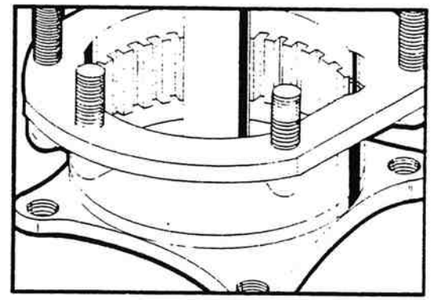

Figure 7-17. Drive Gear Removal from Drive Gear Bore.

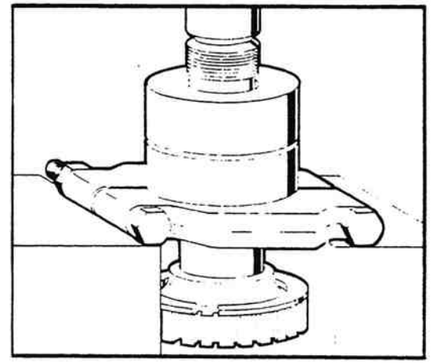

Figure 7-18. Drive Shaft Removal.

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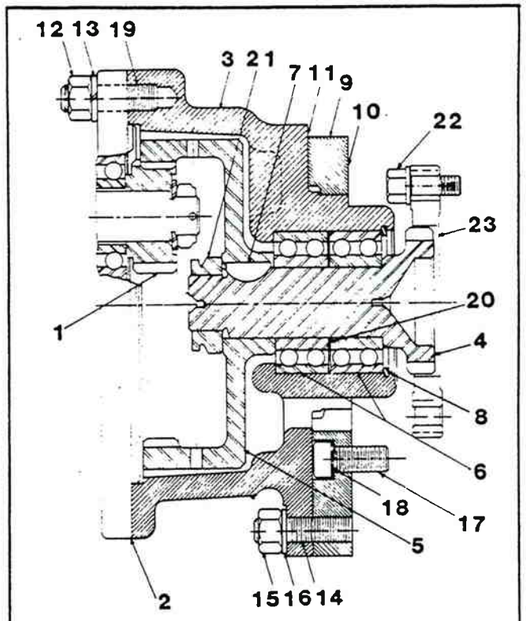

1	Gear Pinion	13	Lock Washer
2	Gasket	14	Stud
3	Housing	15	Nut
4	Alternator Drive Shaft	16	Lock Washer
5	Alternator Drive Gear	17	Capscrew
6	Alternator Drive Bearing	18	Lock Washer
7	Key	19	Stud
8	Retaining Ring	20	Spacer
9	Adapter Plate	21	Drive Gear Shaft Nut
10	Gasket	22	Bolt
11	Gasket	23	Drive Plate
12	Nut		

Figure 7-19. Gear-Driven Alternator Drive Adapter (Cross Section).

REASSEMBLY

1. Place the retaining ring on the shaft and set the shaft on the bed of a hydraulic press.

2. Position one of the bearings on the shaft. Using a hollow bearing mandrel, figure 7-20, press the bearing onto the shaft until it bottoms. Install the bearing spacer, figure 7-21, and press the second bearing onto the shaft in the same manner.

NOTE: A length of steel pipe, 4.5" (114.3 mm) long with an inner diameter of 1.5" (38.1 mm) and a wall thickness of .25" (6.35 mm) will serve as a bearing mandrel.

3. Using a soft hammer, install the Woodruff key into the shaft. Figure 7-22 shows the shaft complete with retaining ring, bearings and Woodruff key installed.

4. Install the shaft and bearing assembly into the alternator drive adapter housing through the engine side of the housing (figure 7-23).

5. Install the retaining ring into the groove of the housing.

6. Support the adapter housing on steel blocks to prevent it from moving while installing the gear onto the shaft.

7. Carefully install the gear onto the shaft ensuring that they are perfectly aligned.

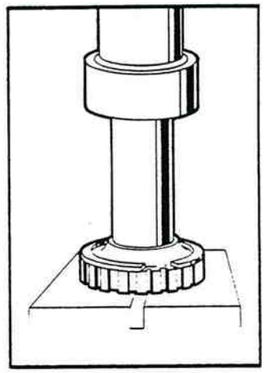

Figure 7-20. Bearing Installation.

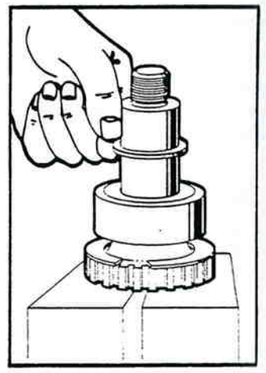

Figure 7-21. Spacer Placement.

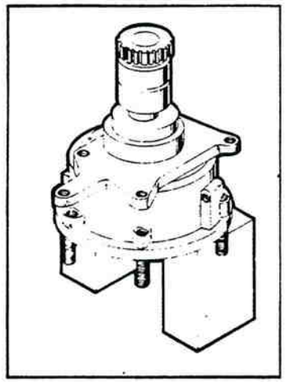

Figure 7-22. Shaft Assembly.

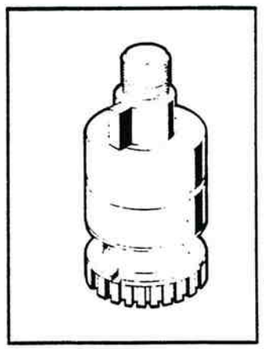

Figure 7-23. Shaft Assembly Installed.

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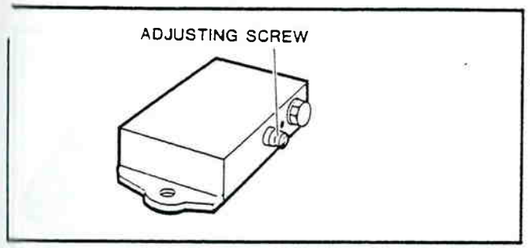

Figure 7-24. Alarm Buzzer.

ALARM BUZZERS

The alarm system buzzers are mounted in a sealed, external junction box below the driver's window. The buzzers are for low air, hot engine, low water, and low oil pressure conditions.

NOTE: Activate each circuit and adjust buzzer for desired sound. To increase sound, turn adjusting screw clockwise; counterclockwise to decrease. Refer to figure 7-24 for adjusting screw.

The manufacturer's specified range is between 65 and 75 decibels. The factory setting is 75 decibels.

VOLTMETER

A voltmeter is installed in the lower center opening of the instrument panel cluster to provide a voltage system reading. Refer to wiring diagram at the end of this section.

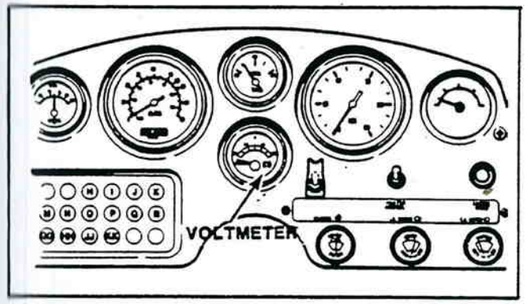

Figure 7-24A. Voltmeter.

TURN SIGNAL & TAIL LAMPS

The stop, turn signal and tail lamps are mounted in castings at the rear corners of the coach.

The turn signal lamps are amber colored; the tail lamps are red. Both of these units are sealed and are serviced as units; there is no bulb or lens. These units are held in the casting by means of a heavy rubber gasket, and are simply snapped in or out of the gasket.

STOP LAMPS

The stop lamps each consist of a spring-loaded socket for the bulb, and a red reflective lens housing. To service the bulb, remove the 4 screws which mount the lens housing to the casting, pull out the lens and remove the socket from the rear of the lens. To remove the socket from the lens housing, push the socket inward, and twist it until the tangs on the socket are in line with the slots in the lens housing. The socket will now pop out. The bulb is removed in a similar fashion from the socket. Push the bulb downward into the socket, and twist it a quarter turn. Release pressure against the bulb and it should be free. See lamp specifications at end of this section for correct replacement bulb.

The stop lamps are illuminated when the service brakes are applied.

HEADLIGHTS

DESCRIPTION

The headlights are double filament "sealed beam" type and operate on a 12V circuit.

Switch marked "Headlights" mounted in the driver's switch panel to the left of the driver controls headlights. High or low headlight beam is selected by means of a floor-mounted dimmer switch. When high beams are on, a tell-tale light marked "Hi Beam" on the instrument panel will glow.

MAINTENANCE

Clean with water and a good glass cleaner whenever dirty.

For maximum illumination headlamps must not be blackened and proper voltage must be maintained. Low battery, loose or dirty electrical contacts in wiring system and poor ground all contribute to a decrease in voltage. Check wiring and connections regularly and keep battery properly charged. When headlamp burns out, a complete new sealed beam unit must be installed.

REMOVAL

Remove bezel retaining screws and remove bezel. Removing three screws which hold sealed beam unit in housing. Pull unit out of housing. Disconnect plug-in socket. Install new sealed beam unit reversing above procedure.

HEADLIGHT ADJUSTMENT

Headlights must be aimed carefully and accurately to assure safe vehicle operation at night. Adjustments can be made quickly and accurately with a headlight tester. However, if equipment is not available, make adjustments as described below.

(A) Place vehicle on level floor so headlights are 25 feet (7.6 m) from a smooth vertical surface perferably of light color. A door or wall is suitable. Center line of vehicle should be perpendicular to this vertical surface.

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(B) Draw a horizontal line on vertical surface at height of light center. Locate point on this horizontal line at which projected centerline of vehicle intersects. Measure distance between lamp centers and divide this distance equally on either side of center mark. Then draw two vertical lines directly ahead of each light center.

(C) Switch on high beam and cover one light adjusting other.

(D) Remove light bezel retaining screws and aim light beam with adjusting screws. Top screw provides horizontal adjustment.

(E) When aiming headlights, beam may appear distorted. A new sealed beam unit must be installed to correct this condition.

(F) After headlight is properly aligned, cover its beam and proceed in same manner as above with opposite light.

VOLTAGE REGULATOR

The voltage regulator illustrated in figure 7-25 is an assembly composed principally of capacitors, resistors and transistors. These components are mounted on a printed circuit board to form a static unit containing no moving parts. Regulators of this type have terminals marked NEG, FLD and POS.

The regulator limits the alternator voltage to a pre-set value by controlling the alternator field current. This is the only function 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, since 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 7-26. This diagram shows only the basic charging system components, and does not show other components such as control relays.

TROUBLESHOOTING

Trouble in the charging system will usually be indicated by undercharged or overcharged batteries. Either condition can result from an improper voltage regulator setting.

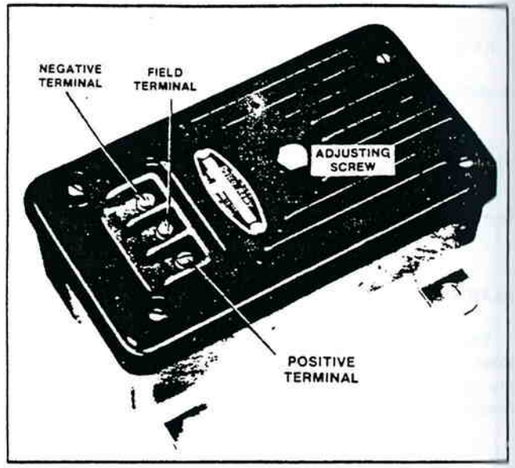

Figure 7-25. Voltage Regulator.

The ideal voltage setting is the one which will maintain the batteries in a fully charged condition with a minimum depletion of water. A record of water usage and battery specific gravity checks over a service period of reasonable length will establish the ideal voltage setting for the vehicle involved. Where maintenance-free batteries are used, the absence of gassing and the continuous appearance of the green dot in the built-in hydrometer indicate the regulator voltage setting is satisfactory

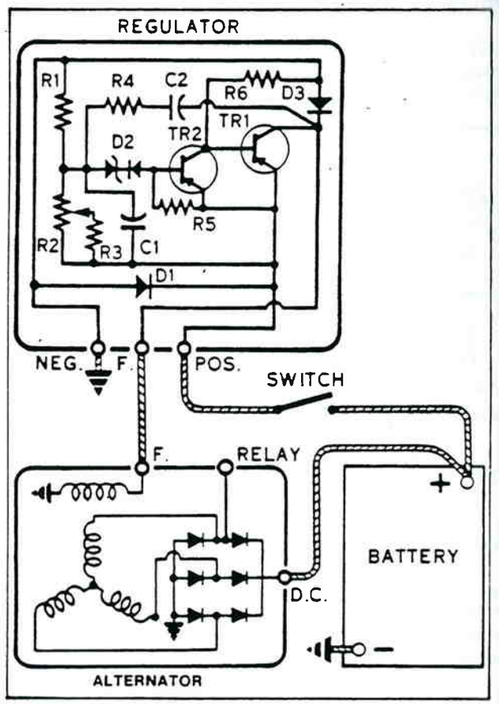

Figure 7-26. Charging System Diagram.

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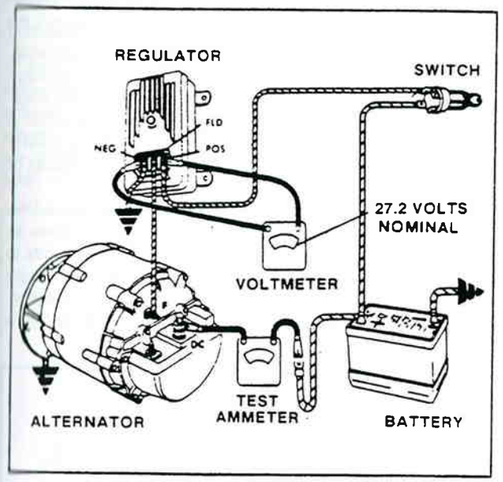

Figure 7-27. Voltage Regulator Adjustment Setup.

VOLTAGE REGULATOR SETTING

To check the voltage setting, connect a voltmeter across the POS and NEG terminals on the regulator and an ammeter at the DC terminal on the alternator (figure 7-27). Operate the engine at approximately 1,000 RPM (about 2,300 alternator RPM) with accessories turned on to obtain 20-200 amperes alternator output and note the voltage setting. The voltage should be steady and reasonably close to 27.2 volts, nominal. Desired variations from the published setting can be obtained by removing the plug from the voltage regulator cover and turning the adjusting screw inside the regulator (figure 7-28). This will change the voltage to meet the needs of vehicle as dictated by operating conditions.

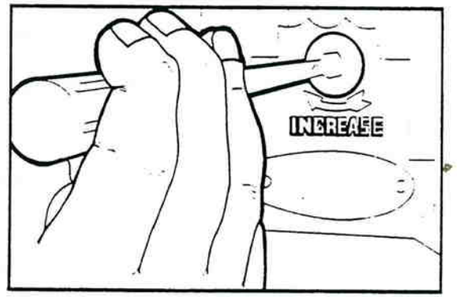

Figure 7-28. Adjusting Voltage Regulator.

If the voltage setting as checked above is steady and reasonably close to the specified value and the battery is undercharged, raise the setting by .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, 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 alternator and from the alternator field.

CAUTION: Do not allow leads to touch vehicle ground.

3. Connect a voltmeter and ammeter in the circuit at the DC terminal on the alternator.
4. Connect a jumper lead from the alternator DC terminal to the field terminal. If two field terminals are used, ground the other field terminal.
5. Connect a carbon pile load across the battery. Turn to off position.
6. See figure 7-29 for wiring connections.
7. Reconnect battery ground cable.
8. Turn on all vehicle accessories.
9. Operate alternator and adjust carbon pile load as required for output of 80 amps at 1,200 RPM or 225 amps at 2,500 RPM (cold).
10. Check the alternator field winding as follows:

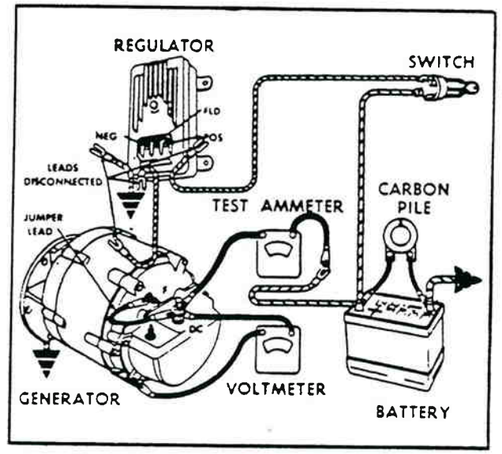

Figure 7-29. Alternator Output Test Setup.

Alternators with one field terminal — Disconnect the lead from the field terminal and connect an ohmmeter from the field terminal to ground. For alternators with two field terminals, disconnect all leads from the field terminals and connect an ohmmeter across the terminals.

A resistance reading above normal indicates an open, and a resistance reading less than normal indicates a short or ground. The normal resistance can be calculated by dividing the indicated voltage by the field current rating of 5.95V ±.25V. 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.

To check for a ground, connect the ohmmeter from either field terminal to ground. A reading equal to or less than the normal resistance value indicates a ground.

The 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.

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If the voltage setting as checked above is steady and reasonably close to the specified value, lower the setting by .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 7-26, a shorted or grounded field or a defective regulator can cause an overcharged battery. The field winding can be checked as above. If the field winding is found not to be defective, the generator is not defective, and the regulator should be checked as covered in section entitled Regulator Checks.

REGULATOR CHECKS

Refer to figure 7-25. Separate the cover from the base, and then remove the panel assembly from the cover. Carefully note the location of all washers and lock washers.

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.

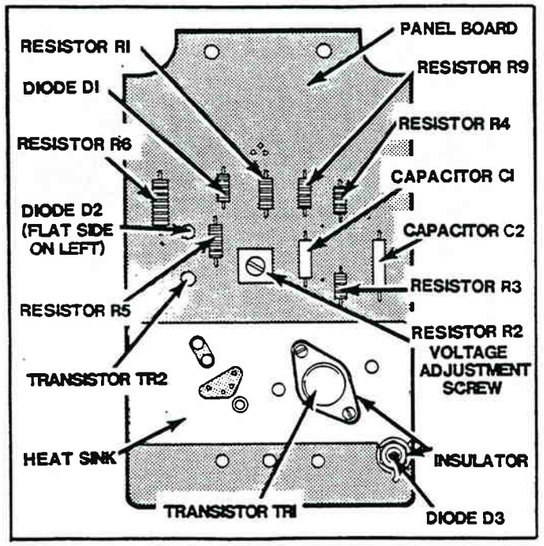

Figure 7-30. Regulator Components.

The component parts are identified in figure 7-30, and are keyed to figure 7-26. Resistor R9 may not be used on 24-volt systems. Before making electrical checks, visually inspect the components and make sure all soldered connections are secure. Various electrical checks with a ohmmeter can be made to determine which components are defective.

The ohmmeter must be accurate, and should be a scale type meter with 1½ 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 manufacturer concerning the meter capabilities.

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 as more than one component may be defective.

A defective part may be replaced by removing the attaching screws and unsoldering the connections. When resoldering, limit solder time to a minimum as excessive heat may damage the printed circuit and component parts. However, firmly soldered connections are essential for satisfactory operation. A resin core 63% tin, 37% lead solder with 360°F. melting point is recommended along with a soldering iron rated at 50 watts or less. Use extreme care to avoid overheating.

Before checking the circuit board, remove transistor TR1, which must be checked separately. Connect the ohmmeter as shown in figure 7-31 and then reverse the ohmmeter leads to obtain two readings on the same component. Use the middle scale on scale-type meters; the 300 ohm value should be within, or nearly within, the middle third of the scale. Refer to figure 7-31 for the following checks:

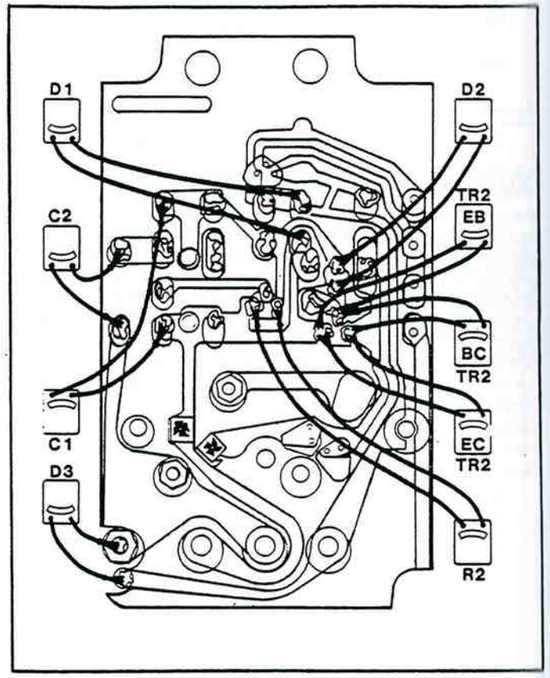

Figure 7-31. Checking Regulator Componets With Ohmmeter.

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.

Resistor R2 — Turn voltage adjustment screw with ohmmeter connected each way. Reading should change as slotted screw is turned. If not, replace R2.

Transistor TR2 — Change the ohmmeter to use the low scale. Check EB; should read low and high. Check BC; should read low and high. Check EC; should both read high. If not, replace TR2.

Transistor TR1 — See figure 7-32. Use the low scale. Each of the three checks should read low and high. If not, replace TR1.

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ADJUSTING VOLTAGE

After repair, the regulator must be adjusted to the desired voltage setting. Follow the procedure under previous section entitled Voltage Regulator Setting. Turn the adjusting screw full range and observe the voltmeter to ensure that the voltage is being controlled, then adjust to the setting desired or the setting listed in Delco Remy Bulletin 1R-188.

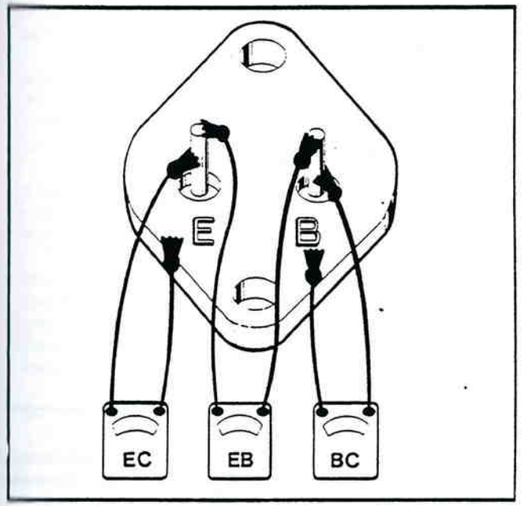

Figure 7-32. Ohmmeter Check of TR1.

STARTING MOTOR

The starting motor has a shift lever and solenoid plunger that is totally enclosed to protect it from exposure to dirt, icing conditions and splash. The commutator end cap can be removed to inspect the brushes. Refer to figures 7-33, 7-34 and 7-35.

Lubrication is provided in the sintered bronze bushings by an oil saturated wick. Oil can be added to each wick by removing an oil reservoir cup which is accessible on the outside of the motor.

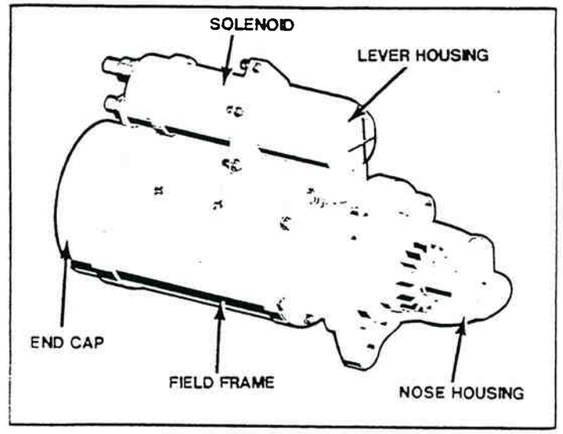

Figure 7-33. Starting Motor.

