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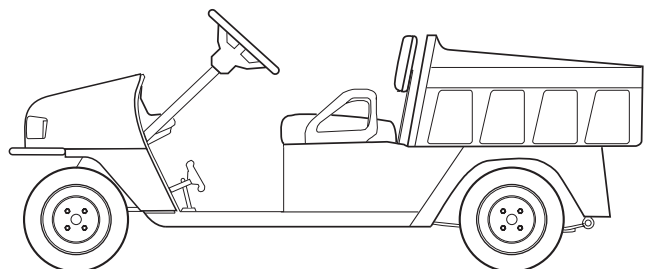
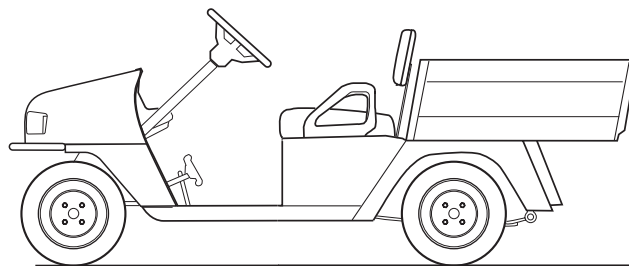
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# TECHNICIAN'S REPAIR AND SERVICE MANUAL



## ELECTRIC POWERED UTILITY VEHICLES

REVISED DATE: OCT 2006

# SAFETY

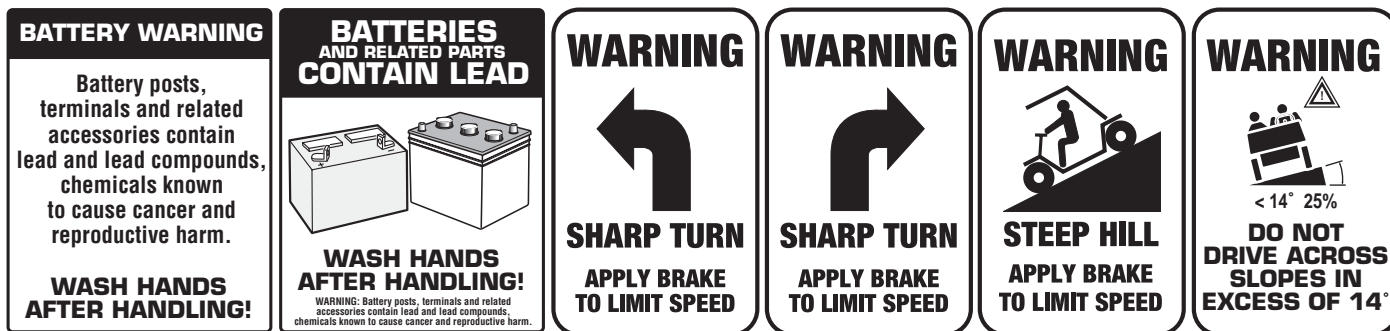
For any questions on material contained in this manual, contact an authorized representative for clarification.

Read and understand all labels located on the vehicle. Always replace any damaged or missing labels.

On steep hills it is possible for vehicles to coast at greater than normal speeds encountered on a flat surface. To prevent loss of vehicle control and possible serious injury, speeds should be limited to no more than the maximum speed on level ground. See GENERAL SPECIFICATIONS. Limit speed by applying the service brake.

Catastrophic damage to the drivetrain components due to excessive speed may result from driving the vehicle above specified speed. Damage caused by excessive speed may cause a loss of vehicle control, is costly, is considered abuse and will not be covered under warranty.

Signs similar to the ones illustrated should be used to warn of situations that could result in an unsafe condition.



Be sure that this manual remains as part of the permanent service record should the vehicle be sold.

## NOTES, CAUTIONS AND WARNINGS

Throughout this guide **NOTE**, **CAUTION** and **WARNING** will be used.

**NOTE** A **NOTE** indicates a condition that should be observed.

**CAUTION** A **CAUTION** indicates a condition that may result in damage to the vehicle.

**WARNING** A **WARNING** indicates a hazardous condition that could result in severe injury or death.

Observe these **NOTES**, **CAUTIONS** and **WARNINGS**; be aware that servicing a vehicle requires mechanical skill and a regard for conditions that could be hazardous. Improper service or repair may damage the vehicle or render it unsafe.

**WARNING** Battery posts, terminals and related accessories contain lead and lead compounds. Wash hands after handling.

(NOTES, CAUTIONS AND WARNINGS CONTINUED ON INSIDE OF BACK COVER)

# TECHNICIAN'S REPAIR AND SERVICE MANUAL

## ELECTRIC UTILITY VEHICLES

**MPT™ 800**

**INDUSTRIAL™ 800**

**MPT™ 1000**

**INDUSTRIAL™ 1000**

**Commander™ 280**

**Commander™ 2100**

**Hauler™ 800**

**Hauler™ 1000**

**STARTING MODEL YEAR: 2004**

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**CUSTOMER SERVICE DEPARTMENT IN USA PHONE: 1-800-241-5855 FAX: 1-800-448-8124**

**OUTSIDE USA PHONE: 010-1-706-798-4311 FAX: 010-1-706-771-4609**

**E-Z-GO DIVISION OF TEXTRON, INC., 1451 Marvin Griffin Rd., AUGUSTA, GEORGIA USA 30906**

## **GENERAL INFORMATION**

**This vehicle has been designed and manufactured in the United States of America (USA) as a 'World Vehicle'. The Standards and Specifications listed in the following text originate in the USA unless otherwise indicated.**

**The use of non Original Equipment Manufacturer (OEM) approved parts may void the warranty.**

**Overfilling batteries may void the warranty.**

### **BATTERY PROLONGED STORAGE**

**All batteries will self discharge over time. The rate of self discharge varies depending on the ambient temperature and the age and condition of the batteries.**

**A fully charged battery will not freeze in winter temperatures unless the temperature falls below -75° F (-60° C).**

**For winter storage, the batteries must be clean, fully charged and disconnected from any source of electrical drain. The battery charger and the controller are both sources of electrical drain. Unplug the battery charger DC plug from the vehicle receptacle.**

**As with all electric vehicles, the batteries must be checked and recharged as required or at a minimum of 30 day intervals.**

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# SAFETY INFORMATION

This manual has been designed to assist the owner-operator in maintaining the vehicle in accordance with procedures developed by the manufacturer. Adherence to these procedures and troubleshooting tips will ensure the best possible service from the product. To reduce the chance of personal injury and/or property damage, the following instructions must be carefully observed:

## GENERAL

Many vehicles are used for a variety of tasks beyond the original intended use of the vehicle; therefore it is impossible to anticipate and warn against every possible combination of circumstances that may occur. No warnings can take the place of good common sense and prudent driving practices.

Good common sense and prudent driving practices do more to prevent accidents and injury than all of the warnings and instructions combined. The manufacturer strongly suggests that the owner-operator read this entire manual paying particular attention to the CAUTIONS and WARNINGS contained therein. It is further recommended that employees and other operators be encouraged to do the same.

If you have any questions, contact your closest representative or write to the address on the back cover of this publication, Attention: Product Service Department.

The manufacturer reserves the right to make design changes without obligation to make these changes on units previously sold and the information contained in this manual is subject to change without notice.

The manufacturer is not liable for errors in this manual or for incidental or consequential damages that result from the use of the material in this manual.

This vehicle conforms to the current applicable standard for safety and performance requirements.

These vehicles are designed and manufactured for off-road use. They do not conform to Federal Motor Vehicle Safety Standards and are not equipped for operation on public streets. Some communities may permit these vehicles to be operated on their streets on a limited basis and in accordance with local ordinances.

With electric powered vehicles, be sure that all electrical accessories are grounded directly to the battery (-) post. **Never use the chassis or body as a ground connection.**

Refer to GENERAL SPECIFICATIONS for vehicle seating capacity.

**Never modify the vehicle in any way that will alter the weight distribution of the vehicle, decrease its stability or increase the speed beyond the factory specification. Such modifications can cause serious personal injury or death.** Modifications that increase the speed and/or weight of the vehicle will extend the stopping distance and may reduce the stability of the vehicle. Do not make any such modifications or changes. The manufacturer prohibits and disclaims responsibility for any such modifications or any other alteration which would adversely affect the safety of the vehicle.

Vehicles that are capable of higher speeds must limit their speed to no more than the speed of other vehicles when used in a golf course environment. Additionally, speed should be further moderated by the environmental conditions, terrain and common sense.

## GENERAL OPERATION

Always use the vehicle in a responsible manner and maintain the vehicle in safe operating condition.

Always read and observe all warnings and operation instruction labels affixed to the vehicle.

Always follow all safety rules established in the area where the vehicle is being operated.

## **SAFETY INFORMATION**

Always reduce speed to compensate for poor terrain or conditions.

Always apply service brake to control speed on steep grades.

Always maintain adequate distance between vehicles.

Always reduce speed in wet areas.

Always use extreme caution when approaching sharp or blind turns.

Always use extreme caution when driving over loose terrain.

Always use extreme caution in areas where pedestrians are present.

## **MAINTENANCE**

Always maintain your vehicle in accordance with the manufacturer's periodic service schedule.

Always ensure that mechanics performing repairs are trained and qualified to do so.

Always follow the manufacturer's directions if you do any maintenance on your vehicle. Be sure to disable the vehicle before performing any maintenance. Disabling includes removing the key from the key switch and removal of a battery wire.

Always insulate any tools used within the battery area in order to prevent sparks or battery explosion caused by shorting the battery terminals or associated wiring. Remove the batteries or cover exposed terminals with an insulating material.

Always check the polarity of each battery terminal and be sure to rewire the batteries correctly.

Always use specified replacement parts. Never use replacement parts of lesser quality.

Always use recommended tools.

Always determine that tools and procedures not specifically recommended by the manufacturer will not compromise the safety of personnel nor jeopardize the safe operation of the vehicle.

Always support the vehicle using wheel chocks and safety stands. Never get under a vehicle that is supported by a jack. Lift the vehicle in accordance with the manufacturer's instructions.

Never attempt to maintain a vehicle in an area where exposed flame is present or persons are smoking.

Always be aware that a vehicle that is not performing as designed is a potential hazard and must not be operated.

The manufacturer cannot anticipate all situations, therefore people attempting to maintain or repair the vehicle must have the skill and experience to recognize and protect themselves from potential situations that could result in severe personal injury or death and damage to the vehicle. Use extreme caution and, if unsure as to the potential for injury, refer the repair or maintenance to a qualified mechanic.

Always test drive the vehicle after any repairs or maintenance. All tests must be conducted in a safe area that is free of both vehicular and pedestrian traffic.

Always replace damaged or missing warning, caution or information labels.

Always keep complete records of the maintenance history of the vehicle.



# **SAFETY INFORMATION**

## **VENTILATION**

Hydrogen gas is generated in the charging cycle of batteries and is explosive in concentrations as low as 4%. Because hydrogen gas is lighter than air, it will collect in the ceiling of buildings necessitating proper ventilation. Five air exchanges per hour is considered the minimum requirement.

Never charge a vehicle in an area that is subject to flame or spark. Pay particular attention to natural gas or propane gas water heaters and furnaces.

Always use a dedicated circuit for each battery charger. Do not permit other appliances to be plugged into the receptacle when the charger is in operation.

Chargers must be installed and operated in accordance with charger manufacturers recommendations or applicable electrical code (whichever is higher).





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# GENERAL INFORMATION & ROUTINE MAINTENANCE



Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

## SERIAL NUMBER PLATE LOCATION

The serial number and manufacture date code label are on the vehicle. One is placed on the body below the front, driver side of the seat. The other is located on the chassis under the seat.

Design changes take place on an ongoing basis. In order to obtain correct components for the vehicle, the manufacture date code, serial number and vehicle model must be provided when ordering service parts.

## TRANSPORTING VEHICLE

### TOWING



*This vehicle is not designed to be towed.*

It is recommended that the vehicle be moved by placing the entire vehicle on a trailer, flatbed truck or other suitable transport.

### HAULING



*To reduce the possibility of severe injury or death while transporting vehicle:*

- Secure the vehicle and contents.*
- Never ride on vehicle being transported.*
- Always remove windshield before transporting.*
- Maximum speed with sun top installed is 50 mph (80 kph).*

If the vehicle is to be transported at highway speeds, the sun top must be removed and the seat bottom secured. When transporting vehicle below highway speeds, check for tightness of hardware and cracks in sun top at mounting points. Always remove windshield when transporting. Always check that the vehicle and contents are adequately secured before transporting. The rated capacity of the trailer or truck must exceed the weight of the vehicle (see GENERAL SPECIFICATIONS for vehicle weight) and load plus 1000 lbs. (454 kg). Lock the park brake and secure the vehicle using ratchet tie downs.

## SERVICING THE ELECTRIC VEHICLE



*To prevent severe injury or death, resulting from improper servicing techniques, observe the following Warnings:*

*Do not attempt any type of servicing operations before reading and understanding all notes, cau-*

*tions and warnings in this manual.*

*Any servicing requiring adjustments to be made to the powertrain while the motor is running must be made with both drive wheels raised.*



*Wear eye protection when working on the vehicle. In particular, use care when working around batteries, or using solvents or compressed air.*

*To reduce the possibility of causing an electrical arc, which could result in a battery explosion, turn off all electrical loads from the batteries before removing any heavy gauge battery wires.*

*To prevent the possibility of motor disintegration, never operate vehicle at full throttle for more than 4 - 5 seconds while vehicle is in a "no load" condition.*

It is in the best interest of both vehicle owner and servicing dealer to carefully follow the procedures recommended in this manual. Adequate preventive maintenance, applied at regular intervals, is the best guarantee for keeping the vehicle both dependable and economical.

Before a new vehicle is put into operation, it is recommended that the items shown in the INITIAL SERVICE CHART be performed (Ref Fig. 1 on page A-1).

ITEM	SERVICE OPERATION
Batteries	Charge batteries
Seats	Remove protective plastic covering
Brakes	Check operation and adjust if necessary
	Establish acceptable stopping distance
	Check hydraulic brake fluid level if equipped
Tires	Check air pressure (see SPECIFICATIONS)
Portable Charger	Remove from vehicle and properly mount

Ref Isc 7

**Fig. 1 Initial Service Chart**

Vehicle batteries must be fully charged before initial use.

## ROUTINE MAINTENANCE



*Some maintenance items must be serviced more frequently on vehicles used under severe driving conditions.*

# GENERAL INFORMATION & ROUTINE MAINTENANCE

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

This vehicle will give years of satisfactory service providing it receives regular maintenance. Refer to the Periodic Service Schedule for appropriate service intervals (Ref Fig. 4 on page A-5). Refer to Lubrication Point for appropriate lubrication location (Ref Fig. 2 on page A-2).

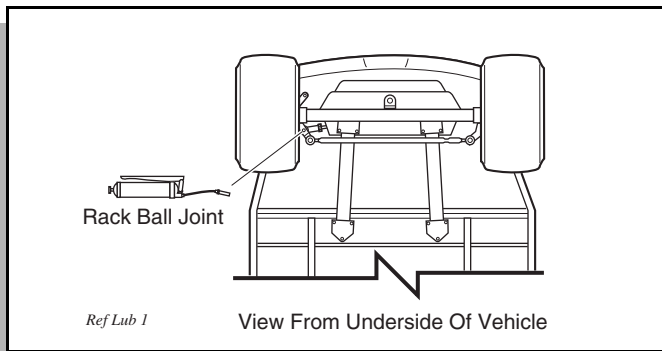


Fig. 2 Lubrication Point

**CAUTION** Do not use more than three (3) pumps of grease for each grease fitting at any one time. Excess grease may cause grease seals to fail or grease migration into areas that could damage components.

Putting more than three pumps of grease in a grease fitting could damage grease seals and cause premature bearing failure.

## REAR AXLE

The only maintenance required for the first five years is the periodic inspection of the lubricant level. The rear axle is provided with a lubricant level check/fill plug located on the bottom of the differential. Unless leakage is evident, the lubricant need only be replaced after five years. The procedure to follow for checking the rear axle lubricant level is in the REAR AXLE section.

## BRAKES

After the vehicle has been put into service, it is recommended that the brakes be checked daily by performing a brake test.

**WARNING** *To prevent severe injury or death resulting from operating a vehicle with improperly operating brake system, the braking system must be properly maintained. All driving brake tests must be done in a safe location with regard for the safety of all personnel.*

For information on conducting a brake test, refer to BRAKES section.

## TIRES

Tire condition should be inspected per the Periodic Service Schedule. Inflation pressures should be checked when the tires are cool. Be sure to reinstall valve dust cap after checking or inflating. For additional information, refer to WHEELS AND TIRES section.

## LIGHT BULB REPLACEMENT

Refer to ELECTRICAL SYSTEM for information regarding light bulb replacement.

## CARE AND CLEANING OF THE VEHICLE

**CAUTION** When pressure washing vehicle, do not use pressure in excess of 700 psi (4825 kPa). To prevent cosmetic damage, do not use any abrasive or reactive solvents to clean plastic parts.

It is important that proper techniques and cleaning materials be used. Using excessive water pressure may cause damage to seals, plastics, the electrical system, body finish or seat material. Do not use pressure in excess of 700 psi (4825 kPa) to wash vehicle.

Normal cleaning of vinyl seats and plastic or rubber trim require the use of a mild soap solution applied with a sponge or soft brush and wipe with a damp cloth.

Removal of oil, tar, asphalt, shoe polish, etc. will require the use of a commercially available vinyl/rubber cleaner.

The painted surfaces of the vehicle provide attractive appearance and durable protection. Frequent washing with lukewarm or cold water is the best method of preserving those painted surfaces.

Do not use hot water, strong soap or harsh chemical detergents.

Rubber parts should be cleaned with non-abrasive household cleaner.

Occasional cleaning and waxing with non-abrasive products designed for 'clear coat' automotive finishes will enhance the appearance and durability of the painted surfaces.

Corrosive materials used as fertilizers or for dust control can collect on the underbody of the vehicle. These materials will accelerate corrosion of underbody parts. It is recommended that the underbody be flushed occasion-

# GENERAL INFORMATION & ROUTINE MAINTENANCE

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

ally with plain water. Thoroughly clean any areas where mud or other debris can collect. Sediment packed in closed areas should be loosened to ease its removal, taking care not to chip or otherwise damage paint.

## VEHICLE CARE PRODUCTS

To help maintain the vehicle, there are several products available through local Distributors, authorized Branches, or the Service Parts Department.