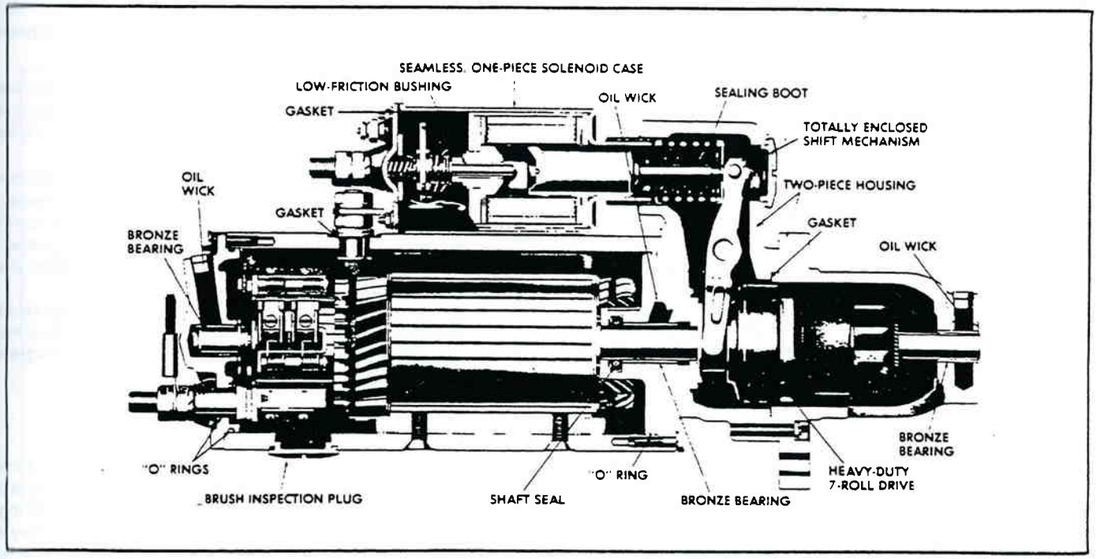

Figure 7-34. 40-MT Starting Motor Cross Section (to Dec. 1985); Also Typical 50-MT.

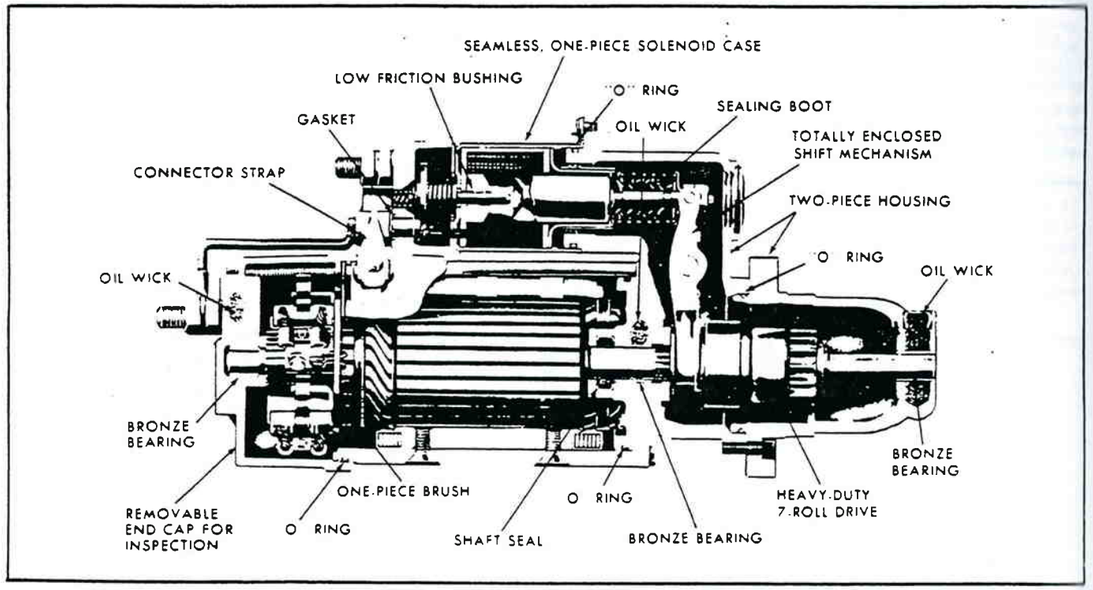

Figure 7-35. 42-MT Starting Motor Cross Section (after Dec. 1985).

The pinion is moved into mesh with the ring gear by the action of the solenoid. The pinion remains engaged until the solenoid circuit is interrupted. In case of a butt engagement the motor will not be energized to prevent damage to the pinion and gear teeth.

Under normal operating conditions, no maintenance will be required between engine overhaul periods. At time of engine overhaul, motors should be disassembled, inspected, cleaned and tested as described in succeeding paragraphs.

A basic circuit is shown in figure 7-36. When the start switch is closed, the magnetic switch contacts close, and the solenoid windings are connected to the battery. The resulting plunger and shift lever movement causes the pinion to engage the engine flywheel ring gear and the solenoid main contacts to close, and cranking takes place.

When the engine starts, pinion overrun protects the armature from excessive speed until the switch is opened, at which time the return spring causes the pinion to disengage. To prevent excessive overrun and damage to the drive and armature windings, the switch must be opened immediately when the engine starts. A cranking period for all types of motors should never exceed 30 seconds without stopping to allow the motor to cool.

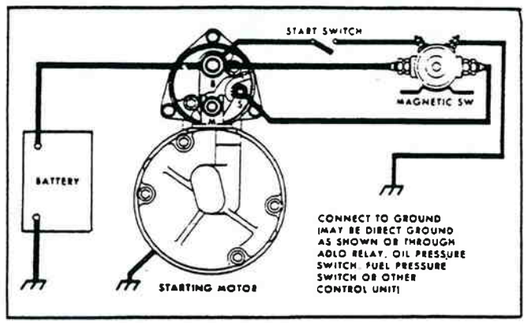

Figure 7-36. Basic Starting Circuit.

Either of two types of starter protection may be present on the MCI Series of coaches. Later production (1987) coaches have the 3N124 Triple Protection Device as standard equipment. The optional Thermal Time Delay Relay may have been installed in lieu of the basic device. Earlier coaches may also have either of these devices, which would have been installed as optional or special equipment.

One of the functions of the Tripple Function Protective Device is to prevent starter re-engagement after the engine is running. Further information on this device can be found later in this section.

The optional Thermal Time Delay Relay prevents starter overheating by limiting the time the starter can be cranked without pause. It differs from the standard protection device in that it does not sense overvoltage to protect electrical components, nor does it prevent starter re-engagement when the engine is running.

The Thermal Time Delay Relay provides a 20-second timed start period followed by a 20-27-second reset delay to allow the starter to cool. Refer to the Thermal Time Delay wiring diagram later in this section.

TROUBLESHOOTING THE CRANKING CIRCUIT

If the cranking system is not performing properly, make the following checks to help determine which part of the circuit is at fault. Insure that the battery is fully charged. The wiring, switches and starting motor cannot be checked if the battery is defective or discharged.

1. Inspect the wiring for damage. Inspect all connections to the starting motor, solenoid, magnetic switch, ignition switch or any other control switch, and battery, including all ground connections.

2. Clean and tighten all connections as required.

3. Inspect all switches to determine their condition. From the vehicle wiring diagram, determine which circuits should be energized with the starting switches closed. Use a voltmeter to detect any open circuits.

4. If the battery, wiring and switches are in satisfactory condition, and the engine is known to be functioning properly, remove the motor and follow the test procedures outlined below.

5. With the starting motor removed from the engine, the armature should be checked for freedom of rotation by prying the pinion with a screwdriver. Tight bearings, a bent armature shaft or a loose pole shoe screw will cause the armature to not turn freely.

6. If the armature does not turn freely, the motor should be disassembled immediately. However, if the armature does rotate freely, the motor should be given a no-load test before disassembly.

The no-load test may point to specific defects which can be verified with tests when disassembled. Also, the no-load test can identify open or shorted fields, which are difficult to check when disassembled. The no-load test also can be used to indicate normal operation on a repaired motor before installation.

NO LOAD TEST

1. Connect a voltmeter from the motor terminal to the ground return terminal, and use an RPM indicator to measure armature speed. See figure 7-37.

2. Connect the motor and an ammeter in series with a fully charged battery of the specified voltage, and a switch in the open position from the solenoid battery terminal to the solenoid switch terminal.

3. Close the switch and compare the RPM, current, and voltage reading with the specifications in the following table.

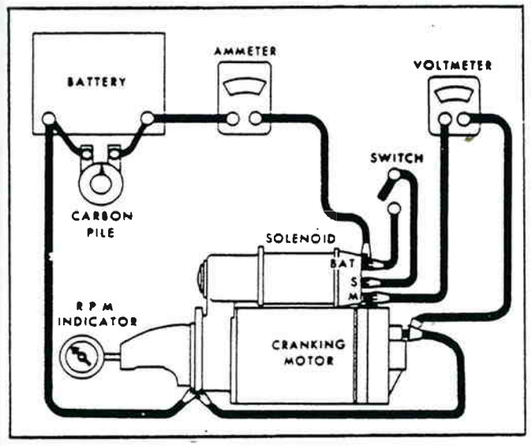

Figure 7-37. No-Load Test Setup.

NO LOAD STARTER TEST SPECIFICATIONS

Starter	Test Voltage	Min. Current Draw (Amps)	Max. Current Draw (Amps)	Min. RPM	Max. RPM
40MT (7G-1-11)	20	70	110	5500	9000
42MT (7G-1-39)	20	60	75	6500	7700
50MT (7G-1-38)	20	95	120	5500	7500

It is not necessary to obtain the exact voltage specified in the chart, as an accurate interpretation can be made by recognizing that if the voltage is slightly higher the RPM will be proportionately higher, with the current remaining essentially unchanged. However, if the exact voltage is desired a carbon pile connected across the battery can be used to reduce the voltage to the specified value.

If more than one 12-volt battery is used, connect the carbon pile to only one of the 12-volt batteries. Make disconnections only with the switch open. Interpret the test results as follows:

NOTE: Rated current draw and no-load speed indicates normal condition of the starting motor.

4. Low free speed and high current draw indicate.

a. Too much friction — tight, dirty, worn bearings, bent armature shaft or loose pole shoes allowing armature to drag.

b. Shorted armature. This can be further checked on a growler after disassembly.

c. Grounded armature or fields. Check further after disassembly.

5. Failure to operate with high current draw indicates:

a. A direct ground in the terminal or fields.

b. "Frozen" bearings (this should have been determined by turning the armature by hand).

6. Failure to operate with no current draw indicates:

a. Open field circuit. This can be checked after disassembly by inspecting terminal connections and tracing circuit with a test lamp.

b. Open armature coils. Inspect the commutator for badly burned bars after disassembly.

c. Broken brush springs, worn brushes, high insulation between the commutator bars or other causes which would prevent good contact between the brushes and commutator.

7. Low no-load speed and low current draw indicate high internal resistance due to poor connections, defective leads, dirty commutator and causes listed in Number 6.

8. High free speed and high current draw indicate shorted field. If shorted fields are suspected, replace the field coil assembly and check for improved performance.

LUBRICATION

1. All bearings, wicks and oil reservoirs should be saturated with SAE No. 20 oil.

2. Place a light coat of lubricant Delco Remy No. 1960954 on the washer located on the shaft between the armature and shift lever housing.

NOTE: Sintered bronze bearings used in these motors have a dull finish, as compared to the early type machined, cast bronze bearings which had a shiny finish.

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3. Before pressing the bearing into place, dip it in SAE No. 20 oil. Also, tangent wicks should be soaked with SAE No. 20 oil. Insert the wick into place first, and then press in the bearing.

CAUTION: Do not drill, ream or machine sintered bearings in any way! These bearings are supplied to size.

It is not necessary to cross-drill a sintered bearing when used with a tangent wick. Because the bearing is so highly porous, oil from the wick touching the outside bearing surface will bleed through and lubricate the shaft.

Middle bearings are support bearings and prevent armature deflection during cranking. As compared to end frame bearings, the clearance between middle bearing and shaft is large and the clearance provides a loose fit when assembled.

DISASSEMBLY AND REPAIR

Normally the starting motor should be disassembled only as necessary to make repair or replacement of the defective parts.

1. Matchmark the relative position of the solenoid, lever housing, and nose housing so the motor can be reassembled in the same manner.

2. Disconnect field coil from solenoid motor terminal and ground return lead from solenoid if present.

3. Remove the attaching bolts and separate the commutator end frame from the field frame.

4. Remove attaching screws to separate brush plate assembly from field frame.

5. Separate the nose housing and field frame from lever housing by removing attaching bolts.

6. Remove pinion stop.

7. Remove armature and clutch assembly from lever housing.

8. Separate solenoid from lever housing by pulling apart.

The drive, armature and fields should not be cleaned in any degresing tank, or with grease-dissolving solvents, since these would dissolve the lubricants in the drive and damage the insulation in the armature and field coils. All parts except the drive should be cleaned with mineral spirits and a brush. The drive can be wiped with a clean cloth.

If the commutator is dirty, it may be cleaned with No. 00 sandpaper.

CAUTION: Never use emery cloth to clean the commutator.

9. Inspect the brushes for wear. If they are worn excessively when compared with a new brush, they should be replaced. Make sure the brush holders are clean and the brushes are not binding in the holders. The full brush surface should ride on the commutator to give proper performance. Check by hand to insure that the brush springs are giving firm contact between the brushes and commutator. If the springs are distorted or discolored, they should be replaced.

10. If the armature commutator is worn, dirty, out of round, or has high insulation, the armature should be put in a lathe so the commutator can be turned. As a final step in this procedure, the commutator should be sanded lightly with No. 00 sandpaper.

NOTE: The undercut operation must be omitted on starting motors having Test Specification 7104 and 7113 as listed in Delco Remy Service Bulletin 1M-188. Do not undercut commutators on motors having this specification.

The armature should be checked for opens, short circuits and grounds as follows:

11. Opens — Inspect the points where the conductors are joined to the commutator bars for loose connections. Poor connections cause arcing and burning of the commutator bars as the cranking motor is used. If the bars are not too badly burned, repair can often be effected by welding the leads in the riser bars (using rosin flux), and turning the commutator in a lathe to remove the burned material.

12. Short Circuits -- Short circuits in the armature are located by use of a growler. When the armature is revolved in the growler with a steel strip such as a hacksaw blade held above it, the blade will vibrate above the area of the armature core in which the short circuit is located. Shorts between bars are sometimes produced by brush dust or copper between the bars. These shorts can be eliminated by cleaning out the slots.

13. Grounds — Grounds in the armature can be detected by the use of a 110-volt test lamp and test points. If the lamp lights when one test point is placed on the commutator with the other point on the core or shaft, the armature is grounded. Grounds occur as a result of insulation failure which is often brought about by overheating of the starting motor produced by excessively long cranking periods or by accumulation of brush dust between the commutator bars and the steel commutator ring.

FIELD COIL CHECKS — The various types of circuits used are shown in the wiring diagrams of Figure 7-38. The field coils can be checked for grounds and opens by using a test lamp.

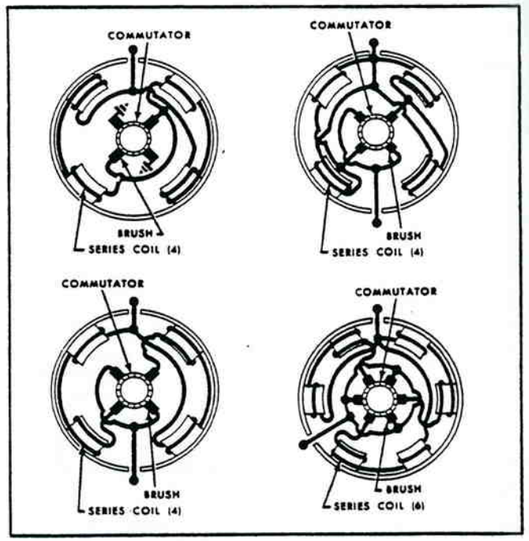

Figure 7-38. Typical Starting Motor Circuits.

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14. Grounds — If the motor has one or more coils normally connected to ground, disconnect the ground connections during this check. Connect one lead of the 110-volt test lamp to the field frame and the other lead to the field connector. If the lamp lights, at least one field coil is grounded which must be repaired or replaced. This check cannot be made if the ground connection cannot be disconnected.

15. Opens — Connect test lamp leads to ends of field coils. If lamp does not light, the field coils are open.

Field coils can be removed from the field frame assembly by using a pole shoe screwdriver. A pole shoe spreader may also be used to prevent distortion of the field frame. Careful installation of the field coils is necessary to prevent shorting or grounding of the field coils as the pole shoes are tightened into place.

Where the pole shoe has a long lip on one side and a short lip on the other, the long lip should be assembled in the direction of armature rotation so it becomes the trailing (not leading) edge of the pole shoe.

SOLENOID CHECKS — A basic three-terminal solenoid circuit is shown in A of Figure 7-39, and a four-terminal solenoid circuit is shown in B. With all other leads disconnected, the solenoid windings can be checked by making test connections as covered below.

THREE-TERMINAL SOLENOID:

CAUTION: To avoid excessive heating, in the following tests, leave the pull-in winding connected no more than 10 seconds at a time. The current will decrease as the heating increases.

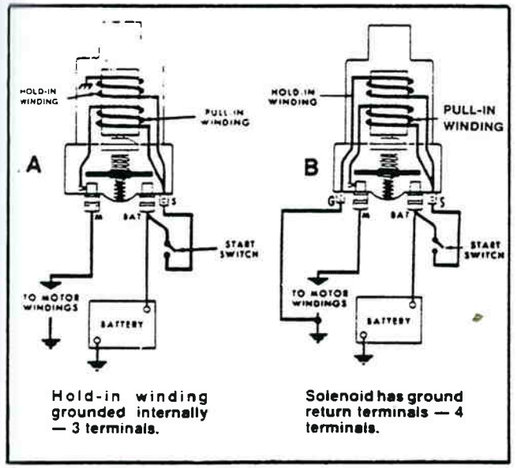

Figure 7-39. Solenoid Circuits.

16. As shown in figure 7-40, make connections to the "S" terminal and a clean metal ground. If needed, use the carbon pile to decrease the battery voltage to the value specified in the following table and compare the ammeter reading with the hold-in winding specifications. A high reading indicates a defective winding (shorted or grounded hold-in or a grounded pull-in), and a low reading indicates excessive resistance.

SOLENOID TEST SPECIFICATIONS

	Pull-In Windows		Hold-In Windows	
Solenoid	Test Voltage	Current Draw	Test Voltage	Current Draw
7G-1-84*	5	85-100	20	110-150
7G-6-25**	5	90-115	20	68 Max

* Used With 42MT Starter (7G-1-39)
** Used With 40MT Starter (7G-1-1) and 50MT (7G-1-38)

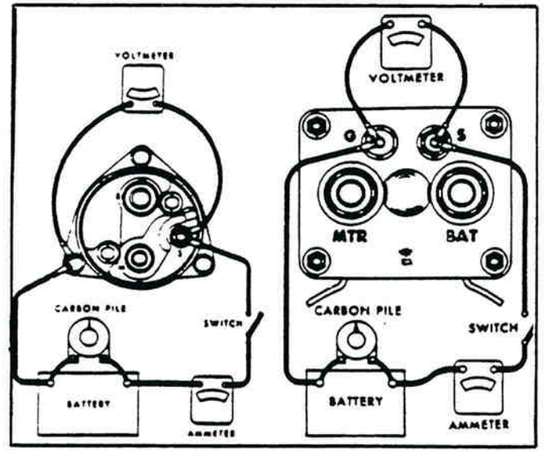

Figure 7-40. Checking Solenoid Hold-In Winding.

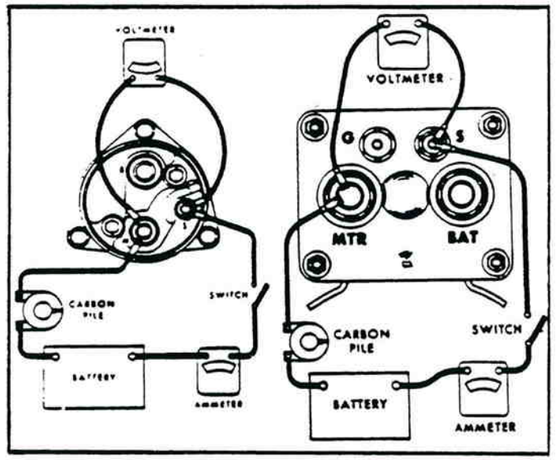

Figure 7-41. Testing Pull-In Winding On Solenoid.

17. To check the pull-in winding connect from the solenoid switch terminal to the solenoid motor terminal (figure 7-41). Compare with the pull-in winding specification. A high reading indicates a shorted pull-in winding, and a low reading indicates excessive resistance.

FOUR-TERMINAL SOLENOID:

18. As shown in figure 7-42, make connections to the "S" and ground return terminals. If needed, use the carbon pile to decrease the battery voltage to the value specified and compare the ammeter reading with the hold-in winding specifications. A high reading indicates a shorted winding, and a low reading indicates excessive resistance.

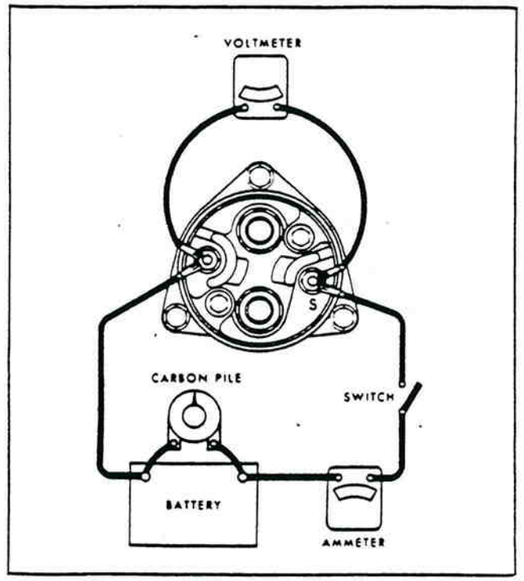

Figure 7-42.

19. To check the pull-in winding connect from the solenoid switch terminal to the solenoid motor terminal. Compare with the pull-in winding specification. A high reading indicates a shorted pull-in winding, and a low reading indicates excessive resistance.

CAUTION: To avoid excessive heating, leave the pull-in winding connected no more than 10 seconds at a time. The current will decrease as the heating increases.

20. To check for grounds, move battery lead from "M" terminal (figure 7-41) to a clean metal ground on the solenoid case (not shown). Ammeter should read zero. If not, hold-in or pull-in winding is grounded.

NOTE: To reduce the voltage to the specified value, connect the carbon pile between the battery and the "M" terminal as shown.

21. The magnetic switch can be checked in the same manner by connecting across its winding.

REASSEMBLY

1. To reassemble the brush plate assembly with brushes on the field frame with armature in place, lift the brushes up so the spring contacts the side of the brush.
2. Assemble to the field frame with the attaching screws.
3. Lift up springs, and position brushes onto commutator.

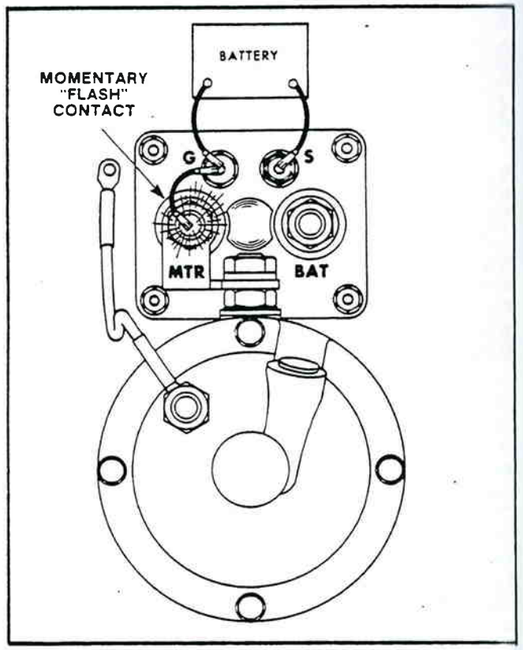

Figure 7-43. Connections for Checking Pinion Clearance (40MT & 50MT).

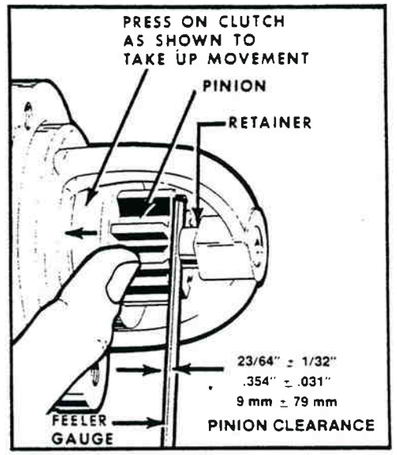

Figure 7-44. Checking Pinion Clearance (40MT & 50MT).

PINION CLEARANCE (40 MT)

To check pinion or drive clearance follow the steps listed below.

1. Make connections as shown in figure 7-43.
2. Momentarily flash a jumper lead from terminal G to terminal MTR. The drive will now shift into cranking position and remain so until the battery is disconnected.
3. Push the pinion or drive back toward the commutator end to eliminate slack movement.
4. Measure the distance between drive and housing (figure 7-44).
6. Adjust clearance by removing plug and turning shaft nut (shown in figure 7-46). Although typical specifications are shown, always refer to 1M-188 for specifications applying to specific models.