- Touch-up paint specially formulated to match vehicle colors for use on TPE (plastic) bodies (P/N 28140-G\*\* and 28432-G\*\*).
- Multi-purpose Battery Protectant formulated to form a long-term, flexible, non-tacky, dry coating that will not crack, peel or flake over a wide temperature range (P/N 75500-G01).
- White Lithium Grease designed to provide lubrication protection in areas where staining or discoloring is a problem, or in areas of extreme temperature ranges (P/N 75502-G01).
- Penetrant/Lubricant, a 4-in-1 product that penetrates the most stubborn of frozen parts, lubricates leaving a light lubricating film, prevents corrosion by adhering to wet or dry surfaces and displaces moisture, sealing against future moisture return (P/N 75503-G01).
- Multi-purpose Cleaner and Degreaser that contains natural, environmentally safe solvents (P/N 75504-G01).
- Multi-purpose Hand Cleaner is an industrial strength cleaner containing no harsh solvents, yet gently lifts grease off hands. May be used with or without water (P/N 75505-G01).
- Battery Cleaner that promotes easy, non-violent neutralization of battery acids and battery acid crystals. The resulting sodium salts are water soluble and easily washed away (P/N 75506-G01).
- Battery Maintenance Kit for complete battery cleaning and watering, with battery maintenance instructions (P/N 25587-G01).
- Biodegradable Cleaner that cleans the toughest dirt and heavy soils by breaking down grease to be easily wiped or rinsed away (P/N 75507-G01).
- Multi-purpose Value Pack sampler package including 4 ounce (118 ml) aerosol cans of Battery Protector, Penetrant/Lubricant, White Lithium Grease, and Carburetor and Choke Cleaner (P/N 75508-G01).

- Plexus plastic cleaner and polish removes minor scratches from windshield (P/N 28433-G\*\*).

## TOP AND WINDSHIELD



*The top does not provide protection from roll over or falling objects.*

*The windshield does not provide protection from tree limbs or flying objects.*

The top and windshield are designed for weather protection only.

Clean with lots of water and a clean cloth. Minor scratches may be removed using a commercial plastic polish or Plexus plastic cleaner available from Service Parts Department.

# GENERAL INFORMATION & ROUTINE MAINTENANCE

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings







## HARDWARE

Periodically the vehicle should be inspected for loose fasteners. Fasteners should be tightened in accordance with the Torque Specifications table (Ref Fig. 3 on page A-4).

Use care when tightening fasteners and refer to the Technician's Repair and Service Manual for specific torque values.

Generally, two grades of hardware are used in the vehicle. Grade 5 hardware can be identified by the three marks on the hexagonal head. Unmarked hardware is Grade 2.

## TORQUE SPECIFICATIONS

<b>ALL TORQUE FIGURES ARE IN FT. LBS. (Nm)</b>											
Unless otherwise noted in text, tighten all hardware in accordance with this chart.											
This chart specifies 'lubricated' torque figures. Fasteners that are plated or lubricated when installed are considered 'wet' and require approximately 80% of the torque required for 'dry' fasteners.											
<b>BOLT SIZE</b>		<b>1/4"</b>	<b>5/16"</b>	<b>3/8"</b>	<b>7/16"</b>	<b>1/2"</b>	<b>9/16"</b>	<b>5/8"</b>	<b>3/4"</b>	<b>7/8"</b>	<b>1"</b>
Grade 2		4 (5)	8 (11)	15 (20)	24 (33)	35 (47)	55 (75)	75 (102)	130 (176)	125 (169)	190 (258)
Grade 5		6 (8)	13 (18)	23 (31)	35 (47)	55 (75)	80 (108)	110 (149)	200 (271)	320 (434)	480 (651)
Grade 8		6 (8)	18 (24)	35 (47)	55 (75)	80 (108)	110 (149)	170 (230)	280 (380)	460 (624)	680 (922)
<b>BOLT SIZE</b>		<b>M4</b>	<b>M5</b>	<b>M6</b>	<b>M8</b>	<b>M10</b>	<b>M12</b>	<b>M14</b>			
Class 5.8 (Grade 2)		1 (2)	2 (3)	4 (6)	10 (14)	20 (27)	35 (47)	55 (76.4)			
Class 8.8 (Grade 5)		2 (3)	4 (6)	7 (10)	18 (24)	35 (47)	61 (83)	97 (131)			
Class 10.9 (Grade 8)		3 (4)	6 (8)	10 (14)	25 (34)	49 (66)	86 (117)	136 (184)			

Ref Tsp 1

**Fig. 3 Torque Specifications**



# GENERAL INFORMATION & ROUTINE MAINTENANCE

*Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings*

## PERIODIC SERVICE SCHEDULE

✓ Check      ◆ Clean, Adjust, etc.      ▲ Replace

**NOTE:** Some maintenance items must be serviced more frequently on vehicles used under severe driving conditions

### DAILY

**BEFORE USE:**

- ✓ Check service brake general operation
- ✓ Check park brake function
- ✓ Check warning device function in reverse
- ✓ Check tire condition
- ✓ Check overall vehicle condition

BATTERIES      ◆ Recharge to full charge state after each day's use

CHARGER / RECEPTACLE      ✓ Inspect connector system at each charge

### WEEKLY

TIRES      ✓ Examine for cuts, excessive wear and pressure (See GENERAL SPECIFICATIONS)

WHEELS      ✓ Check for bent rims, loose or missing lug nuts

### MONTHLY - 20 HOURS (includes items listed in previous table & the following)

BATTERIES      ◆ Clean battery & terminals  
                              ✓ Check charge condition and all connections

WIRING      ✓ Check all wiring for loose connections and broken/missing insulation

SERVICE BRAKE      ✓ Conduct brake performance test

BRAKE FLUID (IF EQUIPPED)      ✓ Check for leakage

ACCELERATOR      ✓ Check for smooth movement

CHARGER / RECEPTACLE      ◆ Clean connections, keep receptacles free of dirt and foreign matter

DIRECTION SELECTOR      ✓ Check attachment, adjust as required

STEERING ASSEMBLY      ✓ Check for abnormal play, tightness of all hardware

TIE ROD/LINKAGES      ✓ Check for excessive play, bent components or loose connections

REAR AXLE      ✓ Check for leakage, add SAE 30 oil as required

### QUARTERLY - 50 HOURS (includes items listed in previous tables & the following)

FRONT AXLE      ✓ Check for damage to axle and loose or missing hardware

FRONT SHOCK ABSORBERS      ✓ Check for oil leakage and loose fasteners

FRONT SPRINGS      ✓ Check for loose hardware, cracks at attachments

**Fig. 4 Periodic Service Schedule**

## GENERAL INFORMATION & ROUTINE MAINTENANCE

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

FRONT WHEEL ALIGNMENT	✓ Check for unusual tire wear, align if required
PARK BRAKE	✓ Check for bent/binding linkage rod ✓ Check for damage or wear to latch arm or catch bracket ◆ Lubricate as required, use light oil. DO NOT LUBRICATE CABLES OR BRAKE LATCH
REAR SHOCK ABSORBERS	✓ Check for oil leakage, loose mounting hardware
HARDWARE AND FASTENERS	✓ Check for loose or missing hardware and components ◆ Tighten or replace missing hardware
<b>SEMI-ANNUAL - 125 HOURS (includes items listed in previous tables &amp; the following)</b>	
BATTERIES	◆ Clean batteries & terminals
DIRECTION SELECTOR	✓ Check for wear and smooth movement (lubricate shaft with light oil if required)
KING PINS	✓ Check for excessive play and tightness of retaining nuts
STEERING ASSEMBLY	✓ Check bellows and pinion seal for damage or grease leakage
RACK END BALL JOINT	◆ Lubricate, use wheel bearing grease
REAR AXLE	✓ Check for unusual noise and loose or missing mounting hardware
<b>ANNUAL - 250-300 HOURS (includes items listed in previous tables &amp; the following)</b>	
FRONT WHEEL BEARINGS	◆ Check and adjust if required (see FRONT SUSPENSION AND STEERING)
REAR AXLE	✓ Check lubricant, add lubricant (SAE 30 oil) as required
SERVICE BRAKES	◆ Clean and adjust, see Technician's Repair and Service Manual ✓ Check brake shoe linings, see Technician's Repair and Service Manual
(HYDRAULIC BRAKES)	✓ Check brake fluid

**Fig. 4 Periodic Service Schedule**

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# SAFETY



Read all of Section A and this section before attempting any procedure. Pay particular attention to all Notes,

## GENERAL

The following text is provided as recommended by part II of ASME/ANSI B56.8-1988. The manufacturer strongly endorses the contents of this specification.

## PART II FOR THE USER

### 4 GENERAL SAFETY PRACTICES

#### 4.1 Introduction

**4.1.1** Like other machines, carriers can cause injury if improperly used or maintained. Part II contains broad safety practices applicable to carrier operations. Before operation, the user shall establish such additional specific safety practices as may reasonably be required for safe operation.

#### 4.2 Stability

**4.2.1** Experience has shown that this vehicle, which complies with this standard, is stable when properly operated and when operated in accordance with specific safety rules and practices established to meet actual operating terrain and conditions. However, improper operation, faulty maintenance, or poor housekeeping may contribute to a condition of instability and defeat the purpose of the standard. Some of the conditions which may affect stability are failure of the user to follow safety practices; also, ground and floor conditions, grade, speed, loading, the operation of the carrier with improper loads, battery weight, dynamic and static forces, and the judgement exercised by the carrier operator.

(a) The user shall train carrier operators to adhere strictly to the operating instructions stated in this Standard.

(b) The user shall survey specific operating conditions and environment, and establish and train carrier operators to comply with additional, specific safety practices.

#### 4.3 Nameplates, Markings, Capacity, and Modifications

**4.3.1** The user shall maintain in a legible condition all nameplates, warnings, and instructions which are supplied by the manufacturer.

**4.3.2** The user shall not perform any modification or addition which affects capacity or safe operation, or make any change not in accordance with the owner's

manual without the manufacturer's prior written authorization. Where authorized modifications have been made, the user shall ensure that capacity, operation, warning, and maintenance instruction plates, tags, or decals are changed accordingly.