PINION CLEARANCE (42MT)

To check pinion or drive clearance follow the steps listed below.

1. Make connections as shown in figure 7-45.
2. Momentarily flash a jumper lead from ground return terminal to terminal MTR (figure 7-45). The drive will now shift into cranking position and remain so until the battery is disconnected.

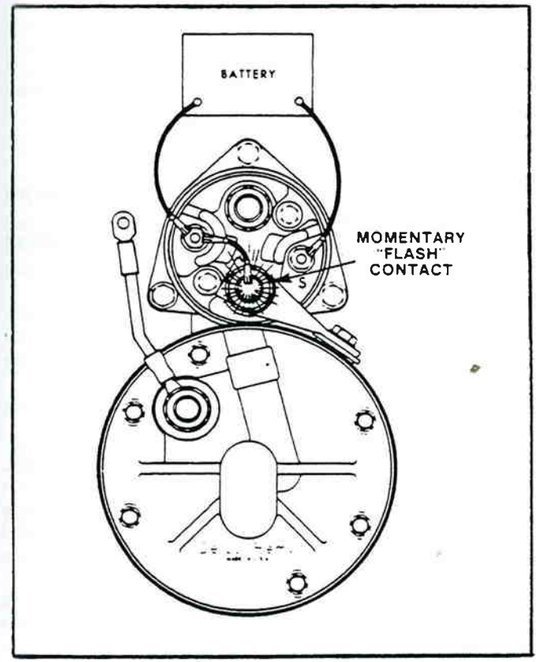

Figure 7-45. Connections for Checking Pinion Clearance (42-MT).

3. Push the pinion or drive back toward the commutator end to eliminate slack movement.
4. Measure the distance between drive and housing (figure 7-46).
5. Adjust clearance by removing plug and turning shaft nut (figure 7-46). Although typical specifications are shown, always refer to 1M-188 for specifications applying to specific models.

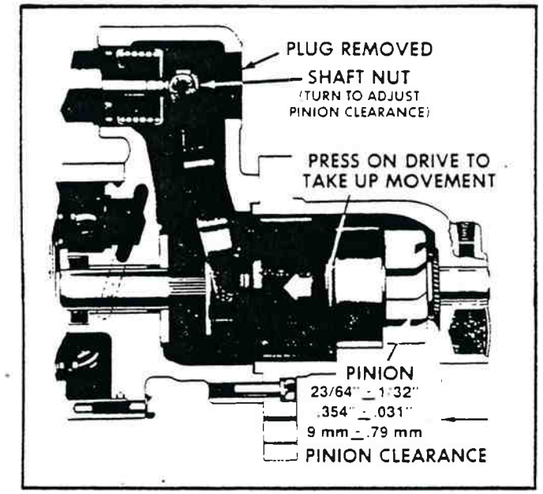

Figure 7-46. Checking Pinion Clearance (42MT).

BATTERIES

DESCRIPTION

Two 12-Volt batteries are connected in series, mounted in a compartment behind the fuel tank compartment door on the right hand front side. Battery cells may be checked and filled at this point.

IMPORTANT: Observe decal on inside of battery compartment for proper connections.

The battery has four (4) major functions to perform on the coach.

(1) It provides a source of current for starting the engine.

(2) It acts as a stabilizer to the voltage in the electrical system.

(3) It can, for a limited time, furnish current when electrical demands of the electrical equipment exceed the output of the generator.

(4) It provides a limited source of power for connected accessories, when the engine is not running.

In replacing batteries, only batteries of the same specification should be used. Refer to "Specifications" at the end of this section.

The electrical system is negative ground, with the negative battery terminal connected to the coach frame.

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CAUTION: Make certain that connections are not reversed, since damage to electrical system components will result.

IMPORTANT: After battery cables have been disconnected, wrap terminal with electrical tape or equivalent to prevent accidental grounding.

Electrolyte level in the battery should be checked at least every 1,000 miles (1,600 km) or every week. If the electrolyte level is found to be low, water should be added to each cell until the level rises to the bottom of the vent well.

NOTE: Do not overfill cells.

Level of electrolyte can be checked by the use of a flashlight and mirror. Hold mirror over each cell opening and direct flashlight beam so level can be seen.

Distilled water should be used to eliminate the possibility of impurities being added to the electrolyte.

NOTE: Do not add any substance to the electrolyte except water.

The freezing point of the electrolyte depends upon its specific gravity. The following table gives freezing temperatures of various specific gravities.

SPECIFIC GRAVITY	°F FREEZING TEMP.	°C
1.100	+18	-8
1.120	+14	-10
1.140	+8	-13
1.160	+2	-27
1.180	-6	-21
1.200	-17	-17
1.220	-31	-35
1.240	-51	-46

(1) Check voltage drop between grounded battery terminal (negative) and vehicle frame. With the starting motor turning over, the voltage reading should be less than 0.3 volts. If more, there is excessive resistance in circuit.

(2) Check voltage drop between positive terminal of battery and starting motor terminal stud while starting motor is operating. If the reading is more than 1.0 volts, the resistance is excessive.

(3) Check voltage drop between the starting motor housing and the bus frame. If over 0.2 volts, the resistance is excessive.

CLEANING AND INSPECTION

The external condition of the battery and the battery cables sould be checked periodically. The top of the battery should be kept clean and the battery hold-down bolts should be kept properly tightened. Neutralize all acid with soda and water solution. Flush trays and battery compartment thoroughly with water. Care must be taken to keep vent plugs tight so that the neutralizing solution does not enter the cells. Repair damage done by acid as required. Scrape all paint bubbles to bare metal. After drying, repaint interior of the battery compartment and the trays with No. 701 Red-Con-Treat Paint. Be sure to check all grommets and cable hangers for possible damage to cables. The hold-down bolts should be kept tight enough to prevent the battery from shaking in its holder, but should not be tightened excessively as to place strain on the battery case.

To ensure a proper contact, the battery cable clamps should be tight on the battery posts. If the posts or cable clamps are corroded, the cables should be disconnected and the posts and clamps cleaned separately with soda solution and a wire brush. A coating of petroleum jelly should then be applied to the battery posts and the inside of cable clamps to prevent oxidation. Corrosion at the posts can be avoided by lightly coating the posts and the cable clamps with petroleum jelly and by placing oil soaked felt washers on terminal posts under clamps.

BATTERY TESTS

Place a load on batteries with starter for 30 seconds and turn on headlights — low beam — 20 amp. draw — and leave on while using an expanded scale volt meter of .01 scale divisions, check all cells for capacity. If all cells read 1.95 Volts or more with less than .05 volts difference between highest and lowest cell reading, battery is good and sufficiently charged.

NOTE: When replacing a battery both batteries must have an equal state of charge. The regulator is controlled by the counter voltage in the good battery, therefore the weak battery will never come up and eventually the good battery will fail.

CHECK SPECIFIC GRAVITY

Use a temperature-correcting hydrometer to measure the specific gravity of each cell.

If any cell has a specific gravity below 1.215 charge batteries as described below.

NOTE: If the electrolyte level in any cell is too low to produce a reading, add water to the battery and perform "Battery Charge" described later.

BATTERY CHARGE

If battery is under 1.230 specific gravity, it must be charged. If the specific gravity reading is less than .050 points between lowest and highest cell, recharge for 24 hours at 12 to 15 amps and 15 volts. Battery is fully charged when reading is checked for three (3) consecutive hourly checks, and no increase is noted.

If the reading of any cell fails to reach 1.250 @ 80°F or if a variation exists of more than 25 gravity points between cells after charging, replace the battery.

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NOTE: Highly sulfated batteries may have to be charged at 16 or 17 volts to start charging current to flow through the battery, then reduce rate to regular charge of 15 volts. They may require up to 48 hours charging.

NOTE: Do not allow electrolyte temperature to go above 125°F (52°C).

HIGH RATE DISCHARGE TEST

Never check a battery in a discharge state. Specific gravity must be above 1.230 for the high rate discharge test. If battery was slow-charged, it should stand 8 to 10 hours between performing high rate discharge.

HOOK UP

The battery leads must be connected to the battery, red to positive, black to negative. Turn the voltmeter selector to the 16 volt position. Connect the voltmeter leads to the battery posts.

TEST PROCEDURE

Turn the load selector clockwise until the upper scale of the D.C. amperes meter reads two times the ampere-hour rating of the battery. Hold this load on for 15 seconds. While the load is on, read the battery terminal voltage on the 16 Volt scale of the D.C. Volts meter. Turn all controls to off and disconnect the tester.

NOTE: If the terminal voltage reads 10.6 or more the battery is good.

(1) Check voltage drop between grounded battery terminal (negative) and vehicle frame. With the starting motor turning over, the voltage reading should be less than 0.3 volts. If more, there is excessive resistance in circuit.

(2) Check voltage drop between positive terminal of battery and starting motor terminal stud while starting motor is operating. if the reading is more than 1.0 volts, the resistance is excessive.

(3) Check voltage drop between the starting motor housing and the bus frame. if over 0.2 volts, the resistance is excessive.

COMMON CAUSES OF BATTERY FAILURE

When a battery fails, the cause of failure may be outside the battery. For this reason, locate and correct the cause of the failure to prevent recurrence. Some common causes of battery failure are as follows:

(1) Defect in generating system such as high resistance or faulty generator or regulator.

(2) Defective starter or excessive use of accessories.

(3) Dirt and electrolyte on top of batteries.

(4) Hardened battery plates, due to battery being in a low state of charge over a long period of time.

(5) Shorted cells, loss of active material from plates.

(6) Driving conditions or requirements under which the vehicle is used only for short drives.

CAUTION: When making the above checks, make certain the engine does not start accidentally.

EQUIPMENT REQUIRED TO PERFORM ELECTRICAL SYSTEM CHECKS

(A) Salt brine load stack unit which includes the following items:

(1) Load stack electrode.

(2) 28-30 U.S. gallon (106-113 liters) plastic can.

(3) One (1) cart with casters. Cart size 30" high x 18" wide x 24" long (762 mm x 457 mm x 609 mm).

(4) One (1) 0 to 500A external shunted amp. meter to read generator output.

(5) One (1) 0-15A amp. meter to be wired in series with a 10A circuit breaker (reset type) and variable rheostat in field coil circuit.

(6) One (1) 200 Watt and 150 ohm variable rheostat.

(7) One (1) 10A circuit breaker (reset type).

(8) One (1) 0 to 30V Voltmeter.

(9) One (1) 50 M.A. external shunt, for 500A amp. meter.

(10) One (1) Model 10W-12 heath oscilloscope to be mounted on cart along side instrument board (at location desired only).

(11) Two (2) pairs 6" (152 mm) vice-grip pliers to make fast hookup to coach circuit.

(12) Two (2) 8 ft. (2.4 m) pcs. — Welding Cable for leads to load stack electrodes one end and vice grips on other end.

(B) **Note:** The following items are required in cart for checking and servicing batteries and starter.

(1) One (1) Columbia type AC-DC tong test amp. meter 0-800 amp. scale-plus 0-150 extra scale and carrying case. The tong tester is used to check current draw on engine starter as follows:

(a.) Clamp tongs around battery cable to the starter.

(b.) Spin engine over with starter with fuel rack in no fuel position to prevent engine from cranking. Operate 5 seconds and record reading. Should be winding 29.5 to 34.6 amps. approx. Hold in windings 4.5 to 6.0 amps.

(C) One (1) exide CA-200 battery tester-analyzer or an expanded scale volt meter of .01 scale divisions to perform the battery light load test. The CA-200 analyzer is recommended as it will test all type batteries by activating the meter with the electrolyte solution. Same procedure is followed.

CAUTION: Battery may be damaged if test probes contact plates.

(D) Wooden battery tool tray painted with creosote.

(E) One (1) battery hydrometer.

(F) Two (2) battery terminal and post cleaner.

(G) One (1) wire brush.

(H) One (1) box baking soda to clean battery and terminals.

(I) One (1) cup of chassis lube and a brush (small) to apply grease to post and terminals to prevent or retard corrosion.

(J) A supply of corrosion resisting felt washers to be placed over battery posts prior to cable terminal installation.

BOOSTER BATTERY STARTING

CAUTION: Any procedure other than the following could result in:

(1) Personal injury caused by electrolyte squirting out of the battery vents.

(2) Personal injury or property damage due to battery explosion.

(3) Damage to the charging system of the booster vehicle or of the immobilized vehicle.

DO NOT attempt to jump start a vehicle having a frozen battery because the battery may rupture or explode. If a frozen battery is suspected, examine all fill vents on the battery. If ice can be seen, or if the electrolyte fluid cannot be seen, do not attempt to start the vehicle with jumper cables as long as the battery remains frozen. Both the booster battery and the discharged battery must be treated carefully when using jumper cables. Follow EXACTLY the procedure outlined below, being careful not to cause sparks.

CONNECTING BOOSTER BATTERY AND JUMPER CABLES

(1) Set parking brake, turn off lights, heater and other loads. Remove 12 Volt leads at battery.

(2) Remove vent caps from both the booster and the discharged batteries. Lay a cloth over the open vent wells of each battery. These two actions help reduce the possibility of explosion which is always present when connecting a "live" booster battery to a "dead" battery.

(3) Attach one end of one jumper cable to the positive terminal of booster battery (identified by a red color "+" or "P" on the battery case, post or clamp), and the other end of the same cable to the positive terminal of the discharged battery. **DO NOT** permit vehicles to touch each other as this could establish a ground connection and counteract the benefits of this procedure.

(4) Attach one end of the remaining negative (—) cable to the negative terminal (black color "—" or "N") of the booster battery, and the other end to ground location on the vehicle being started. DO NOT CONNECT DIRECTLY TO NEGATIVE POST OF DEAD BATTERY — taking care that clamps from one cable do not inadvertently touch the clamps on the other cable. DO NOT lean over the battery when making this connection.

NOTE: The ground is to be at least 12 inches from the battery filler caps, and provide good electrical conductivity and good current carrying capacity.

DISCONNECTING BOOSTER BATTERY & JUMPER CABLES

(1) Taking care that clamps from one jumper cable do not inadvertently touch clamps on the other jumper cable, disconnect jumper lead from ground location on the vehicle being started. DO NOT lean over the battery when disconnecting this lead.

(2) Remove remaining end of negative (—) jumper cable from the booster battery.

(3) Remove one end of the remaining jumper cable from positive terminal of the discharged battery, then remove the other end of the same cable from positive terminal of the booster battery.

(4) Remove cloths from open vent wells of each battery. Discard cloths as they may have corrosive acid on them. Install vent caps on both the booster and the discharged battery.

OPTIONAL 12-VOLT POWER SOURCES

Either of two optional 12-volt power sources may be installed on the coach.

12-VOLT POWER SOURCE - 10-AMP LIMIT

This installation is made with 10-gauge wire and has a 10-amp circuit breaker. Twelve-volt electrical items with a combined current draw of less than 10 amps may be used with this system.

NOTE: Since this 12-volt power source draws only from the rear 12-volt battery, excessive use or heavy loading can result in premature battery failure. Periodic rotation of the batteries will help to extend battery life.

A cut-off relay is provided with this installation and cuts off all power to 12-volt items when the battery disconnect switch (figure 7-1) is shut off.

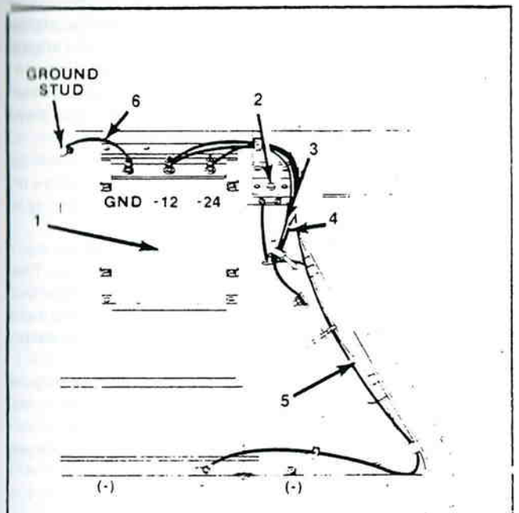
An installation and wiring layout diagram is included in the diagrams and schematics located in the later pages of this section.

12-VOLT POWER SOURCE - 40-AMP LIMIT

Twelve-volt equipment with a combined current draw up to 40 amps can be used with this system. The main features of this system are a battery equalizer and a 40-amp circuit breaker (figure 7-47).

This system is installed on all coaches which have electronically controlled engines (DDEC) or electronically controlled transmissions (ATEC).

A schematic of this system will be found in the later pages of this section.



1. Battery Equalizer
2. Circuit Breaker
3. Cable - - 12V Stud to Circuit Breaker
4. Cable - - 24V Stud to Main Disconnect
5. Cable - - 12V Stud to Positive Post On Rear Battery
6. Cable - Ground

Figure 7-47. Installation of Battery Equalizer and Circuit Breaker.

BATTERY CHARGE EQUALIZER

DESCRIPTION

The battery charge equalizer maintains the voltage balance and charge acceptance rate of each battery to anywhere from 0.1 to 0.01V under a light load and within 0.5V full load.

With this system, it is not necessary to replace both batteries if one of them becomes defective: the equalizer system will maintain a balance between the old and new battery.

NOTE: When replacing only one of the batteries, install the new battery in the grounded position (at the rear of the battery compartment.

OPERATION

When the voltage of the grounded battery is higher than that of the ungrounded battery (battery "B"), the equalizer is in a standby mode. When battery "A" decreases in voltage to just below that of battery "B" the equalizer turns on and transfers just enough power from "B" to "A" to satisfy the load and to maintain an equal voltage and charge in both batteries.

The following three operational conditions will normally be encountered; the equalizer will function as described.

1. A 24VDC load is present; no 12V load is present. The system will operate as a normal 24VDC system would, whether the alternator is on or not and the equalizer is in a standby mode. It will make minute adjustments to keep the batteries in balance.

2. Both 24- and 12-volt loads are present, and the alternator is off. Both batteries will discharge at the same rate even though there is an unequal load. (See opertion above.)

3. Both 12- and 24-volt loads are present and the alternator is on. The alternator will provide 24VDC just as though there were no equalizer or 12V load in the system. The equalizer transfers the 24V to 12V for the load, plus maintains battery balance.

SAFETY FEATURE

The +12-volt output of the equalizer is current limited making it short circuit proof and virtually indestructible. In the unlikely event of a failure of the unit, battery "A" will sustain the load for a limited length of time and you would have about the same condition as if you had a battery failure.

TESTING THE EQUALIZER

The following procedure provides a test to determine if the equalizer is working properly. The test equipment that will be required is one sealed beam 12V headlamp and two jumper wires.

1. Disconnect the ground lead from the equalizer ground stud.

2. Connect one lead of the test seal beam headlamp to the 12V stud on the equalizer. Connect the other lead on the sealed beam headlamp to the ground stud on the equalizer.

3. If the equalizer is operating properly, the headlamp will glow steadily.

4. If a malfunction exists in the equalizer, the light will either glow steadily and then go out, or will not illuminate at all.

5. After test is complete, reconnect the battery ground lead to the equalizer ground stud.

3N124 TRIPLE FUNCTION PROTECTIVE DEVICE

This device is present on many of the MCI Series of coaches manufactured prior to 1987. It is standard equipment on these coaches beginning in 1987.

NOTE: This device is not present on coaches which have the optional Thermal Time Delay Relay.

All three functions are contained in a unit which is mounted in the rear junction box. Refer to the 3N1214 Triple Function Protective Device wiring diagram at the end of this section.

A description of each of the three functions follows.

1. **High Voltage Cutout Funtion —** One section of the Triple Function Protective Device uses a relay to interrupt power to the alternator field solenoid in the event of a high-voltage condition. The interrupt circuit is between the two blue wires coming out of the unit. The contact capabilities are 3 amps DC, which is more than adequate to run the field relay. The relay in the protective device is normally relaxed and the contacts are normally closed. In the event the voltage to the unit

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exceeds 30 volts for a period of time in excess of 0.5 seconds, the relay will energize, thus opening the contacts and interrupting the alternator field relay. It has a self-holding feature so that the interruption will continue until the driver shuts off the master switch and turns it on again. If the high-voltage condition still exists, the unit will trip again. The driver will be aware of the fact because the alternator discharge light will be turned on at the driver's instrument panel and in the engine compartment. The 0.5-second time delay will eliminate false tripping because of momentary transients caused by turn signals, air conditioners, or other circuit interruptions. Under normal circumstances this relay will never be energized; therefore, it draws no power from the coach supply system until an overload condition occurs. If the alternator discharge light should come on, it would indicate a malfunction in the electrical system which should be corrected by maintenance personnel. The driver should be advised, however, to cycle the master switch in an attempt to cure the difficulties in case the high-voltage condition was only momentary. The 0.5-second time delay provides protection from transients, but will still save light bulbs, electric motors and dashboard instruments from failures due to a high-voltage condition.

2. **Low Oil Pressure Switch Interrupt Function —** The function of this element is to prevent the low oil pressure switch from shutting down the engine before oil pressure can be established immediately after engine start-up. The interrupt contacts have 3-amp capabilities and are in the black wires coming out of the unit. These wires should interrupt the low oil pressure switch circuit and are connected in series with that switch. Internally the relay that controls this interrupt is normally unenergized and the contacts are normally closed. When the starter is energized, so also is the interrupt relay, thus opening the low oil pressure switch line. The relay remains energized (and thus the contacts open) for the duration of the cranking cycle **and** for 10 seconds thereafter. The relay in this element is energized only during the cranking cycle and for 10 seconds thereafter, at which time it returns to the relaxed or unenergized state. The only time it draws power, therefore, is during the cranking cycle and for 10 seconds thereafter. Starting a new cranking cycle (initiated prior to the time that the 10-second period from the first cranking cycle has expired), the time delay will be rearmed and a new 10-second cycle will begin at the conclusion of the cranking period.

3. **Starter Protector Function —** The function of this portion of the device is to prevent the starter from being activated if the engine is turning. This element uses the R-1 lead output of the alternator to sense engine movement. If the engine is turning, no matter how slowly, it will prevent the starter from being engaged; however, it will still allow the override features of the starter switch to function. It does not interrupt the override for high engine temperatures or low oil pressure. Neither will it interrupt the starter cycle as soon as the engine begins to crank. The instant the driver releases the starter switch after cranking, the starter is prevented from being re-engaged until the engine comes to a complete halt. This is accomplished by a relay with contact capabilities of 3 amps. This relay remains unenergized until such time as the master switch is turned on. At that time the relay is energized, thus allowing the starter switch to supply power to the starter solenoid relay. It remains energized and thus the starter circuit completed until such time that the driver energizes the starter switch and throughout the cranking cycle. When the starter button is released **and** the engine is turning, the relay de-energizes (thus interrupting the starter solenoid circuit) and remains in this condition as long as the engine is turning, no matter how fast or how slowly. Thus the starter mechanism is prevented from being engaged until the engine comes to a complete stop. Again, under normal operating conditions, the circuit draws no power from the coach, except momentarily between the time the master switch is energized and the engine is started.

While the engine is running should the starter switch be engaged, it will serve to override the high temperature or low oil pressure contacts but will not allow the starter solenoid relay to be activated.

The starter protector element of the 3N124 device is connected to a warning light on the driver's instrument panel. This light, when illuminated, tells the driver that the starter solenoid relay is armed. Under normal operating conditions, the light comes on when the master switch is turned on and will remain on until engine start-up has been accomplished.

Should the warning light remain illuminated after the engine has started, or if it comes on during coach operation, the driver is warned of a fault in the system and that the starter solenoid relay is armed. A broken R-1 lead or a faulty relay would cause the light to come on. Either of these malfunctions would prevent a signal being sent to the starter protection element that the engine is turning over. Under certain operating conditions, such as attempting to crest a long grade without engine shutdown, the driver might press the starter switch. Before pressing the starter switch the driver should be certain that the warning light is not illuminated. **He must not use the override feature of the starter switch if the warning light is on.** If he does so and the engine is turning over, serious damage to the starter or engine flywheel can result.

TESTING OF 3N124 TRIPLE FUNCTION PROTECTIVE DEVICE

To test the Triple Function Protective Device after it is installed in the coach, proceed as follows:

1. With the battery disconnect switch in the "ON" position, turn the master switch "ON" at the driver's instrument panel. the "Starter Alert" telltale light at the dash should be lit. This indicates the starter is armed and ready.

2. To test the starter protection feature, start the engine and DO NOT release starter switch (or keyed ignition switch). The starter should "drop out" almost immediately following engine start-up and the telltale light should go out.

3. With the engine at idle, release the starter switch and attempt to re-engage the starter. There should not be any response.