**4.3.3** As required under paras. 4.3.1 or 4.3.2, the manufacturer shall be contacted to secure new nameplates, warnings, or instructions which shall then be affixed in their proper place on the carrier.

#### 4.4 Fuel Handling and Storage

**4.4.1** The user shall supervise the storage and handling of liquid fuels (when used) to be certain that it is in accordance with appropriate paragraphs of ANSI/NFPA 505 and ANSI/NFPA 30.

**4.4.2** Storage and handling of liquefied petroleum gas fuels shall be in accordance with appropriate paragraphs of ANSI/NFPA 505 and ANSI/NFPA 58. If such storage or handling is not in compliance with these standards, the user shall prevent the carrier from being used until such storage and handling is in compliance with these standards.

#### 4.5 Changing and Charging Storage Batteries for Electric Personnel and Burden Carriers

**4.5.1** The user shall require battery changing and charging facilities and procedures to be in accordance with appropriate paragraphs of ANSI/NFPA 505.

**4.5.2** The user shall periodically inspect facilities and review procedures to be certain that appropriate paragraphs of ANSI/NFPA 505, are strictly complied with, and shall familiarize carrier operators with it.

#### 4.6 Hazardous Locations

**4.6.1** The user shall determine the hazard classification of the particular atmosphere or location in which the carrier is to be used in accordance with ANSI/NFPA 505.

**4.6.2** The user shall permit in hazardous areas only those carriers approved and of the type required by ANSI/NFPA 505.

#### 4.7 Lighting for Operating Areas

**4.7.1** The user, in accordance with his responsibility to survey the environment and operating conditions, shall determine if the carrier requires lights and, if so, shall equip the carrier with appropriate lights in accordance with the manufacturer's recommendations.

# SAFETY

Read all of Section A and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

## 4.8 Control of Noxious Gases and Fumes

**4.8.1** When equipment powered by internal combustion engines is used in enclosed areas, the atmosphere shall be maintained within limits specified in the American Conference of Governmental Industrial Hygienists publication, "Threshold Limit Values for Chemical Substances and Physical Agents in the Workroom Environment". This shall be accomplished by ventilation provided by the user, and/or the installation, use, and proper maintenance of emission control equipment recommended or provided by the manufacturer of the equipment.

## 4.9 Warning Device(s)

**4.9.1** The user shall make periodic inspections of the carrier to be certain that the sound-producing and/or visual device(s) are maintained in good operating condition.

**4.9.2** The user shall determine if operating conditions require the carrier to be equipped with additional sound-producing and/or visual devices and be responsible for providing and maintaining such devices, in accordance with the manufacturer's recommendations.

## 5 OPERATING SAFETY RULES AND PRACTICES

### 5.1 Personnel and Burden Carrier Operator Qualifications

**5.1.1** Only persons who are trained in the proper operation of the carrier shall be authorized to operate the carrier. Operators shall be qualified as to visual, auditory, physical, and mental ability to safely operate the equipment according to Section 5 and all other applicable parts of this Standard.

### 5.2 Personnel and Burden Carrier Operators' Training

**5.2.1** The user shall conduct an operators' training program.

**5.2.2** Successful completion of the operators' training program shall be required by the user before operation of the carrier. The program shall be presented in its entirety to all new operators and not condensed for those claiming previous experience.

**5.2.3** The user should include in the operators' training program the following:

(a) instructional material provided by the manufacturer;

(b) emphasis on safety of passengers, material loads, carrier operator, and other employees;

(c) general safety rules contained within this Standard and the additional specific rules determined by the user in accordance with this Standard, and why they were formulated;

(d) introduction of equipment, control locations and functions, and explanation of how they work when used properly and when used improperly, and surface conditions, grade, and other conditions of the environment in which the carrier is to be operated;

(e) operational performance tests and evaluations during, and at completion of, the program.

### 5.3 Personnel and Burden Carrier Operator Responsibility

**5.3.1** Operators shall abide by the following safety rules and practices in paras. 5.4, 5.5, 5.6, and 5.7.

### 5.4 General

**5.4.1** Safeguard the pedestrians at all times. Do not drive carrier in a manner that would endanger anyone.

**5.4.2** Riding on the carrier by persons other than the operator is authorized only on personnel seat(s) provided by the manufacturer. All parts of the body shall remain within the plan view outline of the carrier.

**5.4.3** When a carrier is to be left unattended, stop carrier, apply the parking brake, stop the engine or turn off power, turn off the control or ignition circuit, and remove the key if provided. Block the wheels if machine is on an incline.

**5.4.4** A carrier is considered unattended when the operator is 25 ft. (7.6 m) or more from the carrier which remains in his view, or whenever the operator leaves the carrier and it is not within his view. When the operator is dismounted and within 25 ft. (7.6 m) of the carrier still in his view, he still must have controls neutralized, and the parking brake(s) set to prevent movement.

**5.4.5** Maintain a safe distance from the edge of ramps and platforms.

**5.4.6** Use only approved carriers in hazardous locations, as defined in the appropriate safety standards.

**5.4.7** Report all accidents involving personnel, building structures, and equipment.

Read all of Section A and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

**5.4.8** Operators shall not add to, or modify, the carrier.

**5.4.9** Carriers shall not be parked or left unattended such that they block or obstruct fire aisles, access to stairways, or fire equipment.

## 5.5 Traveling

**5.5.1** Observe all traffic regulations, including authorized speed limits. Under normal traffic conditions keep to the right. Maintain a safe distance, based on speed of travel, from a carrier or vehicle ahead; and keep the carrier under control at all times.

**5.5.2** Yield the right of way to pedestrians, ambulances, fire trucks, or other carriers or vehicles in emergency situations.

**5.5.3** Do not pass another carrier or vehicle traveling in the same direction at intersections, blind spots, or at other dangerous locations.

**5.5.4** Keep a clear view of the path of travel, observe other traffic and personnel, and maintain a safe clearance.

**5.5.5** Slow down or stop, as conditions dictate, and activate the sound-producing warning device at cross aisles and when visibility is obstructed at other locations.

**5.5.6** Ascend or descend grades slowly.

**5.5.7** Avoid turning, if possible, and use extreme caution on grades, ramps, or inclines; normally travel straight up and down.

**5.5.8** Under all travel conditions the carrier shall be operated at a speed that will permit it to be brought to a stop in a safe manner.

**5.5.9** Make starts, stops, turns, or direction reversals in a smooth manner so as not to shift the load, endanger passengers, or overturn the carrier.

**5.5.10** Do not indulge in dangerous activities, such as stunt driving or horseplay.

**5.5.11** Slow down when approaching, or on, wet or slippery surfaces.

**5.5.12** Do not drive carrier onto any elevator unless specifically authorized to do so. Approach elevators slowly, and then enter squarely after the elevator car is properly leveled. Once on the elevator, neutralize the controls, shut off power, and set parking brakes. It is advisable that all other personnel leave the elevator before a carrier is allowed to enter or exit.

**5.5.13** Avoid running over loose objects, potholes, and bumps.

**5.5.14** To negotiate turns, reduce speed to improve stability, then turn hand steering wheel or tiller in a smooth, sweeping motion.

## 5.6 Loading

**5.6.1** Handle only stable and safely arranged loads. When handling off-center loads which cannot be centered, operate with extra caution.

**5.6.2** Handle only loads within the capacity of the carrier as specified on the nameplate.

**5.6.3** Handle loads exceeding the dimensions used to establish carrier capacity with extra caution. Stability and maneuverability may be adversely affected.

## 5.7 Operator Care of Personnel and Burden Carriers

**5.7.1** At the beginning of each shift during which the carrier will be used, the operator shall check the carrier condition and inspect the tires, warning devices, lights, battery(s), speed and directional controllers, brakes, and steering mechanism. If the carrier is found to be in need of repair, or in any way unsafe, the matter shall be reported immediately to the designated authority and the carrier shall not be operated until it has been restored to safe operating condition.

**5.7.2** If during operation the carrier becomes unsafe in any way, the matter shall be reported immediately to the designated authority, and the carrier shall not be operated until it has been restored to safe operating condition.

**5.7.3** Do not make repairs or adjustments unless specifically authorized to do so.

**5.7.4** The engine shall be stopped and the operator shall leave the carrier while refueling.

**5.7.5** Spillage of oil or fuel shall be carefully and completely absorbed or evaporated and fuel tank cap replaced before starting engine.

**5.7.6** Do not operate a carrier with a leak in the fuel system or battery(s).

**5.7.7** Do not use open flames for checking electrolyte level in storage battery(s) or liquid level in fuel tanks.

## 6 MAINTENANCE PRACTICES

### 6.1 Introduction

**6.1.1** Carriers may become hazardous if maintenance is neglected. Therefore, maintenance facilities,

# SAFETY

Read all of Section A and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

trained personnel, and procedures shall be provided. Such facilities may be on or off the premises.

## 6.2 Maintenance Procedures

**6.2.1** Maintenance and inspection of all carriers shall be performed in conformance with the manufacturer's recommendations and the following practices.

(a) A scheduled preventive maintenance, lubrication, and inspection system shall be followed.

(b) Only qualified and authorized personnel shall be permitted to maintain, repair, adjust, and inspect carriers.

(c) Before undertaking maintenance or repair, follow the manufacturer's recommendations for immobilizing the carrier.

(d) Block chassis before working underneath it.

(e) Before disconnecting any part of the engine fuel system of a gasoline or diesel powered carrier with gravity feed fuel systems, be sure shutoff valve is closed, and run engine until fuel system is depleted and engine stops running.

(f) Before disconnecting any part of the engine fuel system of LP gas powered carriers, close the LP gas cylinder valve and run the engine until fuel in the system is depleted and the engine stops running.

(g) Operation to check performance of the carrier shall be conducted in an authorized area where safe clearance exists.

(h) Before commencing operation of the carrier, follow the manufacturer's instructions and recommended procedures.

(i) Avoid fire hazards and have fire protection equipment present in the work area. Do not use an open flame to check level or leakage of fuel, battery electrolyte, or coolant. Do not use open pans of fuel or flammable cleaning fluids for cleaning parts.

(j) Properly ventilate the work area.

(k) Handle LP gas cylinders with care. Physical damage, such as dents, scrapes, or gouges, may dangerously weaken the tank and make it unsafe for use.

(l) Brakes, steering mechanisms, speed and directional control mechanisms, warning devices, lights, governors, guards, and safety devices shall be inspected regularly and maintained in a safe operating condition.

(m) Special carriers or devices designed and approved for hazardous area operation shall be inspected to ensure that maintenance preserves the original approved safe operating features.

(n) Fuel systems shall be checked for leaks and condition of parts. If a leak is found, action shall be taken to prevent the use of the carrier until the leak has been eliminated.

(o) The carrier manufacturer's capacity, operation, and maintenance instruction plates, tags, or decals shall be maintained in legible condition.

(p) Batteries, motors, speed and directional controllers, limit switches, protective devices, electrical conductors, and connections shall be inspected and maintained in conformance with manufacturers recommended procedures.

(q) Carriers shall be kept in a clean condition to minimize fire hazards and facilitate detection of loose or defective parts.

(r) Modifications and additions which affect capacity and safe machine operation shall not be performed by the customer or user without manufacturer's prior written authorization; where authorized modifications have been made, the user shall ensure that capacity, operation, warning, and maintenance instruction plates, tags, or decals are changed accordingly.

(s) Care shall be taken to ensure that all replacement parts are interchangeable with the original parts and of a quality at least equal to that provided in the original equipment.

## End of ASME/ANSI B56.8-1988, Part II



Read all of Section A and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

## NOTES, CAUTIONS AND WARNINGS

Throughout this manual, the following **NOTES**, **CAUTIONS** and **WARNINGS** are used. For the protection of all personnel and the vehicle, be aware of and observe the following:

**NOTE** A *NOTE* indicates a condition that should be observed.

**CAUTION** A **CAUTION** indicates a condition that may result in damage to the vehicle or surrounding facilities.

**WARNING** A **WARNING** indicates a hazardous condition which could result in serious injury or death.

## IMPORTANT SAFETY WARNING

In any product, components will eventually fail to perform properly as the result of normal use, age, wear or abuse.

It is virtually impossible to anticipate all possible component failures or the manner in which each component may fail.

Be aware that a vehicle requiring repair indicates that the vehicle is no longer functioning as designed and therefore should be considered potentially hazardous. Use extreme care when working on any vehicle. When diagnosing, removing or replacing any components that are not operating correctly, take the time to consider the safety of yourself and others around you if the component should move unexpectedly.

Some components are heavy, spring loaded, highly corrosive, explosive or may produce high amperage or reach high temperatures. Battery acid and hydrogen gas could result in serious bodily injury to the technician/mechanic and bystanders if not treated with utmost caution. Be careful not to place hands, face, feet or body in a location that could expose them to injury should an unforeseen situation occur.

Always use the appropriate tools listed in the tool list and wear approved safety equipment.

## MODIFICATIONS TO VEHICLE

**WARNING** To prevent personal injury or death to the operator or passenger(s), do not make changes to the weight distribution or the center of gravity which could make the vehicle unstable or prone to roll over.

Do not modify the vehicle in any manner that will change the weight distribution of the vehicle.

## GENERAL MAINTENANCE

**WARNING** To prevent severe injury or death resulting from improper servicing techniques, observe the following Warnings:

**Do not attempt any type of servicing operations before reading and understanding all notes, cautions and warnings in this manual.**

When any maintenance procedure or inspection is performed, it is important that care be exercised to insure the safety of the technician/mechanic or bystanders and to prevent damage to the vehicle.

Always read and understand the **entire** relevant manual section (chapter) before attempting any inspection or service.

# SAFETY

Read all of Section A and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

## BEFORE SERVICING THE VEHICLE

Before attempting to inspect or service a vehicle, be sure to read and understand the following warnings:



**To prevent personal injury or death, observe the following:**

**ing:**

**Before working on vehicle, remove all jewelry (watches, rings, etc.).**

**Be sure that no loose clothing or hair can become caught in the moving parts of the powertrain.**

**Use care not to contact hot objects.**

**Any servicing requiring adjustments to be made to the powertrain while the motor is running must be made with both wheels raised.**

**To prevent the possibility of motor disintegration, never operate vehicle at full throttle for more than 4 - 5 seconds while vehicle is in a "no load" condition.**

**Wear OSHA approved clothing and eye protection when working on anything that could expose the body or eyes to potential injury. In particular, use care when working with or around batteries, compressed air or solvents.**

**Always turn the key switch to 'OFF' and remove the key before disconnecting a live circuit.**

**When connecting battery cables, pay particular attention to the polarity of the battery terminals. Never confuse the positive and negative cables.**

**The parking 'PARK' brake should always be set, except for cases where the powertrain must be allowed to rotate or service is being performed on the brake system.**

**If repairs are to be made that will require welding or cutting, the batteries must be removed.**

### Additional Warnings

Before working on the electrical system, be sure to read and understand the following warnings that pertain to electrical system repair or maintenance:



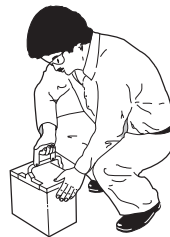
**To prevent battery explosion that could result in severe personal injury or death, keep all smoking materials, open flame or sparks away from the batteries.**

**Hydrogen gas is generated in the charging cycle of batteries and is explosive in concentrations as low as 4%. Because hydrogen gas is lighter than air, it will collect in the ceiling of buildings necessitating proper ventilation. Five air exchanges per hour is considered the minimum requirement.**

**Be sure that the key switch is off and all electrical accessories are turned off before starting work on vehicle.**

**Batteries should always be removed before any servicing or repairs that could generate sparks.**

**Never disconnect a circuit under load at a battery terminal.**



**Batteries are heavy. Use proper lifting techniques when moving them. Always lift the battery with a commercially available battery lifting device. Use care not to tip batteries when removing or installing them; spilled electrolyte can cause burns and damage.**

**The electrolyte in a storage battery is an acid solution which can cause severe burns to the skin and eyes. Treat all electrolyte spills to the body and eyes with extended flushing with clear water. Contact a physician immediately.**



**Wear eye protection when working on the vehicle. In particular, use care when working around batteries, or using solvents or compressed air.**

**Any electrolyte spills should be neutralized with a solution of 1/4 cup (60 ml) sodium bicarbonate (baking soda) dissolved in 1 1/2 gallons (6 liters) of water**

Read all of Section A and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

and flushed with water.



**Wrap wrenches with vinyl tape to prevent the possibility of a dropped wrench from 'shorting out' a battery, which could result in an explosion and severe personal injury or death.**

**Aerosol containers of battery terminal protectant must be used with extreme care. Insulate metal container to prevent can from contacting battery terminals which could result in an explosion.**

**CAUTION** Overfilling batteries may result in electrolyte being expelled from the battery during the charge cycle. Expelled electrolyte may cause damage to the vehicle and storage facility.

## BATTERY REMOVAL & INSTALLATION

Tool List	Qty. Required
Insulated wrench, 1/2".....	1
Socket, 1/2", 3/8" drive.....	1
Ratchet, 3/8" drive.....	1
Battery carrier .....	1
Torque wrench (in. lbs.), 3/8" drive.....	1

**NOTE** In the following text, there are references to removing/installing bolts etc. Additional hardware (nuts, washers etc.) that are removed must always be installed in its original position unless otherwise specified. Non-specified torques are as shown in table contained in Section "A".

**CAUTION** Before any electrical service is performed on 48 volt model vehicles, the Run-Tow/Maintenance switch must be placed in the 'Tow/Maintenance' position.

If a power wire (battery, motor or controller) is disconnected for any reason on the 48 volt model vehicle, the Run-Tow/Maintenance switch must be left in the 'Tow/Maintenance' position for at least 30 seconds after the circuit is restored.

Turn vehicle key to 'OFF' and remove. Insure all optional electrical accessories are turned OFF.

Using an insulated wrench, remove the negative (-) cable first, the positive (+) cable and then all other cables from

the vehicle batteries. Remove the battery hold down by removing the hardware and lifting the retainer from the batteries.

Remove the batteries using a commercial battery carrier.

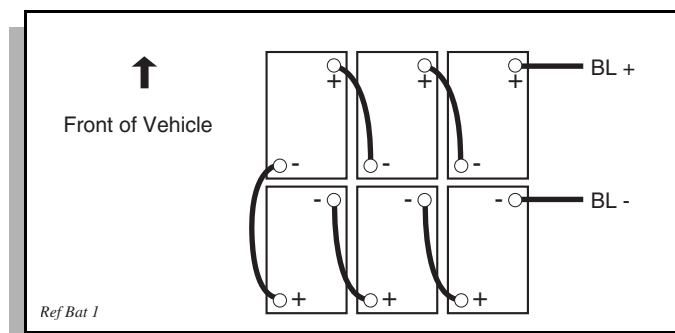
If the batteries have been cleaned and any acid in the battery rack area neutralized on a regular basis, no corrosion to the battery racks or surrounding area should be present. If any corrosion is found, it should be immediately removed with a putty knife and wire brush. The area should be washed with a solution of sodium bicarbonate (baking soda) and water and thoroughly dried before priming and painting with a corrosion resistant paint.