4. Ground the left-hand "Hot Engine" alarmstat and hold the starter switch prior to engine shutdown. The engine should continue to run without starter engagement as long as the starter switch is held in the "ON" position (starter bypass feature).

CAUTION: If the telltale light remains on following engine start-up, release the starter switch (or keyed ignition switch) immediately and DO NOT perform step 3. (No Starter Protection)

5. To test the Low Oil Pressure Switch interrupt feature, ground circuit #60 at the 3-lb. oil sender while the engine is running. The engine will shut down following approximately a 10-second delay.

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6. To test the Overvoltage Protection Feature, place a voltammeter between "A1" and ground at the regulator (50VDC scale).

7. With the engine running at fast idle (no load), SLOWLY move the adjustment screw at the regulator clockwise and observe the voltage reading. The alternator should "drop out" between 30 and 31 volts.

CAUTION: If the alternator does not "drop out" at 31 volts, DO NOT proceed any further. (No Overvoltage Protection.) Readjust the regulator to 27.2VDC.

8. If the alternator does "drop out," turn the regulator adjustment screw back (counterclockwise) approximately ¼ turn and turn the master switch off at the dash.

9. Start the engine and adjust the regulator back to 27.2VDC.

10. If any one of the above test steps fails, replace the defective unit.

ENGINE HEATERS (OPTIONAL)

BLOCK AND OIL PAN HEATERS

An engine block heater is available as optional equipment. It is 115 volt, 1500 watt, single loop element type, fitted in the block behind the crankcase dipstick.

An oil pan immersion heater is also available as optional equipment. It is a 115 volt, 200 watt single loop element type fitted in the side of the oil pan.

Both heaters are supplied with a 3/16" HPN cord and plug set when ordered separately. When ordered together, or with the optional lavatory tank immersion heater, a junction box is supplied. This box is installed in an external access door at the rear of the coach.

These heaters are non-serviceable except for the cords and if faulty must be replaced.

ALARMSTATS (WITH NON-DDEC ENGINES)

Two alarmstats are installed, one at the front of each cylinder head, to warn the operator if the engine overheats.

When the engine coolant rises to a specific temperature, the alarmstat closes the electrical circuit, causing the HOT ENGINE tell-tale light on the instrument panel to illuminate and the buzzer to sound in the driver's compartment. The activation of the alarmstats will cause the engine to automatically shut down.

Alarmstats are set to close at 210°F (99°C). An optional model that closes at 220°F (104°C) is also available. The temperature at which the alarmstat closes is stamped on the hex.

At time of general inspection, ground the alarmstats by making contact between the terminal post on top of the alarmstat and the alarmstat body. The warning buzzer should sound and the tell-tale light should illuminate, indicating that the wiring is in order. Remove any accumulation of dirt and grease from outside of alarmstats.

ELECTRIC HORNS

The coach is equipped with two 24-volt electric horns. They are located in the left hand front service compartment (figure 7-48).

The horns are operated by pressing a button at the center of the steering wheel or by using the electric foot switch. (When optional air horns are used, the foot switch is replaced by an air horn valve.) The tone is created by a vibrating diaphragm which causes an air column to vibrate.

No maintenance is normally required except a current adjustment of the adjusting screws. One horn produces a high note and the other a low note.

Figure 7-48. Horns.

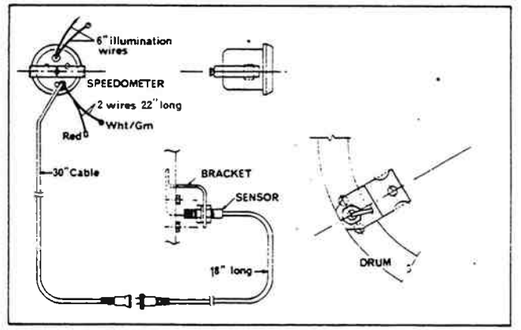

Figure 7-49. Electronic Speedometer Installation.

SINGLE SENSOR SPEEDOMETER

WITH LEFT FRONT WHEEL TAKEOFF

DESCRIPTION

A single sensor type speedometer with left front wheel takeoff is installed as standard equipment. The speedometer head is installed on the left side of the instrument panel. A single sensor is mounted on the backing plate on the left front wheel. Also four capscrews are mounted 180° apart on the backing plate.

OPERATION

As the left front wheel turns, the heads of the cap screws pass under the sensor. The sensor simply "counts" the number of times a cap screw head passes by. As they pass, a pulse is generated and sent up the cable to the speedometer head.

The gap between the sensor and cap screws is set at the factory and should not require adjustment. However, if the speedometer does not register at low speeds or high speeds the following procedure should be followed to correct the situation.

PROCEDURE FOR CORRECTING SENSOR GAP

(A) Make sure all four cap screw heads pass approximately the same distance from sensor pickup.

(B) Start with a gap between sensor pickup and screw heads of about ⅛" (3mm).

(C) Watch the speedometer needle on the instrument panel as it slows down. The needle will begin to shake as the speed decreases. When the indicated speed drops to seven to five mph (12-9 km/h), the needle should suddenly drop to zero. If it continues to display a reading below 5 mph (9 km/h) the gap is too narrow and sould be widened slightly. If this is not done, the needle may shake and become erratic at highway speeds.

Conversely, if the needle drops to zero at 15 mph (23 km/h) or more, the gap is too wide and sould be narrowed slightly.

When adjusting the gap, always recheck speedometer reading to make sure the gap is increased or decreased correctly.

ELECTRONIC SPEEDOMETER TROUBLESHOOTING

SYMPTOMS	POSSIBLE CAUSE	SOLUTION
A. No indication on meter.	A. 1) Magnets Off.	A. 1) Install magnets.
	2) Magnets very weak.	2) Install new magnets.
	3) Magnets not close enough.	3) Reposition magnets.
	4) Bad cable. (Can be verified by plugging in another cable and waving magnet past pickup).	4) Replace cable.
	5) Bad head. (Can be verified by plugging replacement head into installation cable and driving vehicle. Indication on new head determines cable O.K. but old head not.	5) Replace head.
B. Low reading on head.	B.	B.
1) Exactly half of correct reading and steady.	1) One magnet off.	1) Replace magnet.
2) (a) Exactly half of correct reading at high speeds but jumpy at low speeds.	2) (a) One magnet too far away from pickup.	2) (a) Reposition magnet.
(b) Exactly half of correct reading at high speeds but jumpy at low speeds.	(b) One magnet too weak.	(b) Replace magnet.
3) Low reading and unsteady at all speeds.	3) (a) Bad head	3) (a) Replace head & return it to factory.
	(b) Intermittently open cable. (Test by trying new head plugged into old cable and held by hand while vehicle is moving).	

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ELECTRONIC SPEEDOMETER TROUBLESHOOTING (Cont'd)

SYMPTOMS	POSSIBLE CAUSE	SOLUTION
4) Low reading just slightly but speady and same percentage low at all speeds.	4) Improperly calibrated head or wrong size tire.	4) Install proper head or recalibrate existing head.
C. High Reading.	C.	C.
1) High reading at all speeds but steady. Reads same percentage high at all speeds.	1) Head improperly calibrated or for different tire size.	1) Replace head with properly calibrated unit or recalibrate existing head.
2) Meter pinned at maximum reading.	2) (a) Bad head. Try new head in vehicle.	2) (a) Replace head & return to factory.
	(b) Shorted cable (if new head does the same thing or clears but is erratic as you move cable connector, this proves cable is not good).	(b) Replace cable or clear short by disassembling connector and pulling on wires & carefully reassembling.
3) Reads two times too high exactly.	3) Magnets too close.	3) Move pickup away from magnets.
4) Reads two times too high at speeds (over 25-30) but accurate at Low speeds.	4) Magnets too close.	4) Move pickup away from magnets.
5) Reads 1-1/2 times too high exactly.	5) One magnet too close or to powerful.	5) Correct spacing depending upon reason for magnet being too close.
6) Reads 1-1/2 times too high at high speeds but accurately at low speeds.	6) One magnet too close or too powerful.	6) Correct spacing or replace magnet.

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ELECTRONIC SPEEDOMETER TROUBLESHOOTING (Cont'd)

SYMPTOMS	POSSIBLE CAUSE	SOLUTION
7) Difficult to define high reading which changes with amount of electrical equipment running in coach. (Heater, radio, fan, etc.)	7) Unit needs filter because of electrical hash or noise.	7) Install filter. (All serial numbers higher than M73xx or lower with white dot have filter inside).
8) Jumpy needle.	8) (a) Needs filter	8) (a) Install filter.
	(b) Intermittent short in cable. Check by trying new cable.	(b) Replace cable.
D. Needle reads above zero.	D.	D.
1) With power off.	1) Incorrect zero adjust setting.	1) Replace head or carefully remove glass and readjust.
2) With power on.	2) Leaky transistor.	2) Replace head & return it to factory.
E. Combination of any of the above.	E.	E. Correct problems each in order.
F. Needle sticks at one spot.	F.	F.
1) Jumps both going up and down the scale.	1) Bad Head.	1) Replace.

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LIGHT BULB DATA

EXTERIOR LAMPS	NUMBER
Headlamps - Low Beam	H5006
Headlamps - High Beam	H4001
Fog Lamps (Clear, Sealed Beam)	4880
Side Turn Signal Lamps (Front Side)	1638
Stop Lamps	1683
Destination Sign Lamps	1691 IF
Tail Lamps	1252
Rear License Plate Lamps	624
Center Identification Lamps	624
Roof Corner Clearance Lamps (Side)	624
Side Marker Lamps	624
Intermediate Side Marker Lamps	624
Side Turn Signal Lamps (Rear Side)	1638
Backup Lamps	1638
Turn Signal Lamps	1638

INTERIOR LAMPS	NUMBER
Window Fluorescent Lamps	F40/WW
Overhead Aisle Fluorescent Lamps	F30 T12/WW/RS
Turn Lamp	265 Green
Generator Discharge - Remote Control Panel	456
Lavatory OCCUPIED Sign	265
Trailing Axle	265
Low Water Level	265
Low Fuel Level	456
Fire Alarm	265
Auto Transmission Illumination	265
Engine Compartment	456
Lavatory Main Lamp	1638
Lavatory Night Lamp	1495
Reading Lamps	1691 IF
Indirect Lamps	1495
Driver's Lamp	1203
Switch Panel Illumination Lamps	265 Green
Instrument Panel Lamps (Green)	757
Step Lamp	624
Baggage Compartment Lamps	308 IF
Engine Compartment Lamps	456
Running Lamps (blue)	1495
In-Station 115V - Baggage	25T8
In-Station 115V - Destination	15T7 DC/IF
In-Station 115V - Ceiling, Fluorescent	15T8
Heat On (green)	265
Air Conditioning (red)	456
Low Oil (red)	456
Not Gen (amber)	265
Emergency Brake (green)	456
Lavatory Emergency (red)	265
Low Air (red)	456
Hot Engine (red)	456
Back-Up Lamps (green)	456
High Beam (blue)	265
Hazard Warning Flasher (green)	265
Stop Lamps (green)	265
Fog Lamp (green	265
Aisle Lamps (seat) (blue)	1251
Speedometer Lamp (green)	356

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AIR CONDITIONING JUNCTION BOX CONNECTIONS

STUD	CIRCUIT NUMBER	COLOR	GAUGE	DESCRIPTION
1	14	White-Red	16	Diode to Stud 8 - Coach Heat Sensing Unit
2	16	Black	16	Sensing Element A and Potentiometer
3	31	Green-Black	14	Baggage Compartment Lamps
4	44	Yellow	16	Left Hand Turn Lamps
5	45	Yellow-Red	16	Right Hand Turn Lamps
6	23	White-Green	16	Spare
6		Black	10	12-Volt Power Source
7	56 & 56A	Green	18	Hot Water Valve
8	55	Orange	16	Sensing Element C
9	21	Blue-White	16	12-Volt Headlight Relay
10	66	Orange-White	16	Spare
11	14H (3 wires)	White-Green	14	A/C Tell-Tale and Liquid Line Solenoid
12	70	White-Green	18	Spare
13	53	Black-Blue	16	Fuel Gauge (Optional) or Fuel Sensor (Optional)6
14	47	Red-Yellow	14	Evaporator Motor Relay
15	14P	Green-Yellow	16	Condenser Motor Relay Coil

REMOTE CONTROL BOX (HORIZONTAL BAR)

1	14P	Green-Yellow	16	Hi-Lo Pressure Switch Feeder
2	14L	Yellow	16	A/C Clutch
2	14H	White-Green	16	Liquid Line Solenoid
2	BL	Black	16	Hi-Lo Pressure Switch
3	14L	Yellow	16	Spare
4	46	Orange-Red	16	Back-Up Lamp
5	44	Yellow	16	Left Hand Turn Lamp
6	46G	Blue	16	Back-Up Lamp (Return)
7	24	Green-Yellow	16	Left Hand Stop Lamps
8	15	Red-Blue	16	Spare
9	6A	Blue-Yellow	16	Engine Stop Valve
10	54	Yellow	16	Spare

REMOTE CONTROL BOX (VERTICAL BAR)

1	17	Red-Black	16	License Plate Lamps
2	15	Red-Blue	16	Tail Lamps
2	15	Red-Blue	16	Side Marker Lamps
3	24	Green-Yellow	16	Right Hand Stop Lamps
4	31	Green-Black	16	Motor Compartment Service Lamps
5	45	Yellow-Red	16	Right Hand Turn Lamps
6	57	Yellow-Green-Green	16	Spare
7	63	Blue-Blue	16	Lavatory Blower
8	63A	Red-Blue	16	Spare

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FRONT JUNCTION BOX CONNECTIONS

Stud	Circuit Number	"Color Codes" All Harnesses Except Driver's Instrument Panel	Gauge	Description
1	26	Orange-Black	16	Oil Pressure Gauge
2	27	Brown	16	Temperature Gauge
3	42	Blue	18	Potentiometer Rotor
4	29	Red-Black	14	Front/Rear Start Switch
5	41	Black-Red	16	Horn Relay
6	44F	Yellow	16	Turn Lamp - Left Front
7	44R	Yellow	16	Turn Lamp - Left Rear and Side
8	45F	Yellow-Red	16	Turn Lamp - Right Front
9	45R	Yellow-Red	16	Turn Lamp - Right Rear and Side
10	25	Gray	14	Emergency Engine Stop
11	5	White-Red	18	24V Discharge Tell-Tale Light
12	OR	Black	18	Starter Alert Tell-Tale Light
13	38	White-Green	18	Low Air Tell-Tale Light
14	3	Black	10	Load Side of Master Switch
14	3	Black	14	Instrument Feeder
14	3	Black	10	Bus Bar Circuit Breaker Feeder (Rear)
15	15	Red-Blue	14	Marker Lamps
15	15	Red	12	Marker Lamps Feeder (Load Side)
16	21	Blue-White	16	Aisle Lamps
16	21		16	Running Lamps
16	43	Green-White	16	Gauge Illumination (Feeder)
17	69	Red-Blue	16	Reverse Throttle Interlock
18	47	Red-Yellow	14	Evaporative Motor Relay Feeder
19	24P	Green-Yellow	16	Stop Lamp Feeder
	9P	Black-Green	18	Feeder-Door Latch-Solenoid Valve
20	24	Green-Yellow	16	Stop Lamps
21	28	Brown-Yellow	16	Lavatory Alarm
22	36C	White	18	Master Control Switch-Galley (Option)
23	22	Black-Yellow	16	Driver's Lamp
24	20	Yellow	12	Indirect Lamp Feeder
	20R & 20L	White-Red (2 wires)	14	Indirect Lamps
25	31	Green-Black	14	Baggage Compartment Lamps
26	39P	Red-White	16	Emergency Brake Tell-Tale & Fast Idle
	24P	Green-Yellow	18	Door Lock Feeder
	3	Black	16	Master Circuit - Emergency Brake Switch & Fast Idle
	3	Black	16	Master Circ. (Load Side) Emg. Brake Switch & Fast Idle Switch
27	35	White-Black	16	High Beam Tell-Tale Light
28	33	Red-Black	12	Feeder-Headlight to Dimmer Switch
28	21	White-Blue	16	12V Cut-Off Relay (Headlights)
29	63A	Maroon	14	Auxiliary A/C (Option)
30	54	Yellow	14	Heating-A/C Feeder
31	55	Orange	16	Sensing Element C
32	50	Green-Red	16	Fire Detector
33	7R	Black-White	14	Right Hand Reading Lights
34	14P	Green-Yellow	16	A/C Malfunction Tell-Tale Light
35	53	Black-Blue	16	Fuel Gauge (Option) or Fuel Level Sensor
36	36A	White	16	Additional Lavatory OCCUPIED Light
37	76	White-Green	18	Driver's Freon Valve
38	30	Brown-White	16	Alarmstat-Hot Engine Sensor and Buzzer
39	32	Orange-Green	16	Jacobs Engine Brake (Option)
40	18	Black-White	16	Low Air Tag Axle Solenoid Valve Feeder
41	46G	Blue	16	Back-Up Lamp Ground Return
42	16	Black	16	Sensing Element A & Potentiometer
43	56	Green	16	Hot Water Valve
44	37	White-Red	16	Step Lamp & Chime Feeder

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FRONT JUNCTION BOX CONNECTIONS (Cont'd)

Stud	Circuit Number	"Color Codes" All Harnesses Except Driver's Instrument Panel	Gauge	Description
45	7L	Maroon	14	Left Hand Reading Lamps
46	40	Gray	16	Fast Idle - Load Side
47	40P	Gray	16	Fast Idle - Line Side
	39	Red-White	16	Emergency Brake Tell-Tale Light & Air Switch
48	59	Yellow-Black	16	Jacobs Engine Brake (Option)
49	66	Orange-White	16	Heated Mirror Switch (Option)
50	60	Yellow	18	3-Lb. Oil Sender
	32	Orange-Green	16	3-Lb. Oil Switch at Dash
51	10	Black-Red	18	Low Water Level Sensor
52	52	Brown-Black	16	Fog Lamp Tell-Tale
53	9	Black-Green	18	Door Latch Skinner Valve
54	58	Blue	16	Rear Wheel Sanders (Option)
55	23	Black	10	12V Power Source - 10 Amp
	23	White-Green	14	Spare
56	61	Orange-Red	16	Jacobs Engine Brake (Option)
57	57	Yellow-Green	16	A/C Control Feeder
A	18A	Black-White	18	Tachograph (Option) or Electronic Speedometer
B	B	Green-White	18	Low Air Tag Axle Tell-Tale Light
C	C	White-Black	18	Tachograph or Tachometer
D	D	Brown-Black	18	Cruise Control (Signal from Sensor) (Option)
WH	WH	White	18	Tachograph (Option)
BR	14H	White-Green	16	Compressor Clutch and Liquid Line Solenoid
GR		Green	18	N-C Spare to Rear
BL	BL	Black	18	Transmission Temperature Tell Tale
	230	Grey-Red	14	Aux. A/C
	36B	White	18	24-12VDC Power Converter (Emerg. Radio Power)
	15B	Red-Blue	16	Marker Lights on Separate Toggle Switch
	45B	Yellow-Red	16	Flashing Warning Lights on 4 Roof Corners

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REAR JUNCTION BOX CONNECTIONS

Stud	Circuit Number	"Color Codes" All Harnesses Except Driver's Instrument Panel	Gauge	Description
1	68A	Orange-Black	14	Parcel Rack A/C Unit From A/C Box Circuit Breaker
1	56A	Green	16	Spare
2	54	Yellow	14	Heating and Air Conditioning
3	15	Red-Blue	14	Marker and License Plate Lamps
3	17	Red-Black	14	Tail Lamps
4	24	Green-Yellow	16	Stop Lamps
5	46G	Blue	16	Back-Up Lamps
6	45	Yellow-Red	16	Right Hand Turn Lamps
7	44	Yellow	16	Left Hand Turn Lamps
8	45B	Yellow-Red	16	Flashing Warning Lights at 4 Roof Corners
9	57	Yellow-Green	16	Spare
9	70	White-Green	18	N.C. Spare
10	27	Brown	16	Water Temperature Gauge
11	59	Yellow-Black	16	Jacobs Engine Brake (Option)
12	29	Red-Black	14	Starter Switch
12	29	Red-Black	14	Remote Starter Switch
13	60	Yellow	16	Engine Stop Switch Relay No. 7
Relay	6	Blue	16	Engine Stop (Battery) No. 2
14	18	Black-White	16	Low Air Tag Axle
15	29S	Black-White	14	Starter Solenoid Relay
16	46	Orange-Red	16	Back-Up Lamp
17	69	Red-Blue	16	Reverse Throttle Interlock
18	62	Green-Black	16	Lavatory Dome Lamp
18	31	Green-Black	16	Motor Compartment Service Lamps
19	32A	Orange-Green	16	Jacobs Engine Brake (Option)
20	5&49	White-Red	18	24V Discharge Lamp
21	30	Brown-White	16	Alarmstat-Hot Engine Sensor
22	40	Gray	16	Fast Idle
23	25	Gray	14	Emergency Engine 8V-71
24	3	Black	10	Load Side Master Circuit
25	3	Black	14	Engine Stop Relay
25	4	Green-Red	14	Rear Stop and Start Switch Feeder
26	OR	Black	18	Tell-Tale Light for Triple Function Protective Device (Option)
27	14	White-Red	16	Spare
28	36A	White	16	Additional Lavatory OCCUPIED Light
29				Spare
30	3A	Black	16	Low Water Level Sensor
31	10	Black-Red	18	Low Water Level Sensor
32	50	Green-Red	16	Fire Detectors (Option)
33	R1	Black-Red	16	24V Discharge Relay Feeder and Blower Cut-In
34	26	Orange-Black	16	Oil Pressure Gauge
35	63	Blue-Blue	16	Lavatory Blower
36	57	Yellow-Green	16	A/C-Feeder-Main Harness
36	14P	Green-Yellow	16	Hi-Lo Pressure Switch Feeder Tell-Tale and Condenser Relay Coil
37	28P	Brown-Yellow		Lavatory Buzzer
38	28	Brown-Yellow	16	Lavatory Buzzer Feeder
39	15B	Red-Blue	16	Marker Lights on Separate Toggle Switch
Relay	36C	White	16	Master Cut-Off Switch-Galley (Option)
40	14P	Green-Yellow	16	Condenser Relay Coil
40	14P	Green-Yellow	16	Low Pressure Tell-Tale
40	14P	Green-Yellow	16	A/C Safety Switches
41	23A	White-Green	16	12V Option Rear
42	58	Blue	18	Rear Wheel Sanders (Option)
43	63A	Red-Blue	14	Auxiliary A/C (Option)
44	60	Yellow	16	Common on Rectifier (Option)

MC-9 MAINTENANCE MANUAL

REAR JUNCTION BOX CONNECTIONS (Cont'd)

Stud	Circuit Number	"Color Codes" All Harnesses Except Driver's Instrument Panel	Gauge	Description
45	60	Yellow	18	Engine Stop Relay
46	60A	Yellow	18	Spare
47	30A	Brown-White	16	Spare
48	F1	Yellow	12	Alternator Field "F1"
49	A1	Yellow-Black	12	24V Regulator
50	61	Orange-Red	16	Jacobs Engine Brake (Option)
51	60	Yellow	18	3 lb. Low Oil Switch (Std.) N.C. Spare
52				Spare
53	6	Blue-Yellow	16	Engine Stop Relay - Terminal 5
53	6	Blue-Yellow	16	Engine Stop Relay & Switch - Line Side
54	6A	Blue-Yellow	16	Engine Stop Valve - Load Side of Switch
55	10A	Black-Red	16	Low Water Level Sensor
56	3A	Black	16	Low Water Level Sensor
57	3A	Black	16	Spare
A	18A	Black-White	16	Elec. Tachometer or Speedometer
B	B	Green-White	18	Lo Air Trailing Axle Tell-Tale Light
C	C	White-Black	18	Tachometer
D	D	Brown-White	18	Tachometer or Speedometer
WH	WH	White	18	Speedometer or Elec. Tachometer
BR	14H	White-Green	16	A/C Tell-Tale & Liquid Line Solenoid
GR	38	Green	18	Low Air Tell-Tale Light
BK	BL	Black	18	Speedometer Spare
Relay	36B	White	18	24-12V Power Converter

MC-9 MAINTENANCE MANUAL

SPECIFICATIONS

ALTERNATOR

Manufacturer	Delco-Remy
Part No.	7G-3-42
Model Number	11177702
Field Current at 80°F (27°C)	
Amperes	7.2-8.0
Volts 24 volts Hot Output	
Amperes	270 at 80°F (27°C) ambient
Volts	28 volts
Approximate RPM	3000
Ground	Negative

REGULATOR (24-VOLT)

Manufacturer	Delco-Remy
Part No.	7G-4-1
Model Number	1118447
Type	Transistor
Voltage Adjustment	External Screw

BATTERIES (24-VOLT SYSTEM)

Ampere Hour Capacity at 20 Hour Rate	225
Number of Plates Per Cell	29
Separators	Plastic
Reserve Capacity	393 mins.
Cold Cranking At 0°F (-18°C)	975 amps
Weight Dry	104 lbs (47 kg)
Weight Wet	146 lbs (66 kg)
Acid to Fill	16.2 Qts. (U.S.) (15.4 liters)
Number of Batteries	1
SAE Number	8D
Grounded Terminal	Negative

STARTER MOTOR

Manufacturer	Delco-Remy
Model / Part Number	42MT / 7G-1-39
	40MT / 7G-1-1
	50MT / 7G-1-38 *
Rotation (Viewing Drive End)	CW
Pinion Clearance	**.354 ± .031" (9mm ± .79 mm)**
No-Load Test	
7G-1-39 (42MT)	
Volts	20
Current Draw (Amps)	60 Min., 75 Max.
RPM	6500 Min., 7700 Max
7G-1-1 (40MT)	
Volts	20
Current Draw (Amps)	70 Min., 110 Max
RPM	5500 Min., 9000 Max.

MC-9 MAINTENANCE MANUAL

SPECIFICATIONS (Cont'd)

7G-1-38 (50 MT)	
Volts	20 volts
Current Draw (Amps)	95 min., 120 max
RPM	5500 min., 7500 max

* With 8V92 Engine

STARTER SOLENOID

Manufacturer	Delco-Remy
Part Number	7G-1-84 (with 42 MT Starter)
	7G-6-25 (with 40 MT & 50 MT Starters)
Test Specifications	
7G-1-84	
Pull-In-Winding	8.5-10.0 Amps at 5 VDC
Hold-In Winding	11.0-15.0 Amps at 20 VDC
7G-6-25	
Pull-In-Winding	9.0-11.5 Amps at 5 VDC
Hold-In Winding	6.8 Amps Max. at 20 VDC

ALARMSTAT (NON-ADJUSTABLE TYPE)

Manufacturer	Kysor
Model Number	1002-05511-34
Part No.	8G-28-7
Contact Points Close At	210°F (99°C)
Model Number (Optional)	1002-05511-36
Part No.	8G-28-8
Contact Points Close At	220°F (104°C)

LOW AIR PRESSURE SWITCH

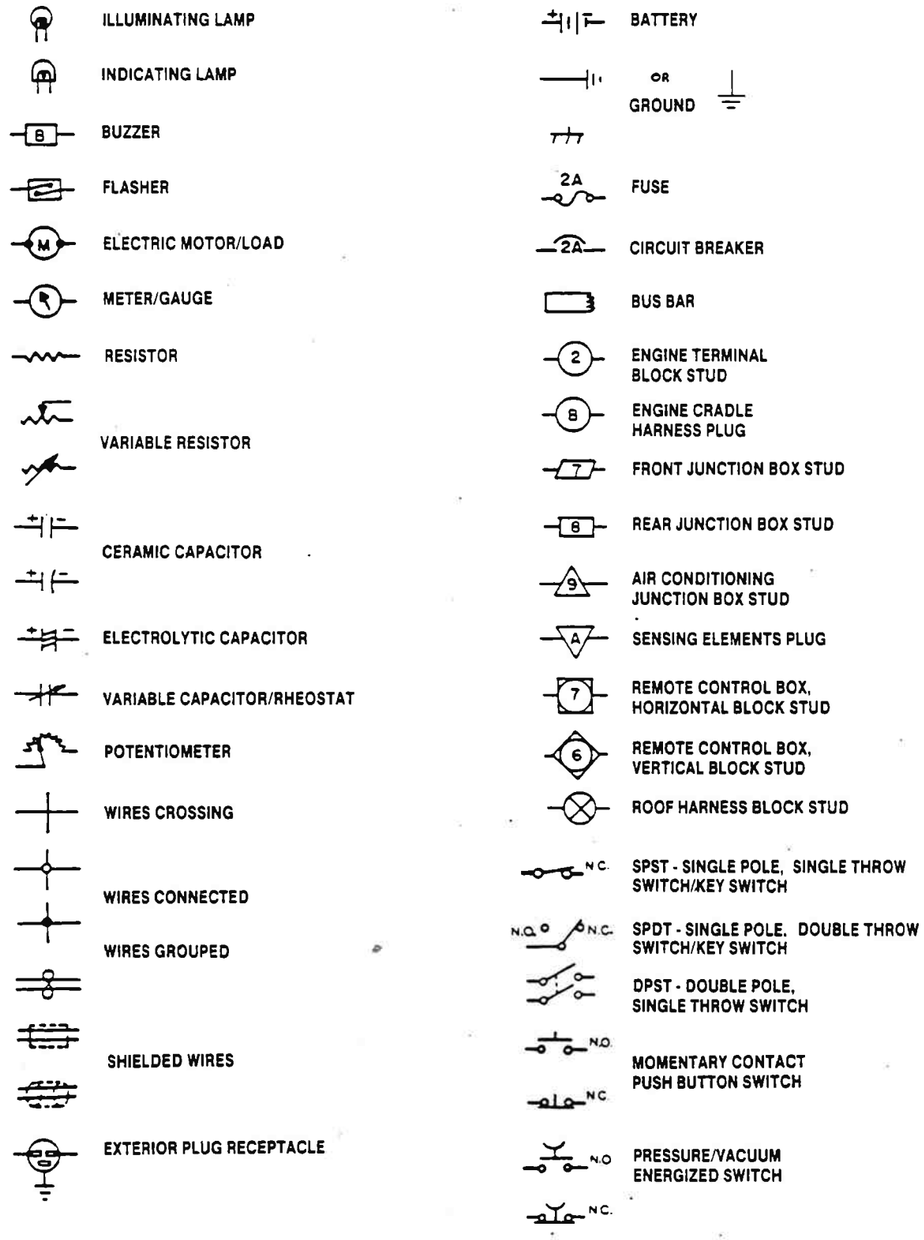
Manufacturer	Nason
Part No.	7J-13-229
Terminals	3
Circuit	SPD1
Maximum Operating Pressure	500 psi
Operation	Contacts set to transfer at 100 psi (max.) increasing pressure Contacts reset at 70 psi as pressure decreases
Setting Tolerance	100 psi (+0, −10 increasing), 70 psi (±5 decreasing)

MC-9 MAINTENANCE MANUAL

WIRING DIAGRAM INDEX

MC-9 MAINTENANCE MANUAL

WIRING DIAGRAM KEY

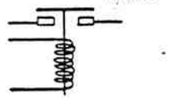


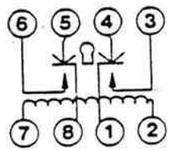
MC-9 MAINTENANCE MANUAL

WIRING DIAGRAM KEY (CONT'D)

FIELD WINDING

RELAY





RELAY

MAGNETIC CORE TRANSFORMER

BK BLACK

BL BLUE

BR BROWN

GR GREEN

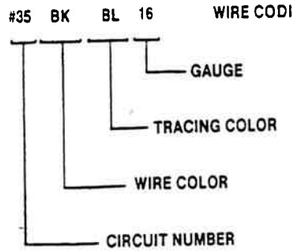
GY GREY

MR MAROON

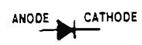
OR ORANGE

YL YELLOW

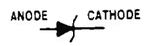
WH WHITE



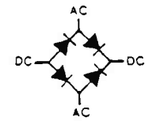
DIODE/RECTIFIER



ZENER DIODE

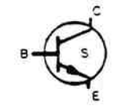


FULL WAVE RECTIFIER

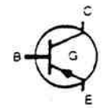


TRANSISTOR

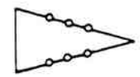
NPN (S-SILICON)



PNP (G-GERMANIUM)



INTEGRATED CIRCUIT (IC)



METRIMATE CONNECTORS

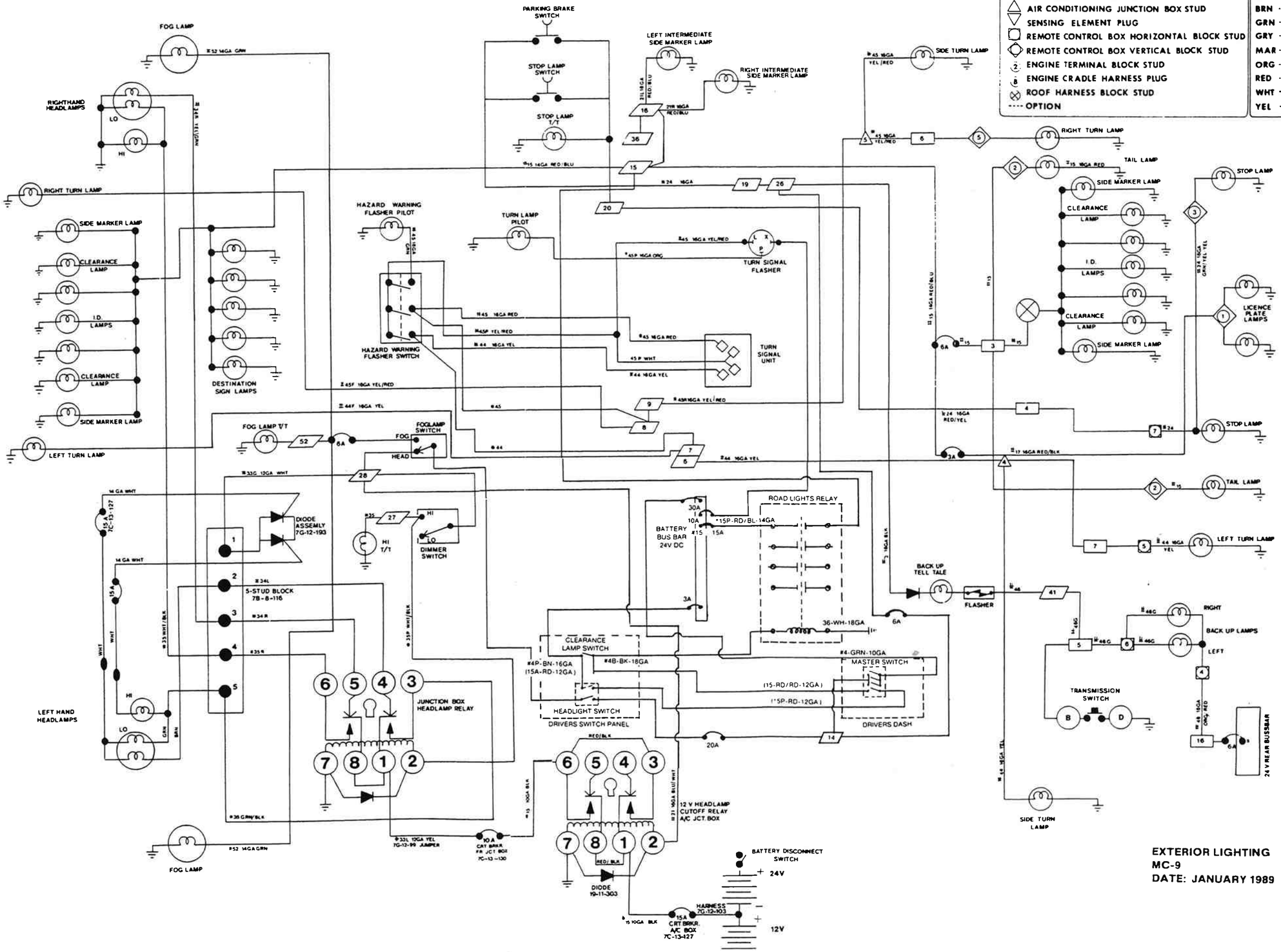
(P1) GAUGES
(P2) LH TELL-TALES
(P3) RH TELL-TALES
(P4) RH SWITCHES
(P5) LH SWITCHES
(P6) PANEL TO LEFT OF DRIVER

METRIMATE CONNECTOR PIN

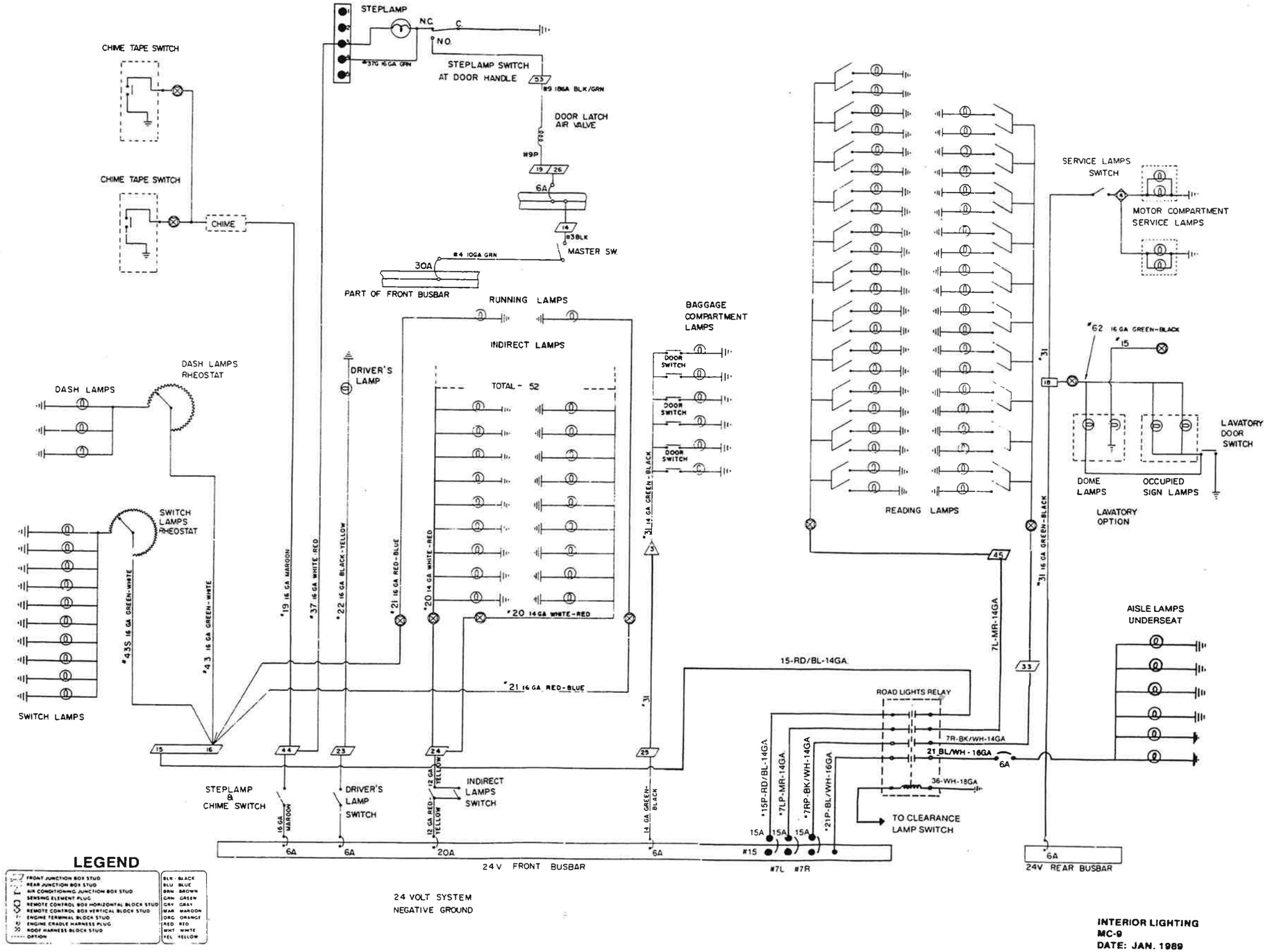
LEGEND

- FRONT JUNCTION BOX STUD
- REAR JUNCTION BOX STUD
- AIR CONDITIONING JUNCTION BOX STUD
- SENSING ELEMENT PLUG
- REMOTE CONTROL BOX HORIZONTAL BLOCK STUD
- REMOTE CONTROL BOX VERTICAL BLOCK STUD
- ENGINE TERMINAL BLOCK STUD
- ENGINE CRADLE HARNESS PLUG
- ROOF HARNESS BLOCK STUD
- OPTION

BLK - BLACK
BLU - BLUE
BRN - BROWN
GRN - GREEN
GRY - GRAY
MAR - MAROON
ORG - ORANGE
RED - RED
WHT - WHITE
YEL - YELLOW



EXTERIOR LIGHTING
MC-9
DATE: JANUARY 1989

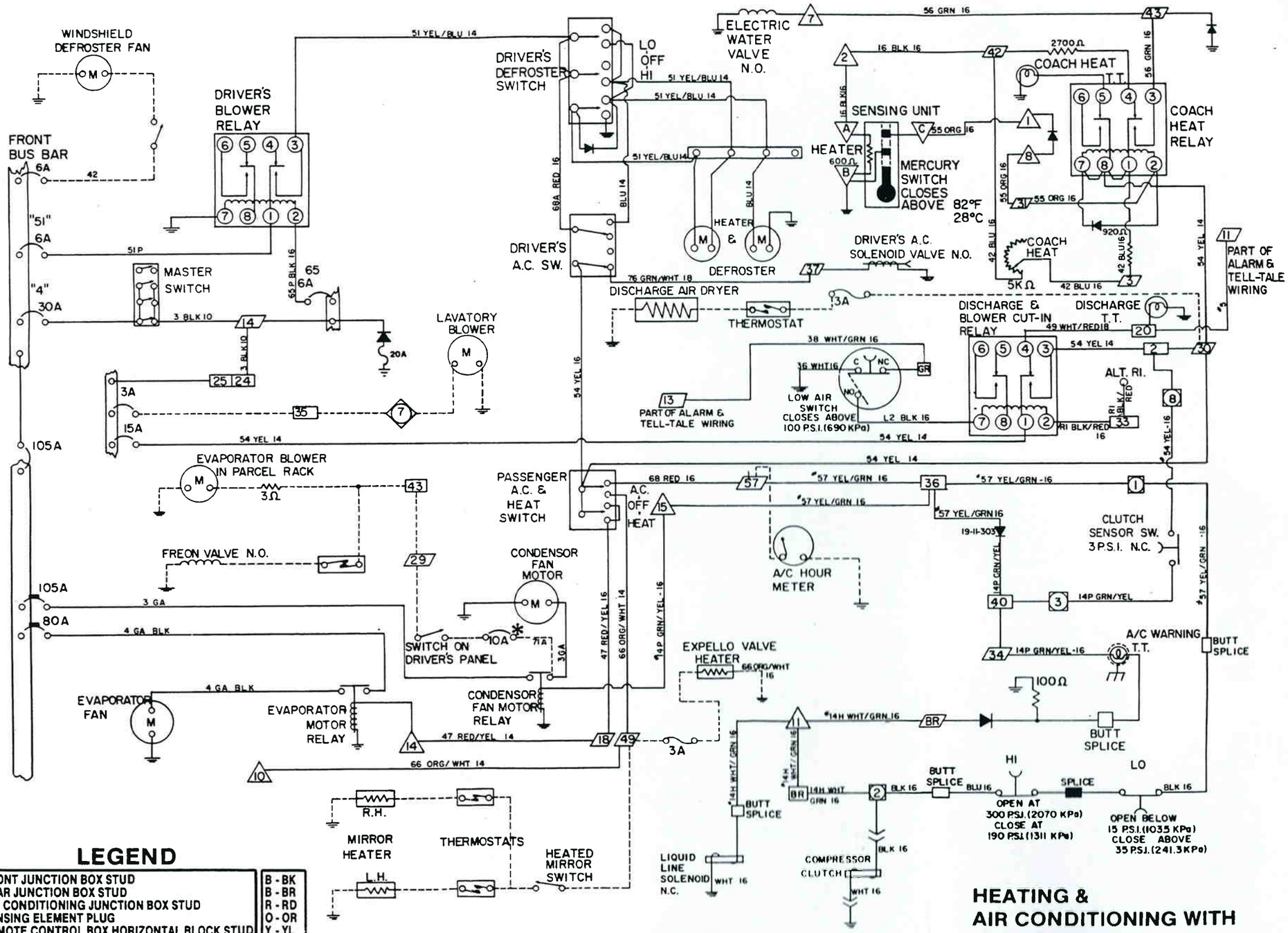


LEGEND

FRONT JUNCTION BOX STUD	BLK - BLACK
REAR JUNCTION BOX STUD	BLU BLUE
AIR CONDITIONING JUNCTION BOX STUD	BRN BROWN
SENSING ELEMENT PLUG	GRN GREEN
REMOTE CONTROL BOX HORIZONTAL BLOCK STUD	GRY GRAY
REMOTE CONTROL BOX VERTICAL BLOCK STUD	MAR MAROON
ENGINE TERMINAL BLOCK STUD	ORG ORANGE
ENGINE CRADLE HARNESS PLUG	RED RED
ROOF HARNESS BLOCK STUD	WHT WHITE
OPTION	YEL YELLOW

24 VOLT SYSTEM
NEGATIVE GROUND

INTERIOR LIGHTING
MC-9
DATE: JAN. 1989

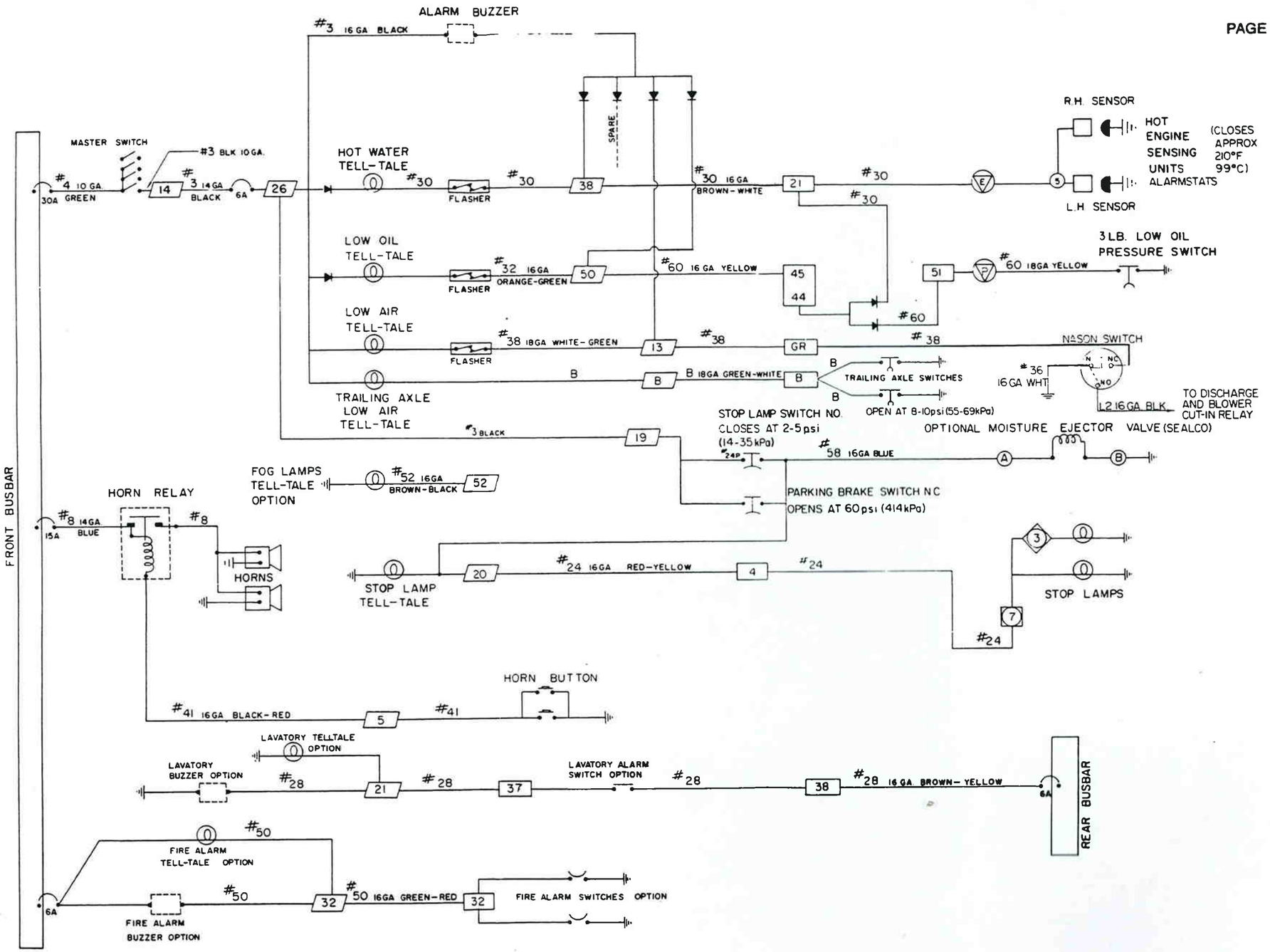


LEGEND

FRONT JUNCTION BOX STUD	B - BK
REAR JUNCTION BOX STUD	B - BR
AIR CONDITIONING JUNCTION BOX STUD	R - RD
SENSING ELEMENT PLUG	O - OR
REMOTE CONTROL BOX HORIZONTAL BLOCK STUD	Y - YL
REMOTE CONTROL BOX VERTICAL BLOCK STUD	G - GR
ENGINE TERMINAL BLOCK STUD	B - BLU
ENGINE CRADLE HARNESS PLUG	V - VO
ROOF HARNESS BLOCK STUD	G - GR
----- OPTION	W - WH