Place batteries into the battery rack. Install the battery hold downs and tighten to 45 - 55 in. lbs. (5 - 6 Nm) torque, to prevent movement but not tight enough to cause distortion of the battery cases.

Inspect all wires and terminals and clean any corrosion from the battery terminals or the wire terminals with a solution of sodium bicarbonate (baking soda) and wire brush if required.

**! WARNING !** **Aerosol containers of battery terminal protectant must be used with extreme care. Insulate metal container to prevent can from contacting battery terminals which could result in an explosion.**

Use care to connect battery cables as shown in the following illustration (Ref Fig. 1 on page B-7)(Ref Fig. 2 on page B-8). **Connect the positive (+) battery cable first**, other battery connecting cables, and then **connect the negative (-) cable last**. Ensure that all battery terminals are installed with crimp up. Tighten the battery post hardware to 90 - 110 in. lbs. (10 - 12 Nm). Protect the battery terminals and battery cable terminals with a commercially available protective coating.



**Fig. 1 36 Volt Battery Connections**

# SAFETY

Read all of Section A and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

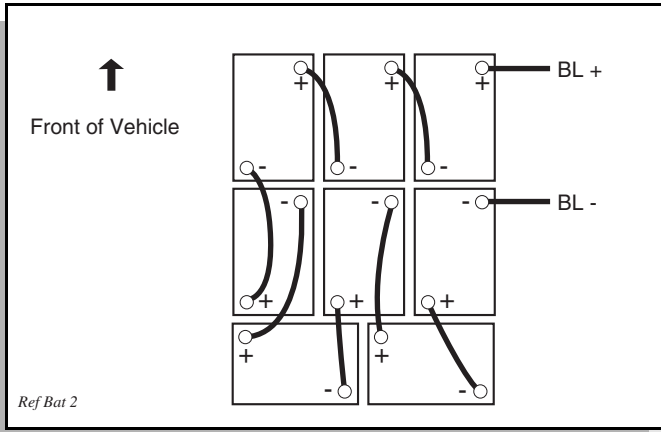


Fig. 2 48 Volt Battery Connections

## LIFTING THE VEHICLE

Tool List	Qty. Required
Floor jack .....	1
Jack stands.....	4
Chocks.....	4

Some servicing operations may require the vehicle be raised.

**⚠ WARNING ⚠** *To prevent possible injury or death resulting from a vehicle falling from a jack, be sure the vehicle is on a firm and level surface. Never get under a vehicle while it is supported by a jack. Use jack stands and test the stability of the vehicle on the stands. Always place chocks in front and behind the wheels not being raised. Use extreme care since the vehicle is extremely unstable during the lifting process.*

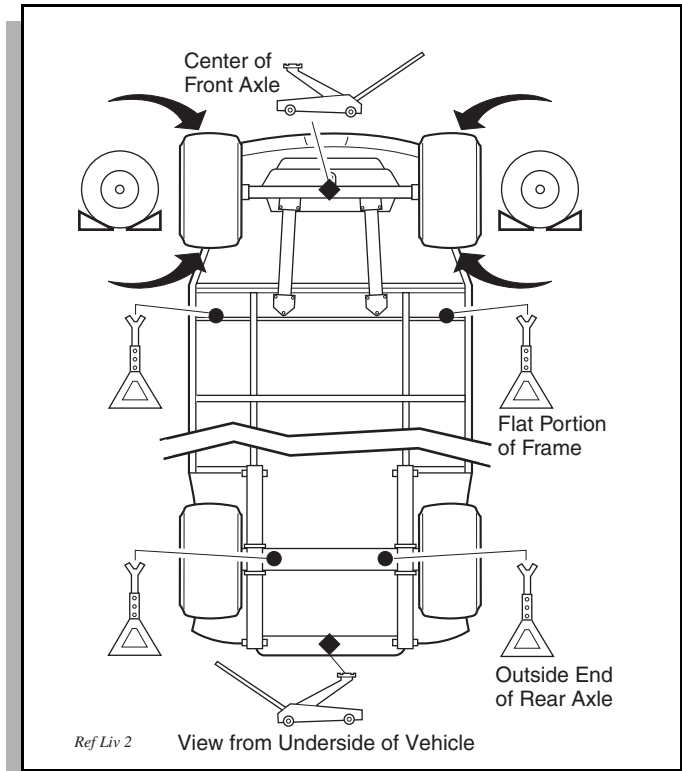


Fig. 3 Lifting the Vehicle

**CAUTION** When lifting the vehicle, position jack stands only in the areas indicated.

## **SAFETY**

*Read all of Section A and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings*

To raise the entire vehicle, install chocks in front and behind each front wheel (Ref Fig. 3 on page B-8). Center jack under the rear frame crossmember. Raise vehicle and locate a jack stand under outer ends of rear axle.

Lower the jack and test the stability of the vehicle on the two jack stands.

Place the jack at the center of the front axle. Raise the vehicle and position jack stands under the inner frame member as indicated.

Lower the jack and test the stability of the vehicle on the four jack stands.

If only the front or rear of the vehicle is to be raised, place the chocks in front and behind each wheel not being raised in order to stabilize the vehicle.

Lower the vehicle by reversing the lifting sequence





**BODY**

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## BODY

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

### BODY

**NOTE** In the following text, there are references to removing/installing bolts etc. Additional hardware (nuts, washers etc.) that are removed must always be installed in their original positions unless otherwise specified. Non-specified torques are as shown in the table in Section A.

#### General

**⚠ WARNING ⚠** To prevent possible injury or death from battery explosion, batteries should always be removed before any servicing that will generate sparks.

*It is important to use a sharp drill bit when removing the rivets on the side of the vehicle. Extreme care must be used when drilling out the rivets located in the front of the body and the bottom side of the body. Excessive pressure could result in the drill bit being forced through the body panel and penetrating a battery. As extra protection, it is recommended that a protective piece of sheet metal be placed between the battery and the rivet. Use of a drill depth stop will provide additional protection.*

In general, body component replacement can be accomplished with a minimum of specialized tools. Most body components are held in place with conventional removable hardware (nuts, bolts, washers and screws). Some components are mounted with 'pop' rivets which require that the rivet head be removed in order to push out the shank of the rivet. The rivet head is easily removed by

drilling into the head with a **sharp** drill bit that is **slightly** larger than the shank of the rivet (Ref Fig. 1 on page C-1). Care must be exercised when drilling to prevent the drill from being forced through and damaging components where it could damage components located immediately behind the rivet. The best way to prevent this from occurring is to use a sharp drill bit that requires very little pressure to cut successfully and to place a piece of protective sheet metal between the surface being drilled and components directly behind it.