* 10A CIR. BRKR. IN A.C. JCT. BOX

HEATING & AIR CONDITIONING WITH 05G COMPRESSOR
MODEL: MC-9
DATE: JAN., 1989



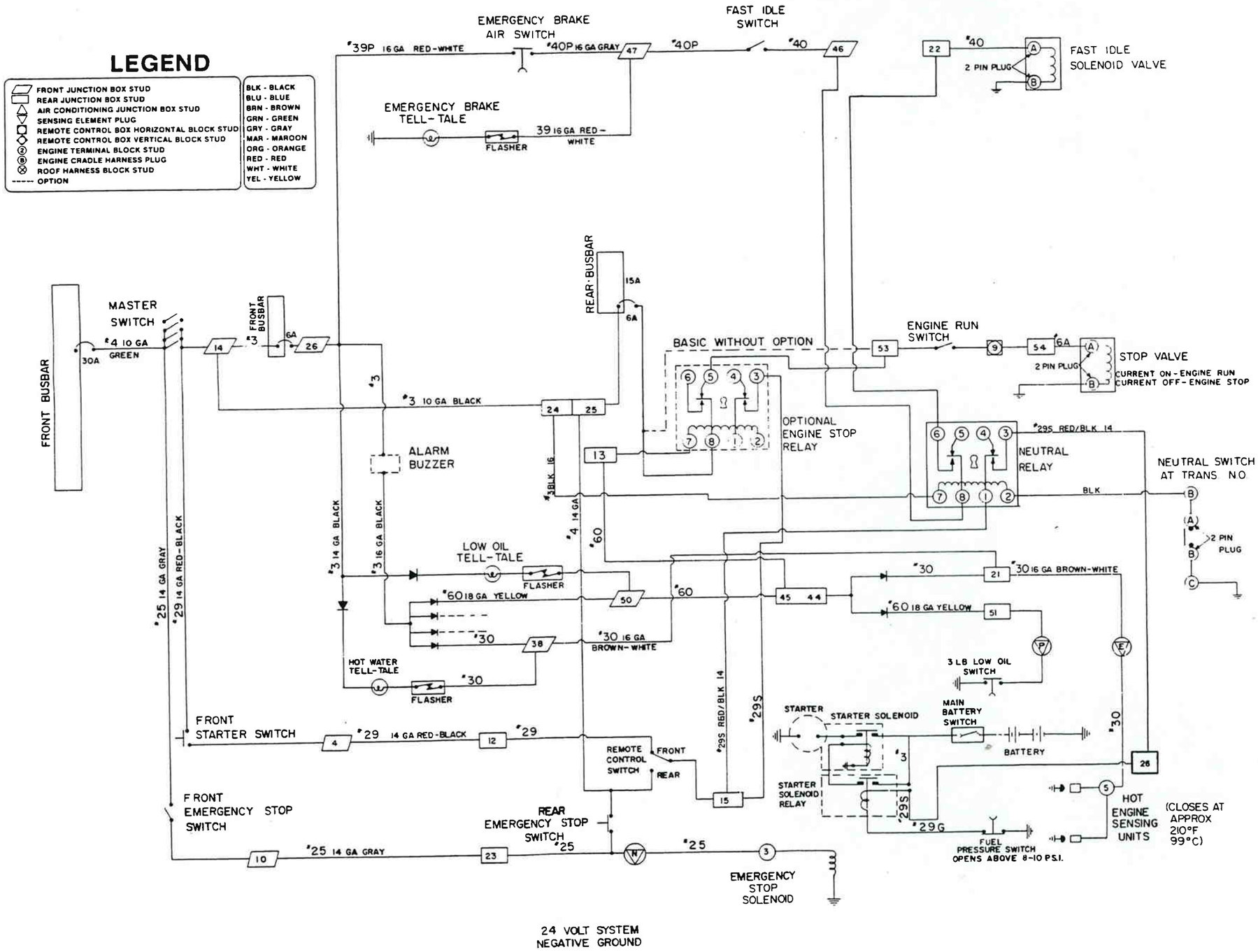
LEGEND

- FRONT JUNCTION BOX STUD
- REAR JUNCTION BOX STUD
- AIR CONDITIONING JUNCTION BOX STUD
- SENSING ELEMENT PLUG
- REMOTE CONTROL BOX HORIZONTAL BLOCK STUD
- REMOTE CONTROL BOX VERTICAL BLOCK STUD
- ENGINE TERMINAL BLOCK STUD
- ENGINE CRADLE HARNESS PLUG
- ROOF HARNESS BLOCK STUD
- ----- OPTION

BLK - BLACK
BLU - BLUE
BRN - BROWN
GRN - GREEN
GRY - GRAY
MAR - MAROON
ORG - ORANGE
RED - RED
WHT - WHITE
YEL - YELLOW

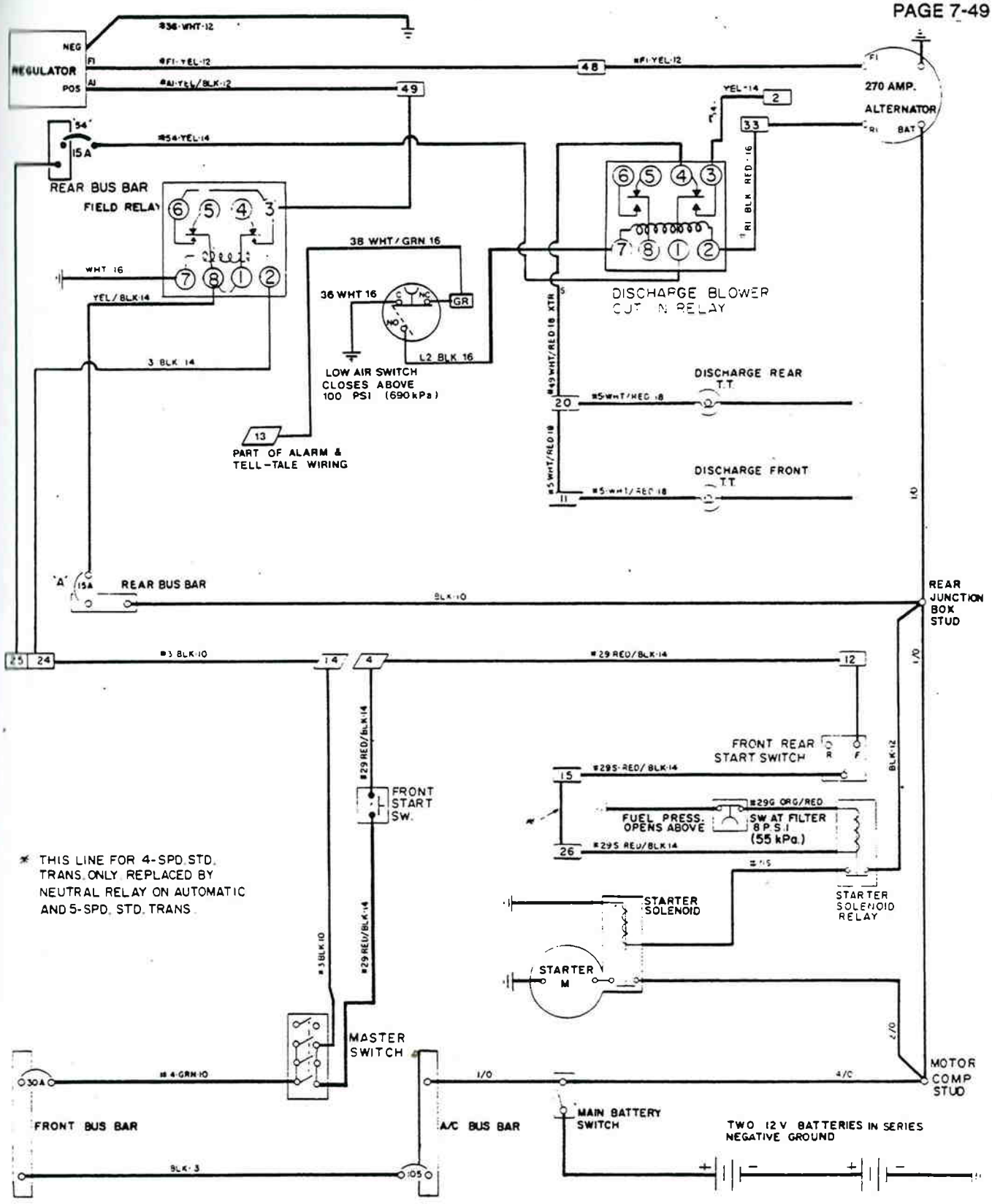
24 VOLT SYSTEM
NEGATIVE GROUND

ALARM & TELL-TALE WIRING
MODEL: MC-9
DATE: JAN. 1989



24 VOLT SYSTEM
NEGATIVE GROUND

MOTOR CONTROL WIRING
MODEL: MC-9
EFFECTIVE UNIT NO. 36355
DATE: JAN. 1989



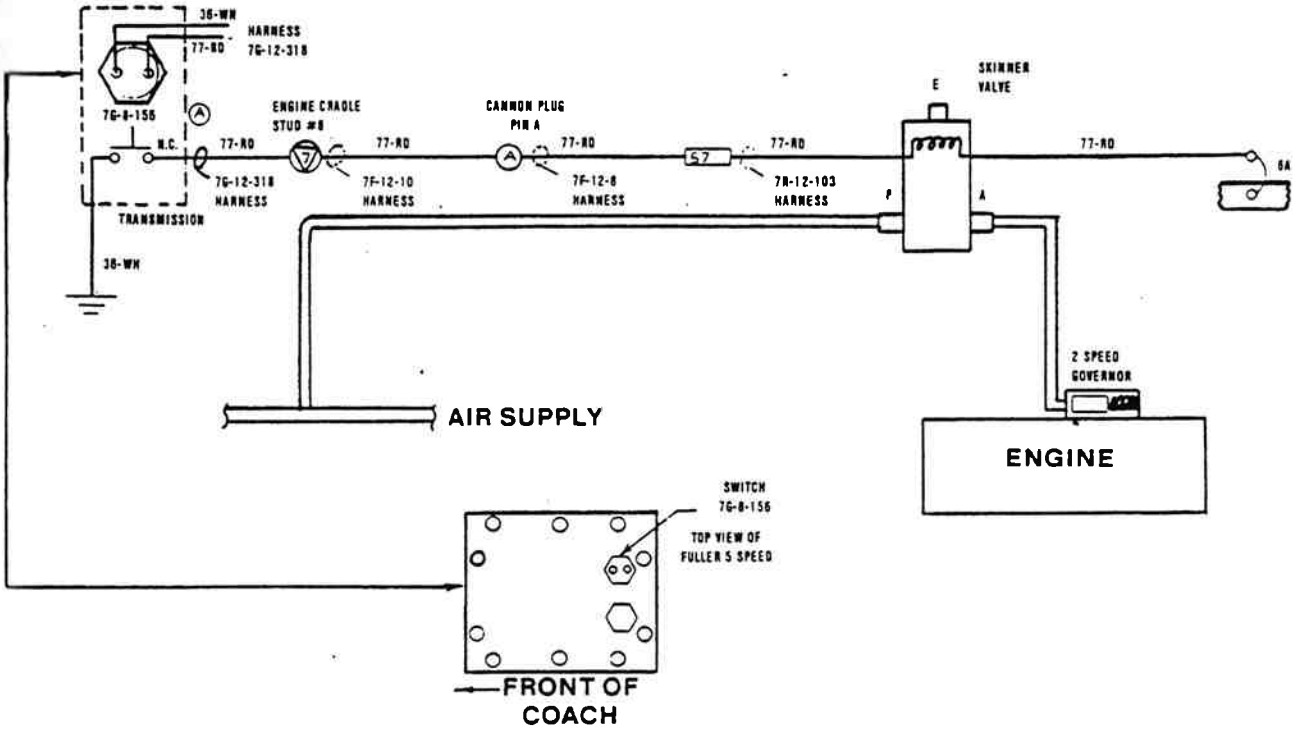
* THIS LINE FOR 4-SPD. STD. TRANS. ONLY. REPLACED BY NEUTRAL RELAY ON AUTOMATIC AND 5-SPD. STD. TRANS.

LEGEND

- FRONT JUNCTION BOX STUD
- REAR JUNCTION BOX STUD
- AIR CONDITIONING JUNCTION BOX STUD
- SENSING ELEMENT PLUG
- REMOTE CONTROL BOX HORIZONTAL BLOCK STUD
- REMOTE CONTROL BOX VERTICAL BLOCK STUD
- (2) ENGINE TERMINAL BLOCK STUD
- (B) ENGINE CRADLE HARNESS PLUG
- ROOF HARNESS BLOCK STUD
- ----- OPTION

BLK - BLACK	
BLU - BLUE	
BRN - BROWN	
GRN - GREEN	
GRY - GRAY	
MAR - MAROON	
ORG - ORANGE	
RED - RED	
WHT - WHITE	
YEL - YELLOW	

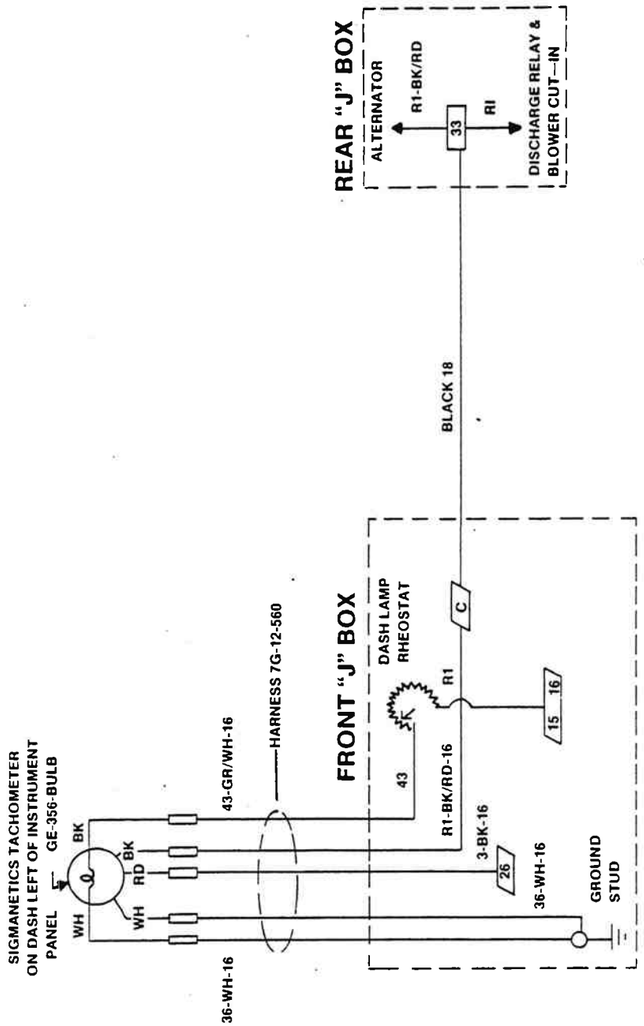
CHARGING & STARTING
MODEL: MC-9
DATE: JAN. 1989



LEGEND

FRONT JUNCTION BOX STUD	BK - BLACK
REAR JUNCTION BOX STUD	BR - BROWN
AIR CONDITIONING JUNCTION BOX STUD	RD - RED
SENSING ELEMENT PLUG	OR - ORANGE
REMOTE CONTROL BOX HORIZONTAL BLOCK STUD	YL - YELLOW
REMOTE CONTROL BOX VERTICAL BLOCK STUD	GR - GREEN
ENGINE TERMINAL BLOCK STUD	BL - BLUE
ENGINE CRADLE HARNESS PLUG	VO - VIOLET
ROOF HARNESS BLOCK STUD	GY - GREY
OPTION	WH - WHITE

TWO-SPEED GOVERNOR
(WITH FULLER 5 SPEED TRANS)
MODEL: MC-9
DATE: JAN. 1989

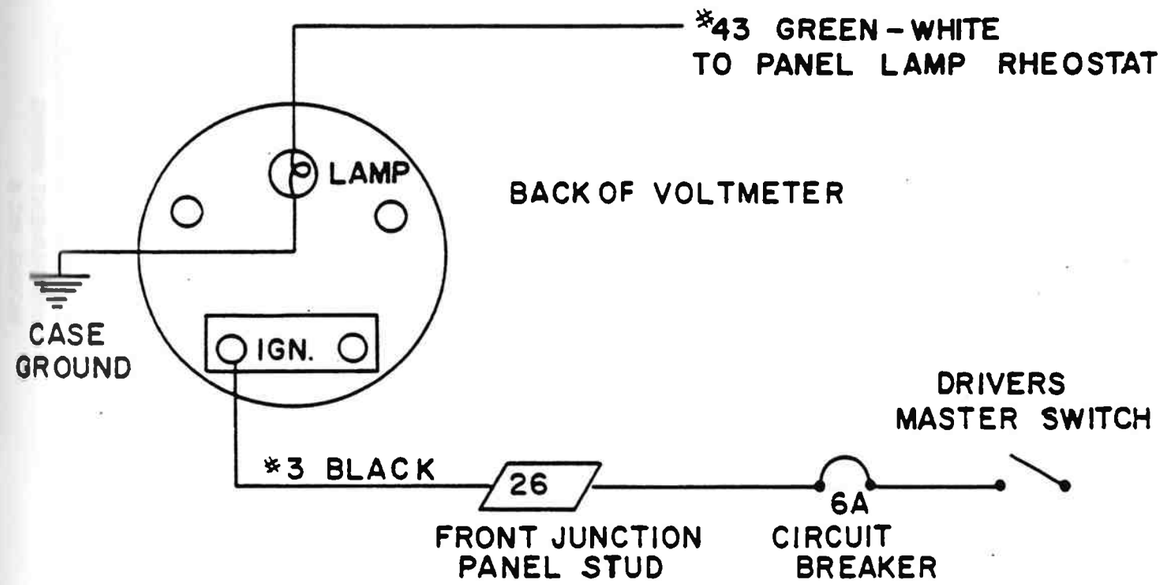


WIRING DIAGRAM
SIGMANETICS TACHOMETER
MODEL: MC-9
DATE JAN. 1989

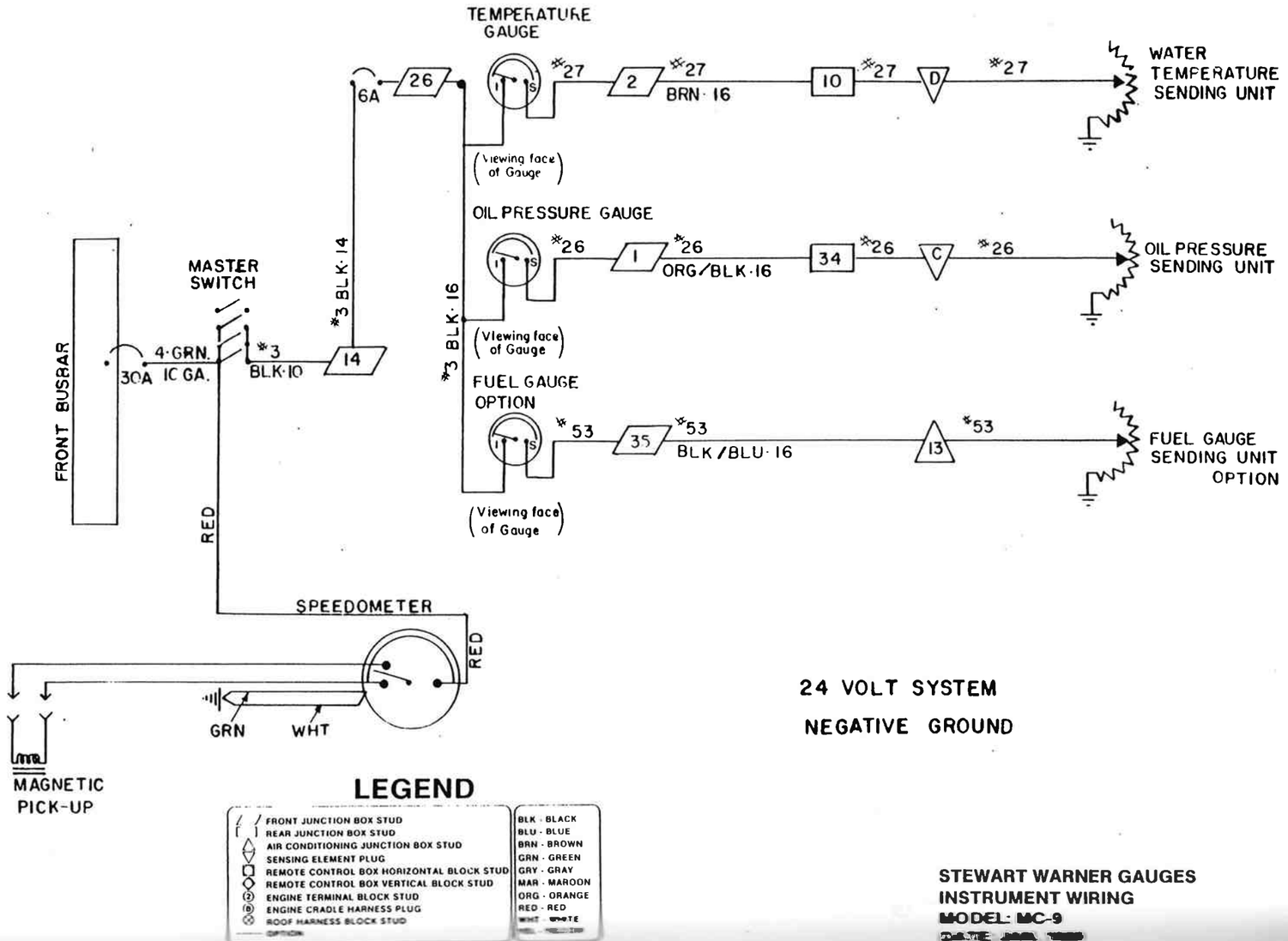
LEGEND

- FRONT JUNCTION BOX STUD
- REAR JUNCTION BOX STUD
- AIR CONDITIONING JUNCTION BOX STUD
- SENSING ELEMENT PLUG
- REMOTE CONTROL BOX HORIZONTAL BLOCK STUD
- REMOTE CONTROL BOX VERTICAL BLOCK STUD
- ENGINE TERMINAL BLOCK STUD
- ENGINE CRADLE HARNESS PLUG
- ROOF HARNESS BLOCK STUD
- ----- OPTION

B - BK	
B - BR	
R - RD	
O - OR	
Y - YL	
G - GR	
B - BLU	
V - VO	
G - GR	
W - WH	



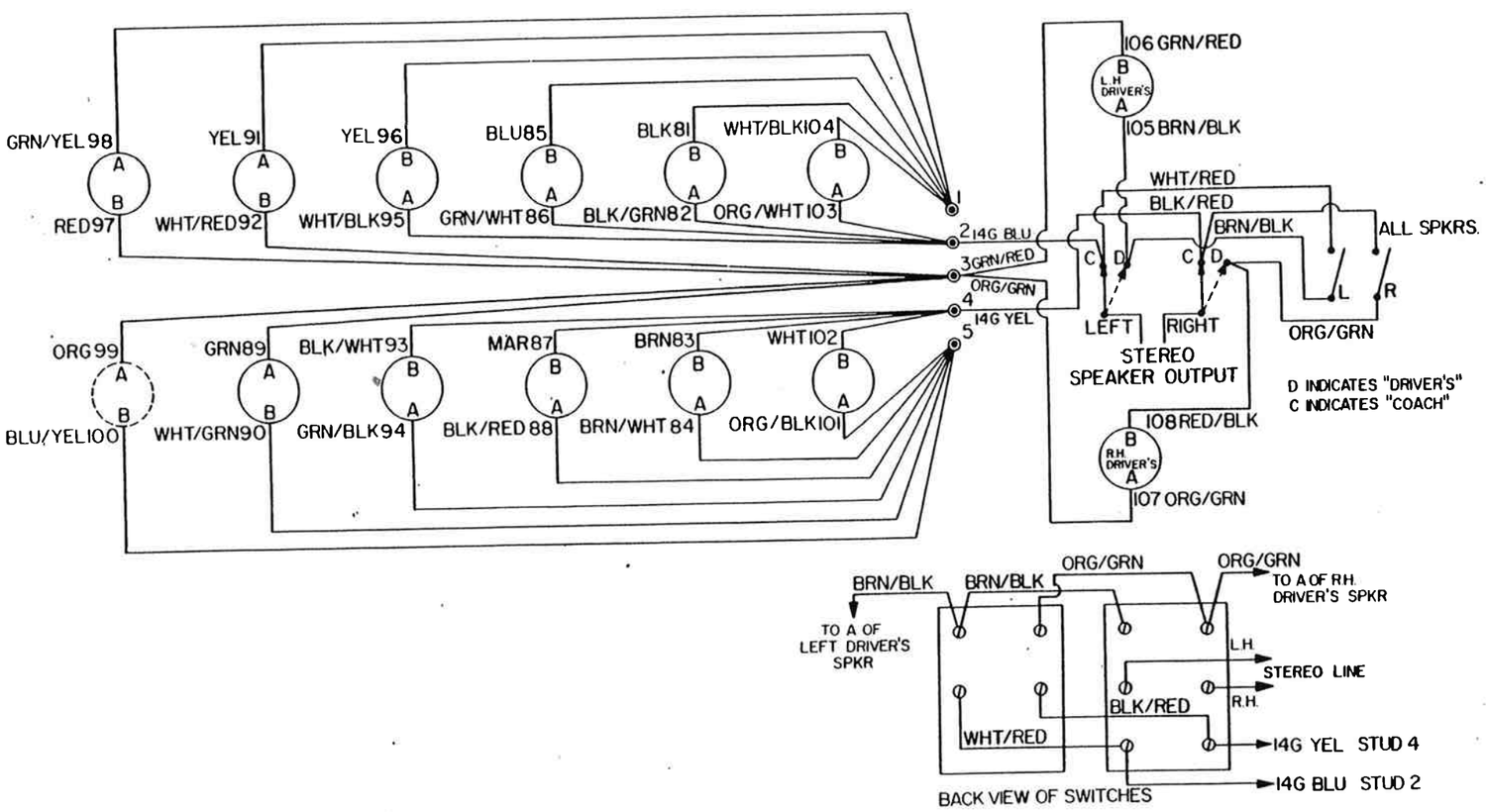
VOLTMETER INSTALLATION
(24-VOLT-NEGATIVE GROUND)
MODEL: MC-9
DATE: JAN. 1989



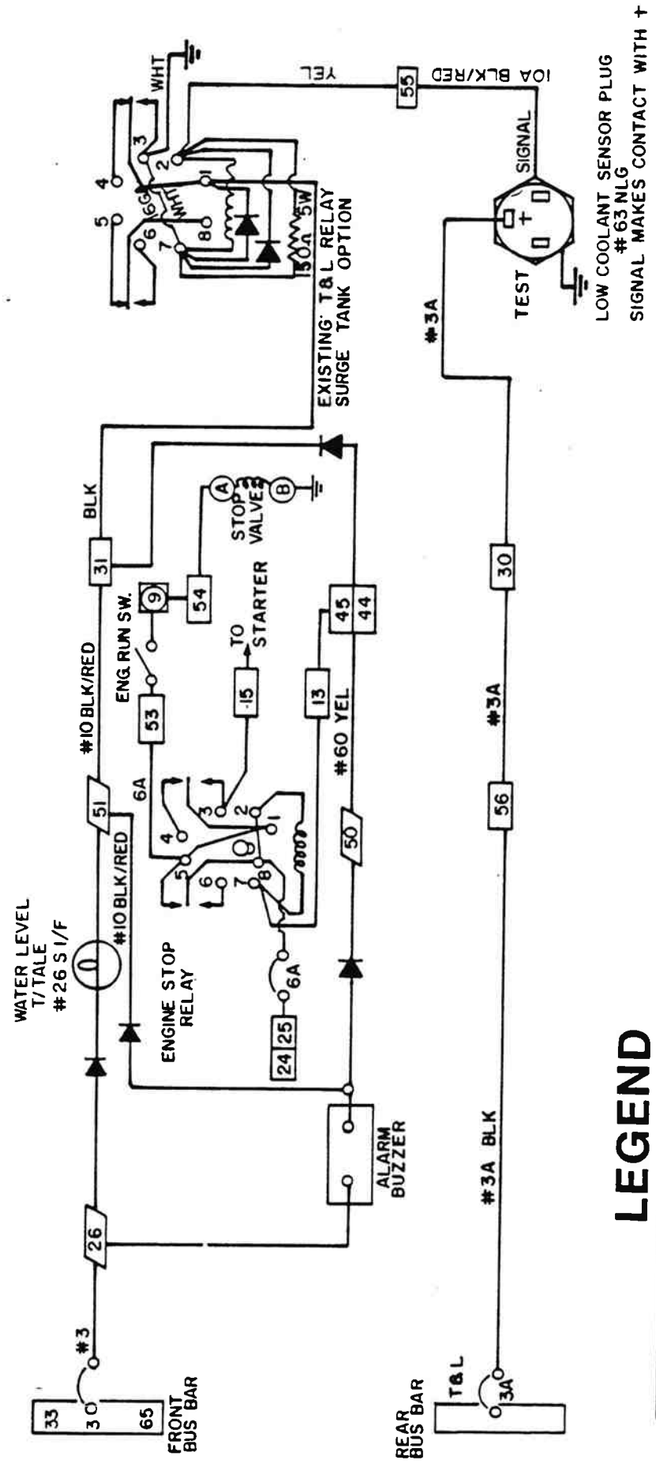
LEGEND

FRONT JUNCTION BOX STUD	BLK - BLACK
REAR JUNCTION BOX STUD	BLU - BLUE
AIR CONDITIONING JUNCTION BOX STUD	BRN - BROWN
SENSING ELEMENT PLUG	GRN - GREEN
REMOTE CONTROL BOX HORIZONTAL BLOCK STUD	GRY - GRAY
REMOTE CONTROL BOX VERTICAL BLOCK STUD	MAR - MAROON
ENGINE TERMINAL BLOCK STUD	ORG - ORANGE
ENGINE CRADLE HARNESS PLUG	RED - RED
ROOF HARNESS BLOCK STUD	WHT - WHITE
OPTION	

STEWART WARNER GAUGES
INSTRUMENT WIRING
MODEL: MC-9
DATE: JAN. 1989



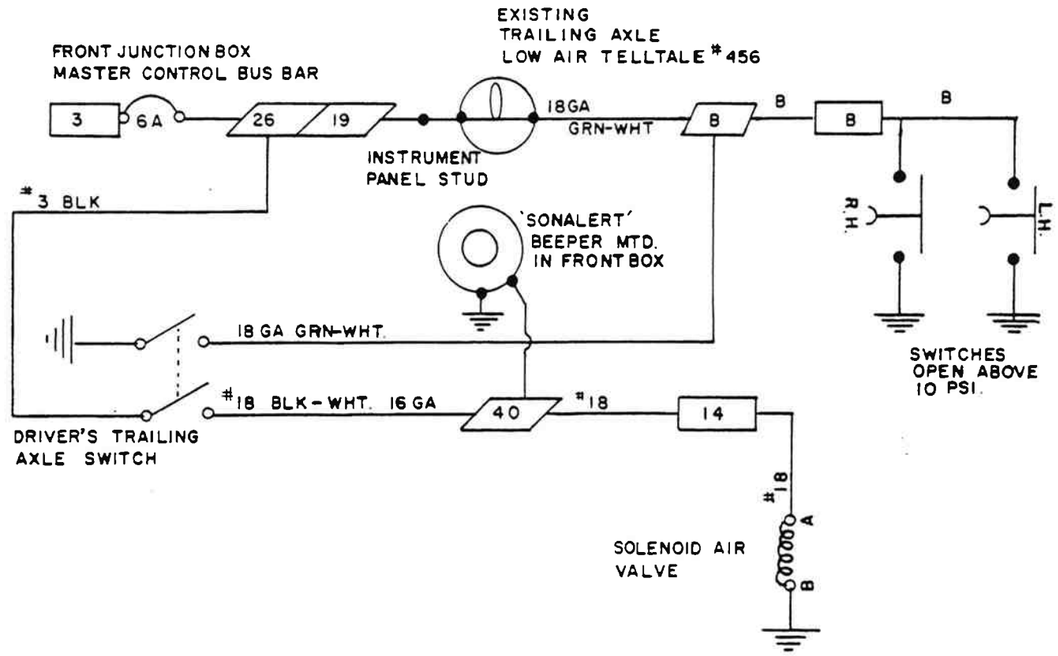
STEREO SPEAKER DIAGRAM
WITH OPTIONAL DRIVER'S SPEAKERS
MODEL: MC-9
DATE: JAN. 1989



LEGEND

FRONT JUNCTION BOX STUD	BLK - BLACK
REAR JUNCTION BOX STUD	BLU - BLUE
AIR CONDITIONING JUNCTION BOX STUD	BRN - BROWN
SENSING ELEMENT PLUG	GRN - GREEN
REMOTE CONTROL BOX HORIZONTAL BLOCK STUD	GRY - GRAY
REMOTE CONTROL BOX VERTICAL BLOCK STUD	MAR - MAROON
ENGINE TERMINAL BLOCK STUD	ORG - ORANGE
ENGINE CRADLE HARNESS PLUG	RED - RED
ROOF HARNESS BLOCK STUD	WHT - WHITE
----- OPTION	YEL - YELLOW

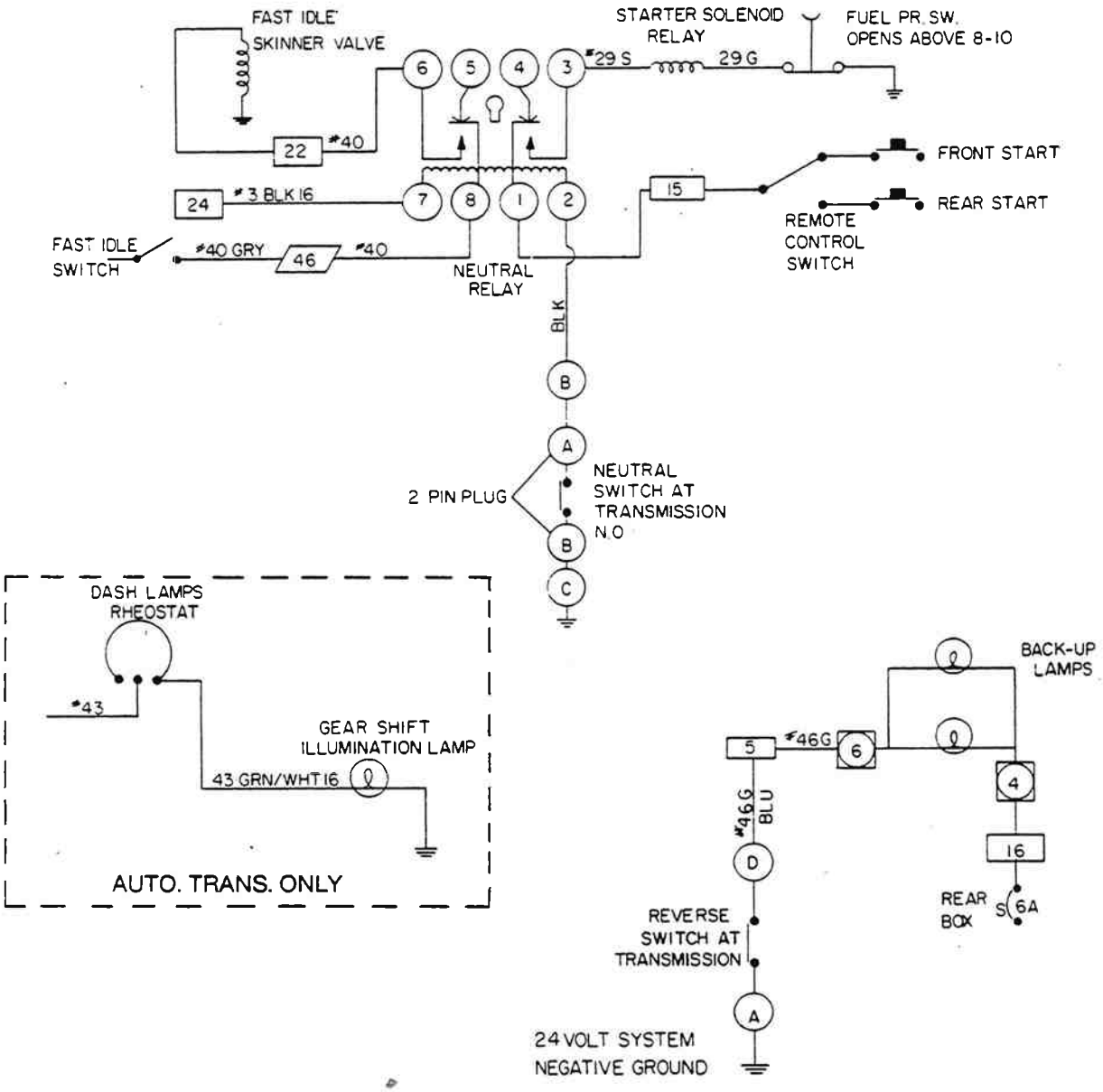
WIRING DIAGRAM
LOW COOLANT LEVEL - WARNING & SHUTDOWN OPTION
MODEL: MC-9
DATE: JAN 1989



LEGEND

FRONT JUNCTION BOX STUD	BLK - BLACK
REAR JUNCTION BOX STUD	BLU - BLUE
AIR CONDITIONING JUNCTION BOX STUD	BRN - BROWN
SENSING ELEMENT PLUG	GRN - GREEN
REMOTE CONTROL BOX HORIZONTAL BLOCK STUD	GRY - GRAY
REMOTE CONTROL BOX VERTICAL BLOCK STUD	MAR - MAROON
ENGINE TERMINAL BLOCK STUD	ORG - ORANGE
ENGINE CRADLE HARNESS PLUG	RED - RED
ROOF HARNESS BLOCK STUD	WHT - WHITE
----- OPTION	YEL - YELLOW

TRAILING AXLE UNLOADING WIRING DIAGRAM (OPTIONAL)
MODEL: MC-9
DATE: JAN. 1989

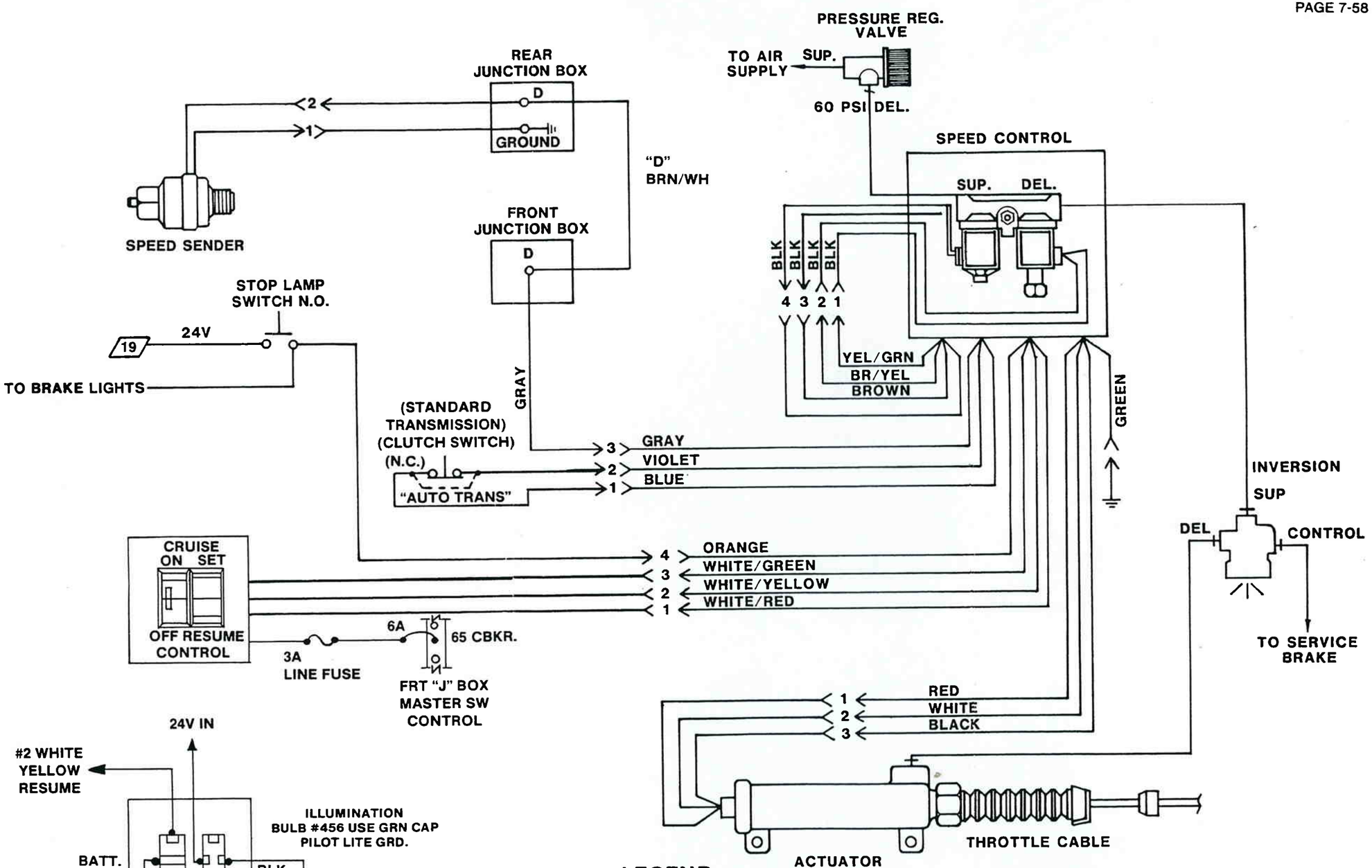


LEGEND

- FRONT JUNCTION BOX STUD
- REAR JUNCTION BOX STUD
- AIR CONDITIONING JUNCTION BOX STUD
- SENSING ELEMENT PLUG
- REMOTE CONTROL BOX HORIZONTAL BLOCK STUD
- REMOTE CONTROL BOX VERTICAL BLOCK STUD
- ENGINE TERMINAL BLOCK STUD
- ENGINE CRADLE HARNESS PLUG
- ROOF HARNESS BLOCK STUD
- ----- OPTION

BLK - BLACK
BLU - BLUE
BRN - BROWN
GRN - GREEN
GRY - GRAY
MAR - MAROON
ORG - ORANGE
RED - RED
WHT - WHITE
YEL - YELLOW

TRANSMISSION WIRING DIAGRA
MODEL: MC-9
DATE: JAN. 1989

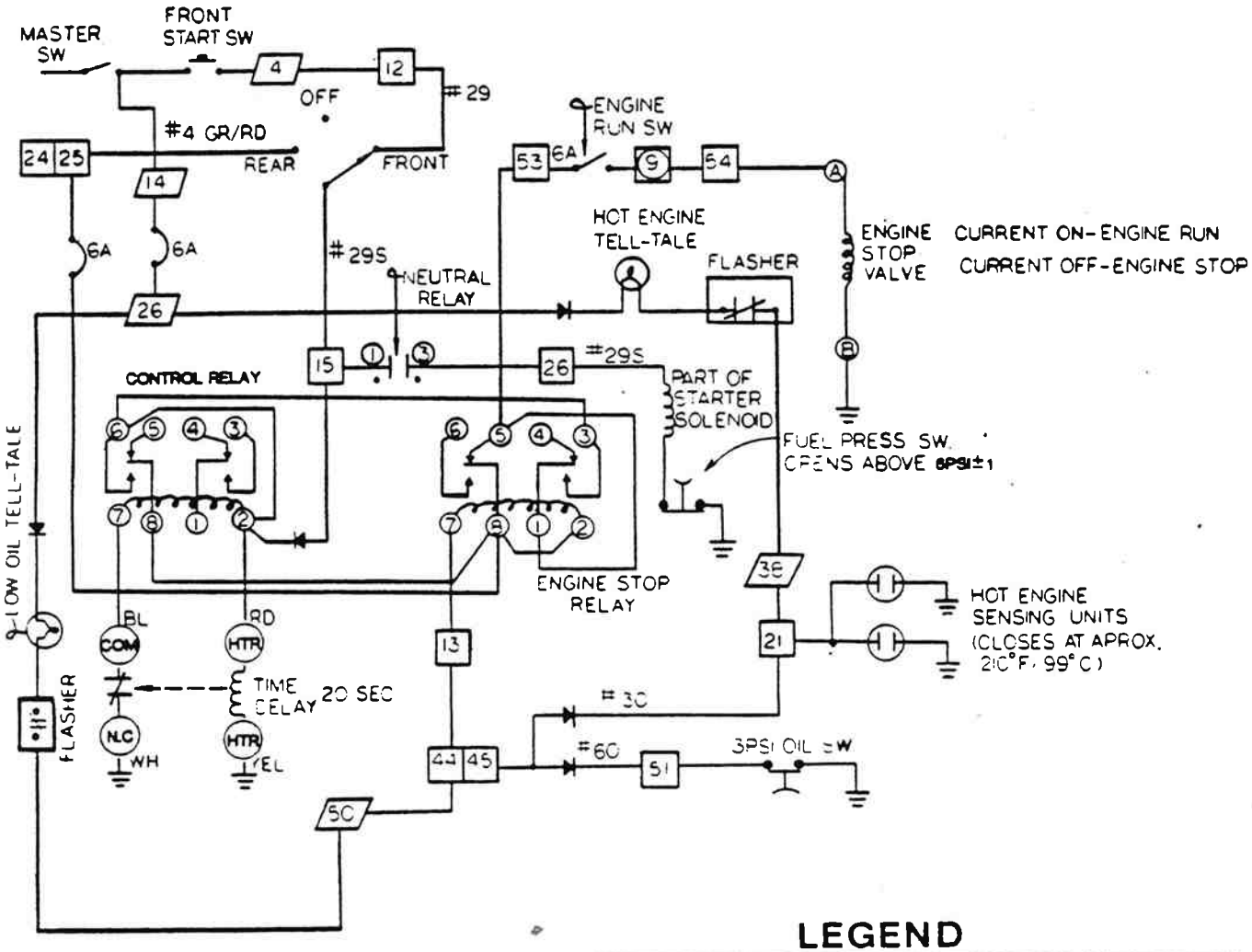


CONTROL SWITCH WIRING
(BACK VIEW)

LEGEND

FRONT JUNCTION BOX STUD	BK - BLACK
REAR JUNCTION BOX STUD	BR - BROWN
AIR CONDITIONING JUNCTION BOX STUD	RD - RED
SENSING ELEMENT PLUG	OR - ORANGE
REMOTE CONTROL BOX HORIZONTAL BLOCK STUD	YL - YELLOW
REMOTE CONTROL BOX VERTICAL BLOCK STUD	GR - GREEN
ENGINE TERMINAL BLOCK STUD	BL - BLUE
ENGINE CRADLE HARNESS PLUG	VO - VIOLET
ROOF HARNESS BLOCK STUD	GY - GREY
----- OPTION	WH - WHITE

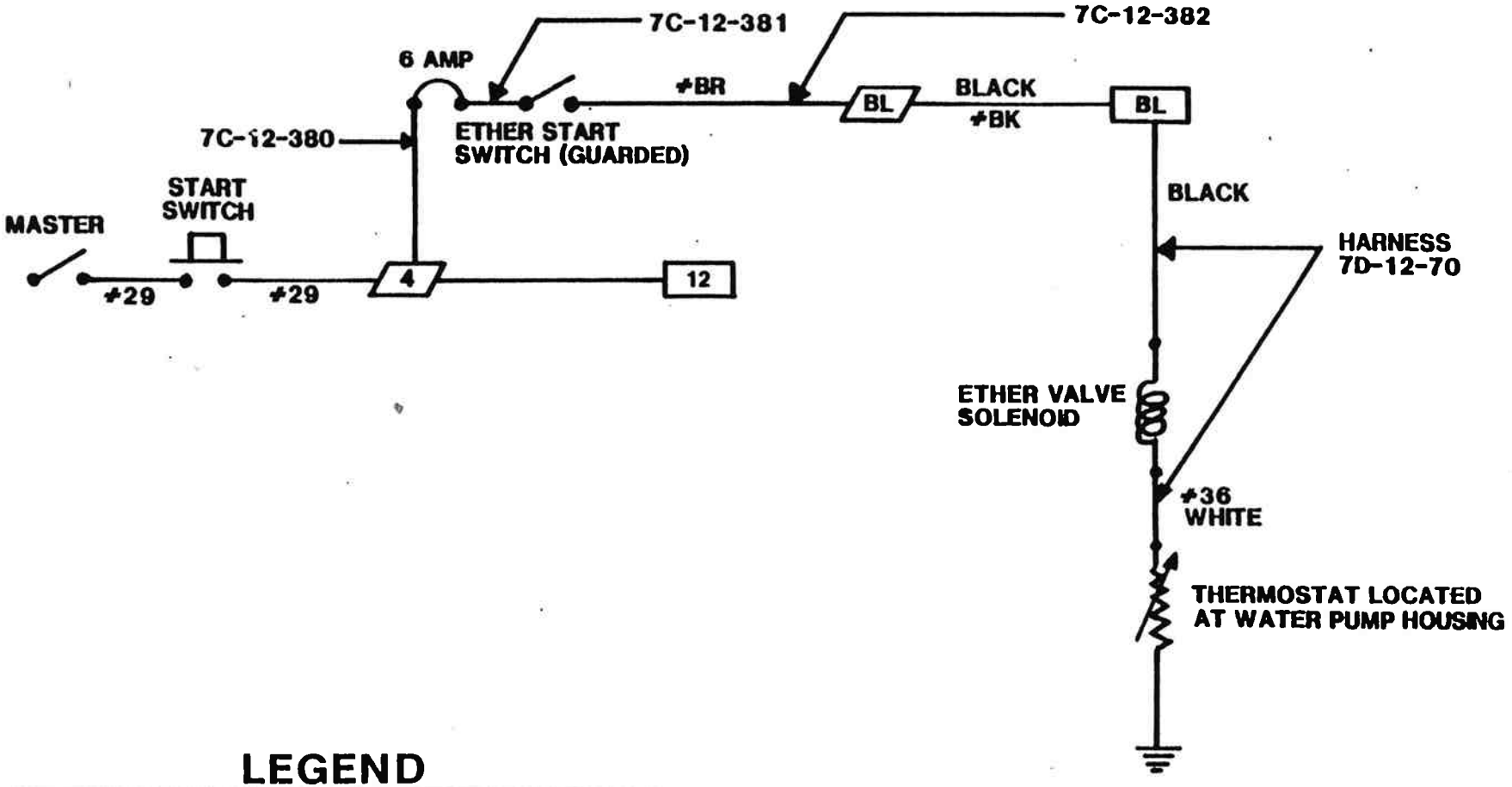
CRUISE CONTROL WIRING
MODEL: MC-9
DATE: JAN. 1989



LEGEND

FRONT JUNCTION BOX STUD	BK - BLACK
REAR JUNCTION BOX STUD	BR - BROWN
AIR CONDITIONING JUNCTION BOX STUD	RD - RED
SENSING ELEMENT PLUG	OR - ORANGE
REMOTE CONTROL BOX HORIZONTAL BLOCK STUD	YL - YELLOW
REMOTE CONTROL BOX VERTICAL BLOCK STUD	GR - GREEN
ENGINE TERMINAL BLOCK STUD	BL - BLUE
ENGINE CRADLE HARNESS PLUG	VO - VIOLET
ROOF HARNESS BLOCK STUD	GY - GREY
OPTION	WH - WHITE

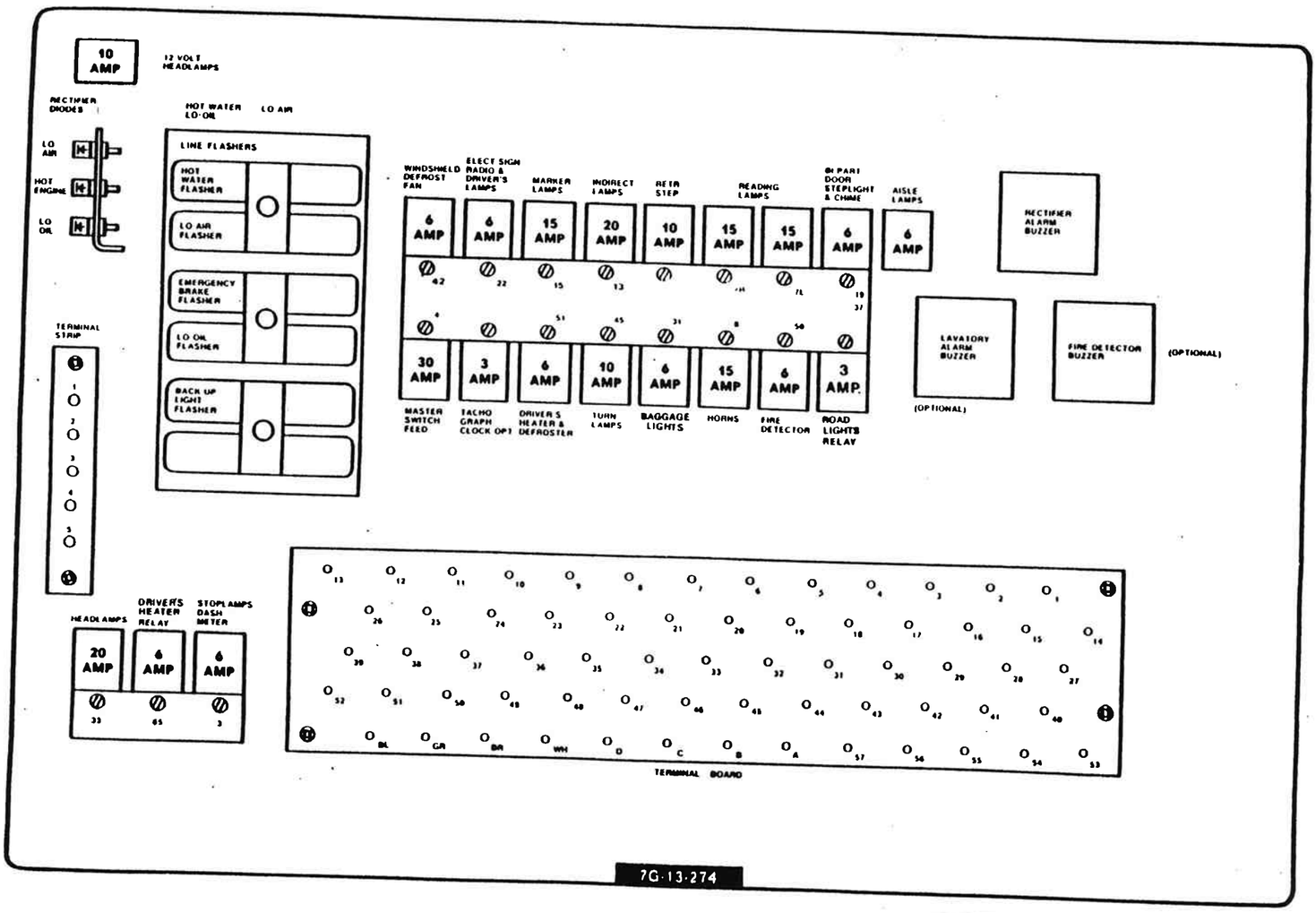
STARTING CIRCUIT WITH THERMAL TIME DELAY
MODEL: MC-9
DATE: JAN. 1989



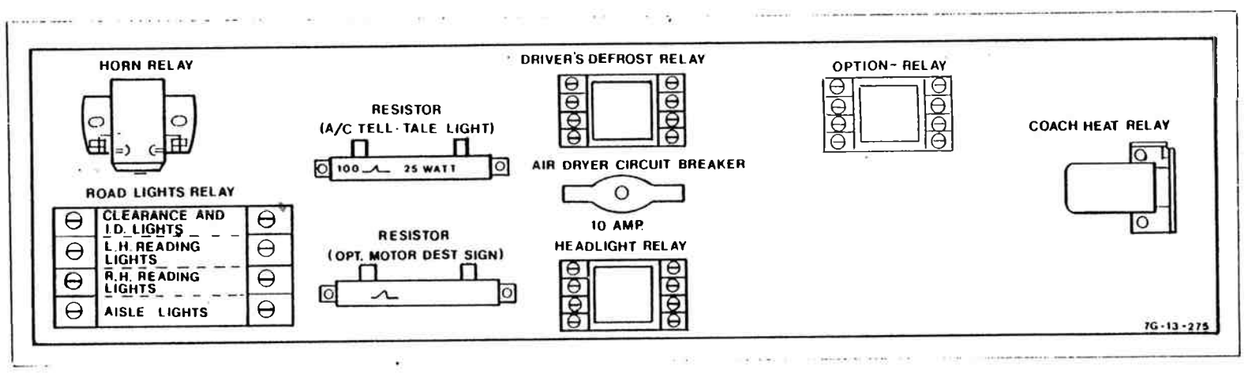
LEGEND

FRONT JUNCTION BOX STUD	B - BK
REAR JUNCTION BOX STUD	B - BR
AIR CONDITIONING JUNCTION BOX STUD	R - RD
SENSING ELEMENT PLUG	O - OR
REMOTE CONTROL BOX HORIZONTAL BLOCK STUD	Y - YL
REMOTE CONTROL BOX VERTICAL BLOCK STUD	G - GR
ENGINE TERMINAL BLOCK STUD	B - BLU
ENGINE CRADLE HARNESS PLUG	V - VO
ROOF HARNESS BLOCK STUD	G - GR
OPTION	W - WH

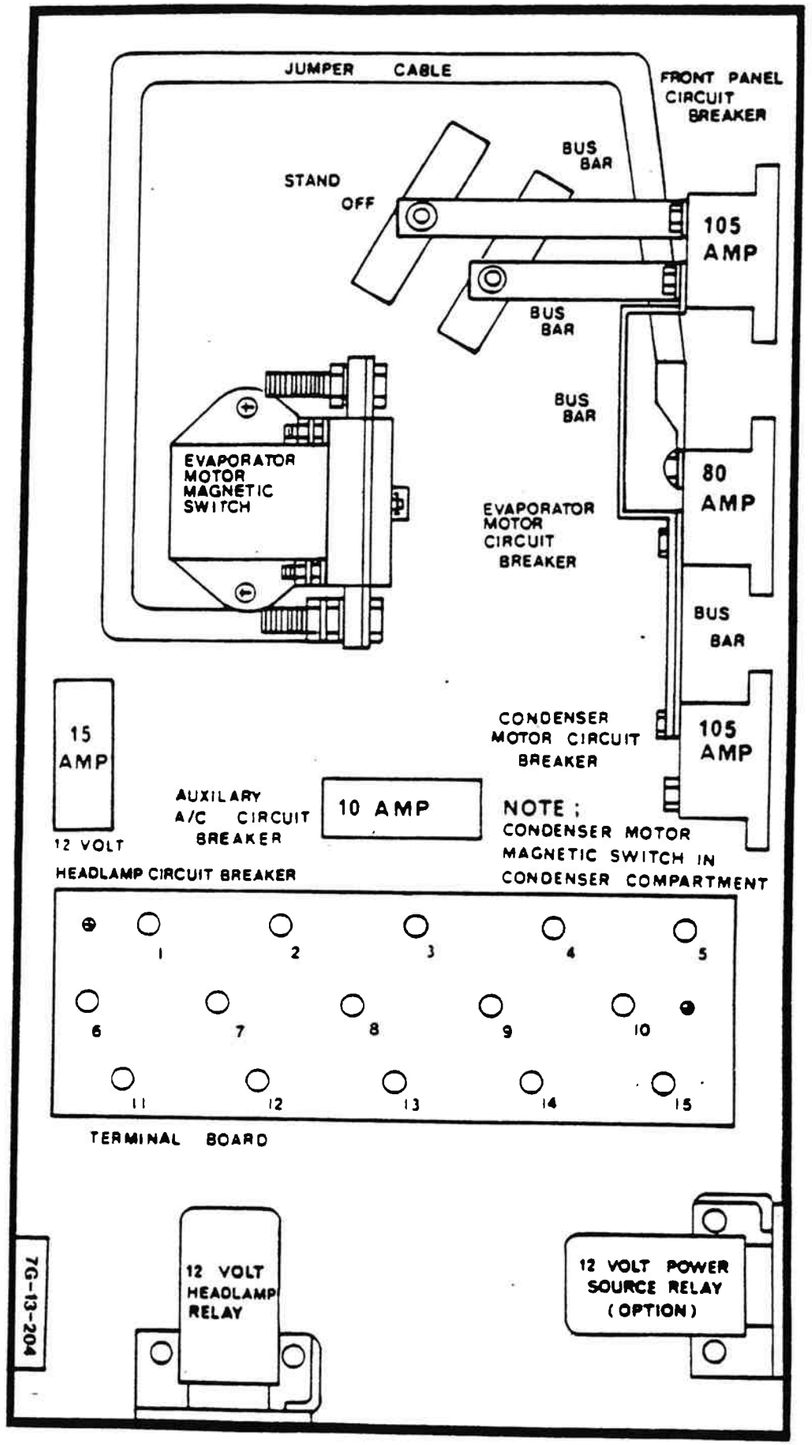
WIRING DIAGRAM
PRESSURIZED ETHER START SYSTEM
MODEL: MC-9
DATE: JANUARY 1989



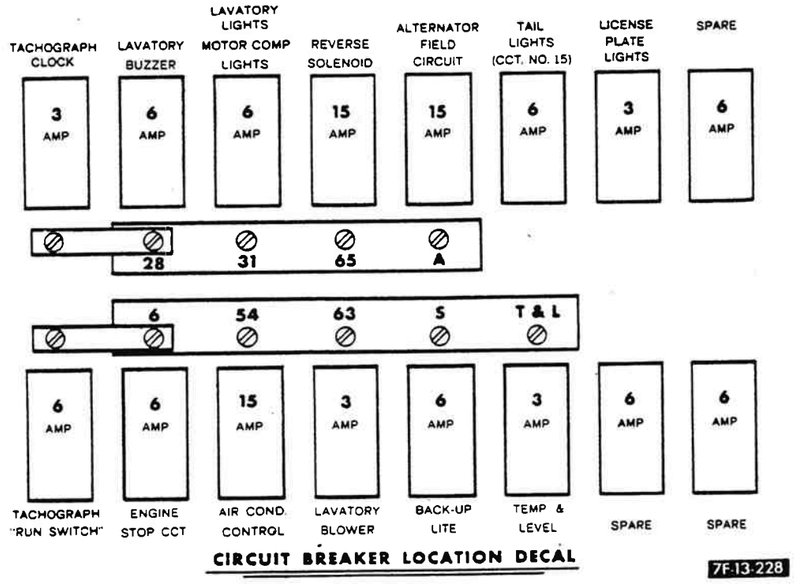
FRONT JUNCTION BOX DECAL
MODEL: MC-9



FRONT JUNTION BOX RELAY LOCATION DECAL
MODEL: MC-9
DATE: JANUARY 1989



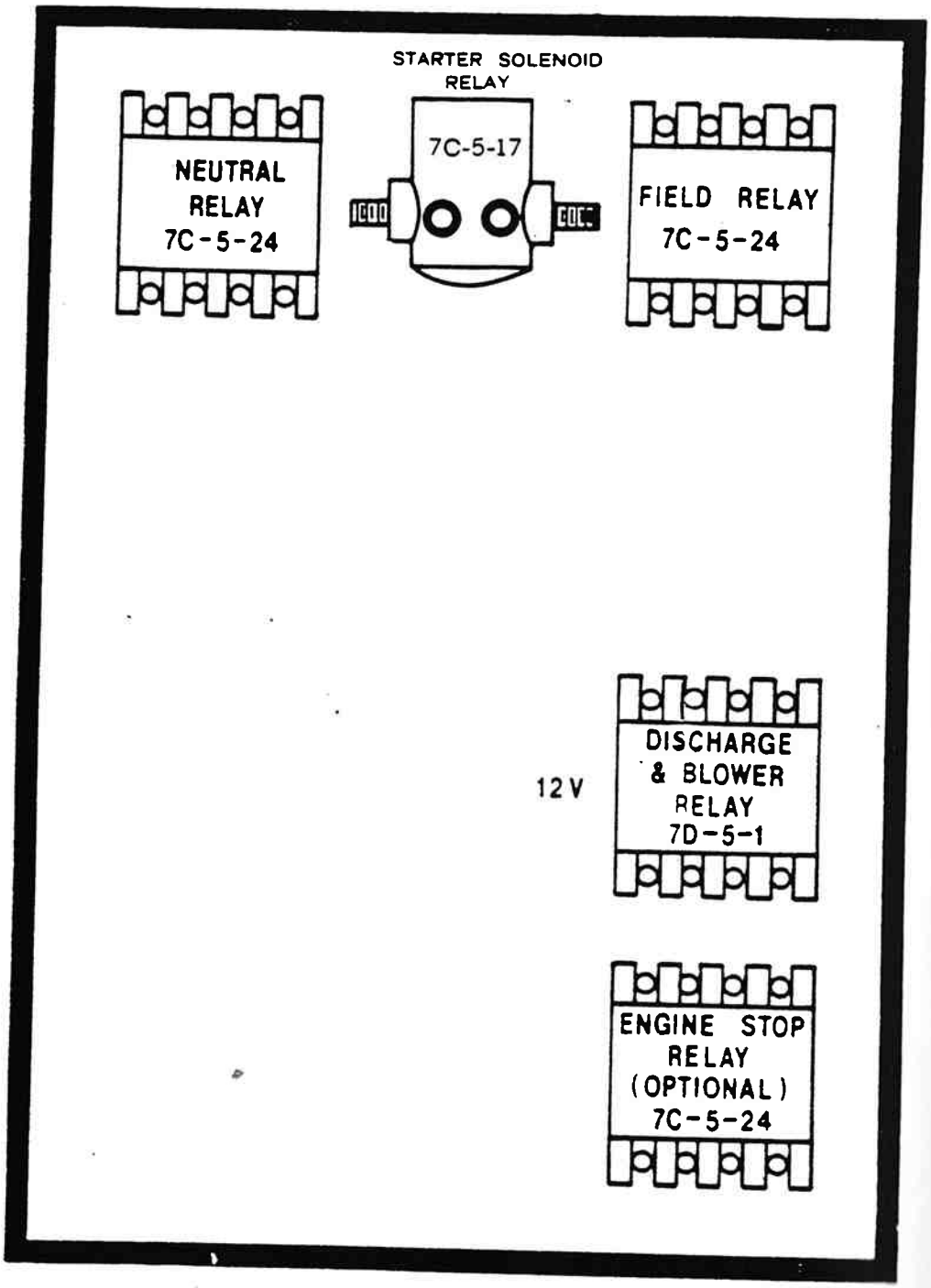
A/C JUNCTION BOX DECAL
MODEL: MC-9
DATE: JAN. 1989



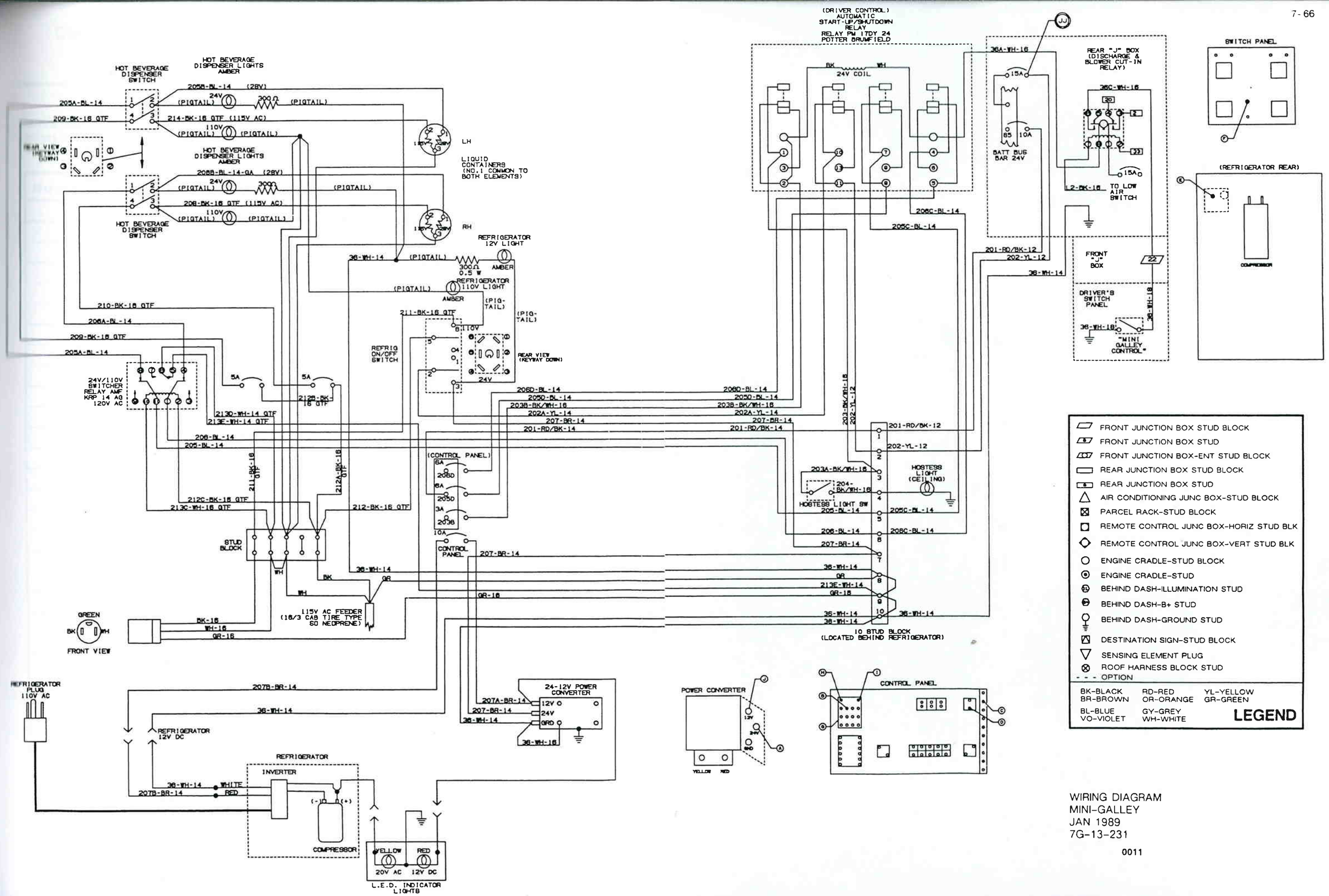
CIRCUIT BREAKER LOCATION DECAL

7F-13-228

CIRCUIT BREAKER LOCATION DECAL - REAR "J" BOX
MODEL: MC-9
DATE: JAN. 1989



REAR JUNCTION BOX RELAY LOCATION
MODEL: MC-9
DATE: JAN. 1989



- FRONT JUNCTION BOX STUD BLOCK
- FRONT JUNCTION BOX STUD
- FRONT JUNCTION BOX-ENT STUD BLOCK
- REAR JUNCTION BOX STUD BLOCK
- REAR JUNCTION BOX STUD
- AIR CONDITIONING JUNC BOX-STUD BLOCK
- PARCEL RACK-STUD BLOCK
- REMOTE CONTROL JUNC BOX-HORIZ STUD BLK
- REMOTE CONTROL JUNC BOX-VERT STUD BLK
- ENGINE CRADLE-STUD BLOCK
- ENGINE CRADLE-STUD
- BEHIND DASH-ILLUMINATION STUD
- BEHIND DASH-B+ STUD
- BEHIND DASH-GROUND STUD
- DESTINATION SIGN-STUD BLOCK
- SENSING ELEMENT PLUG
- ROOF HARNESS BLOCK STUD
- - - OPTION

BK-BLACK BR-BROWN BL-BLUE VO-VIOLET RD-RED OR-ORANGE GY-GREY WH-WHITE YL-YELLOW GR-GREEN

LEGEND

WIRING DIAGRAM
MINI-GALLEY
JAN 1989
7G-13-231

0011

Date 1-1-89

MC-9 MAINTENANCE MANUAL

SERVICE BULLETINS

Service Bulletins will be issued from time to time to acquaint users with the latest service procedures. The number, date and title of bulletins pertaining to this section should be noted below as soon as received. Bulletins should then be filed for future reference.

Number	Date	Subject