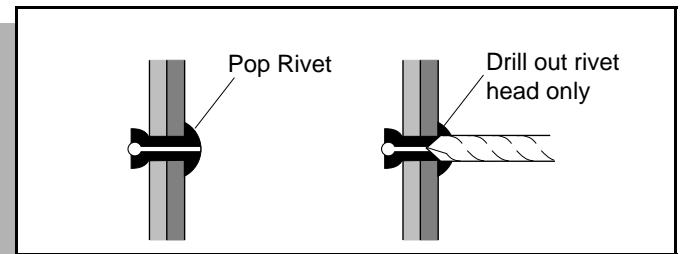


Fig. 1 Drill Out Metal Rivet

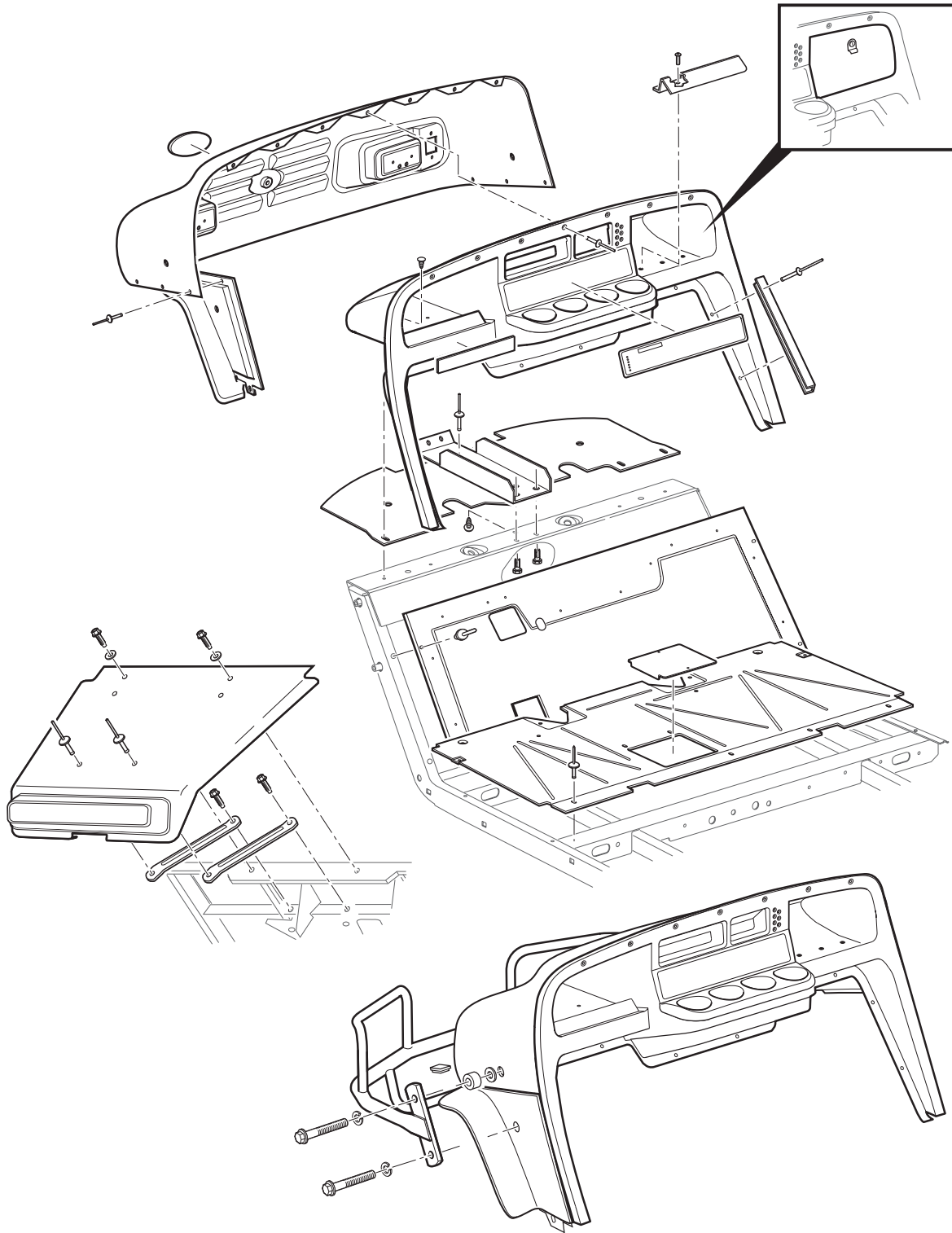
### BODY COMPONENT REPLACEMENT

The body components can be replaced by removing the securing hardware, replacing the component and securing with hardware in the same orientation as removed. The illustrations on the following pages indicate the assembly methods for the various components.

**NOTE** If the instrument panel is to be replaced, the serial number plate and CE plate must be removed and reinstalled on the new instrument panel (Ref Fig. 2 on page C-2)

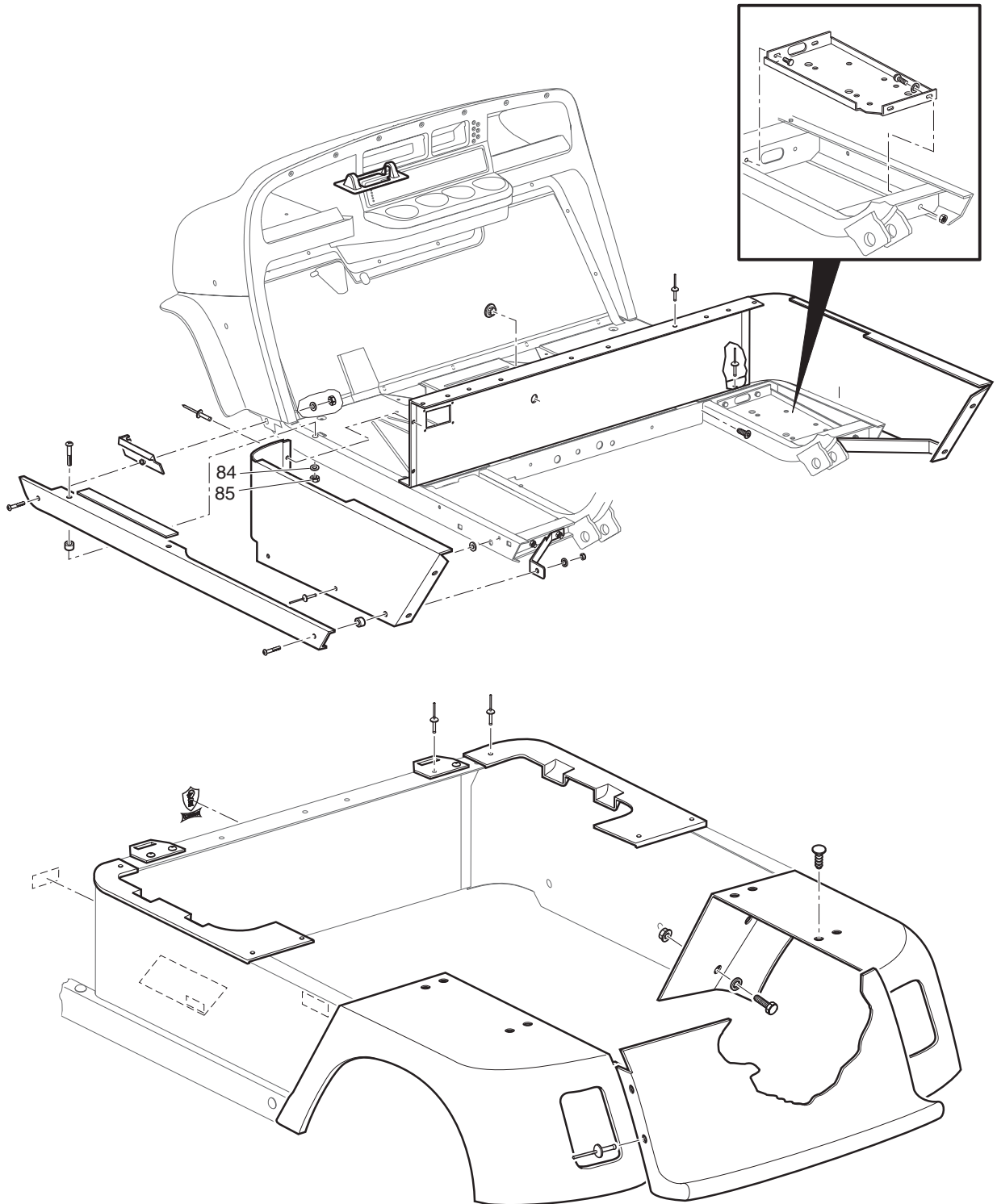
# BODY

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings



**Fig. 2 Body Components (Front)**

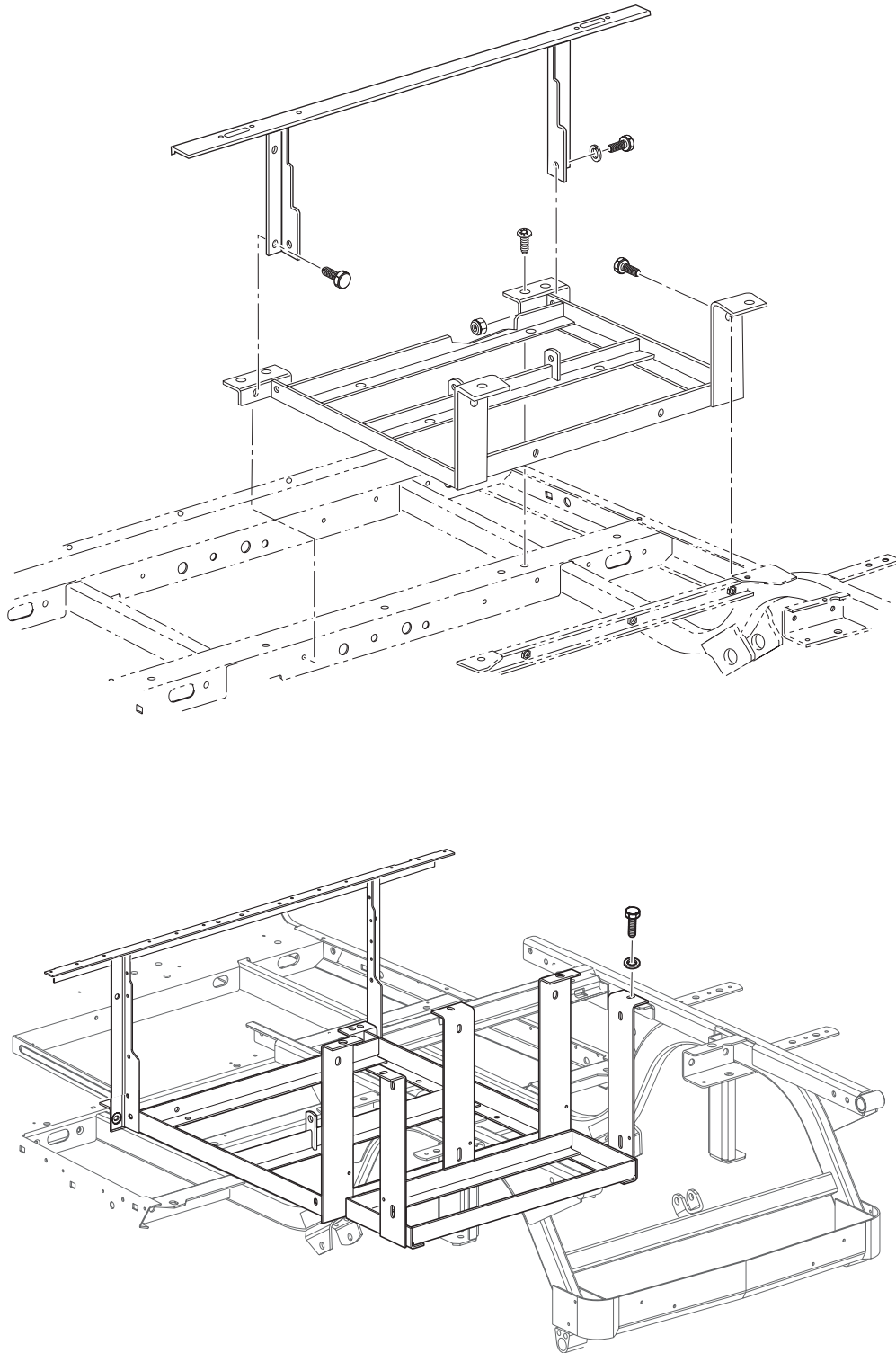
Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings



**Fig. 3 Body Components (Rear)**

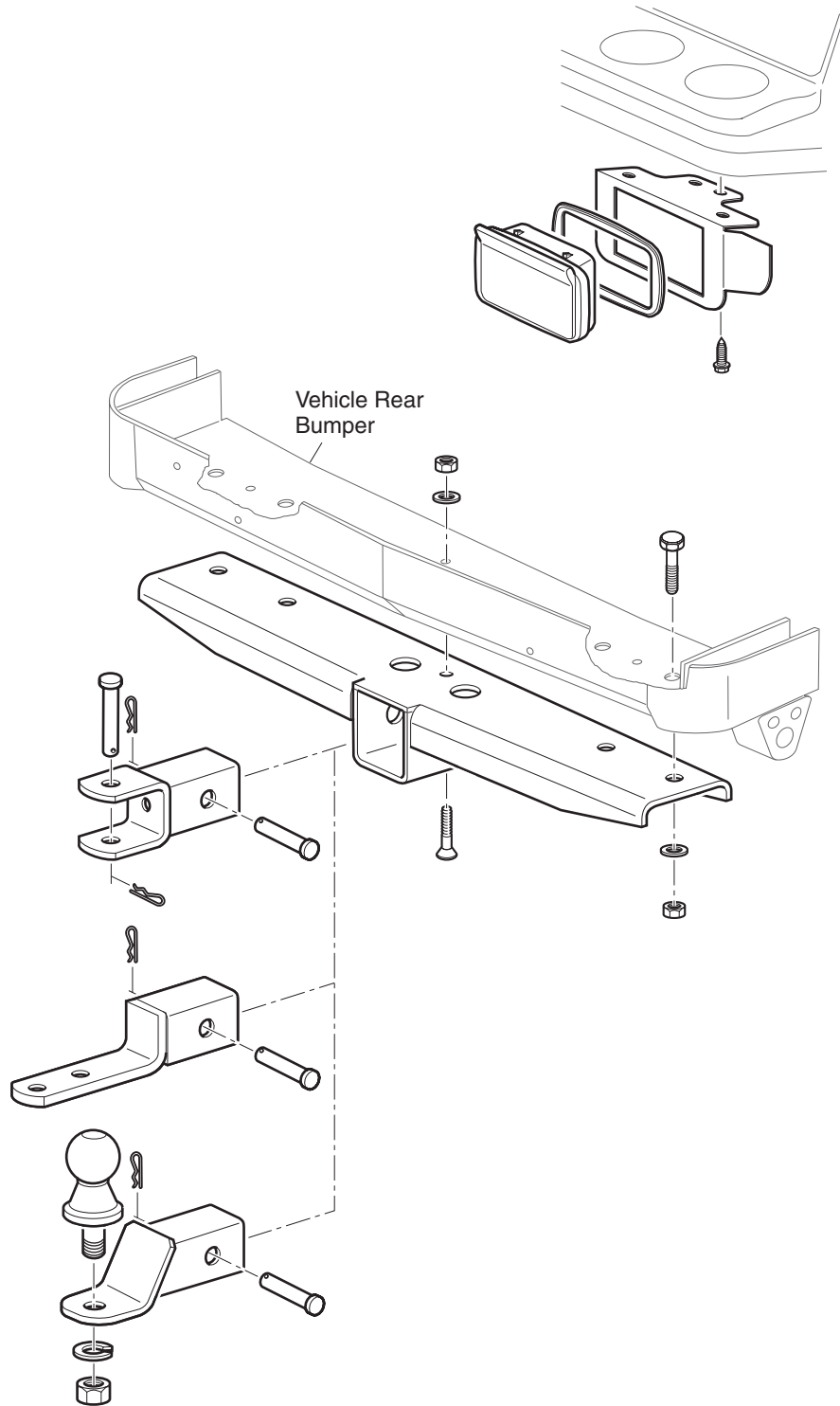
# BODY

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings



**Fig. 4 Battery Rack Components**

*Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings*



**Fig. 5 Ashtray and Hitches**

# BODY

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

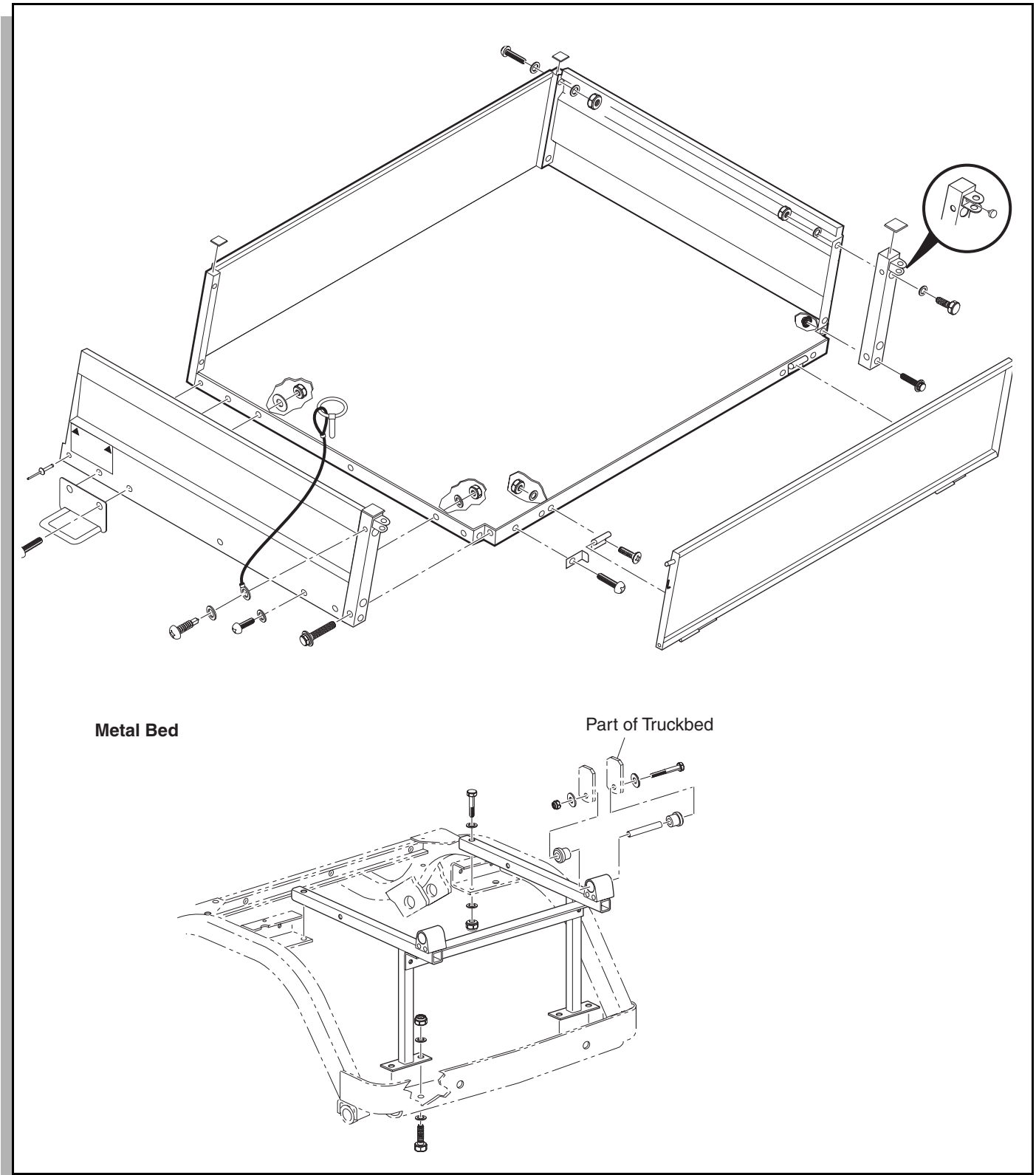
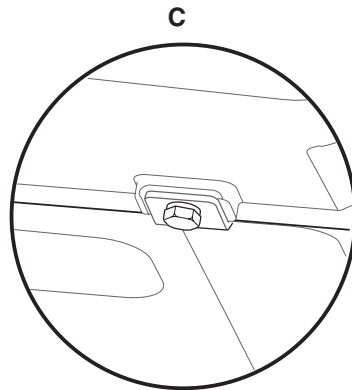
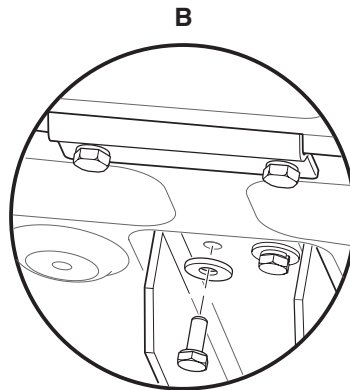
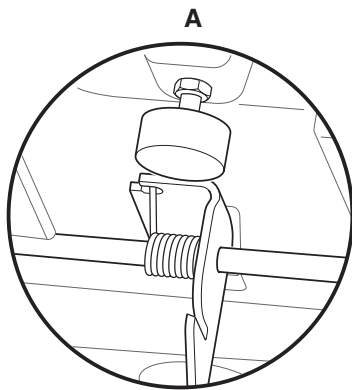
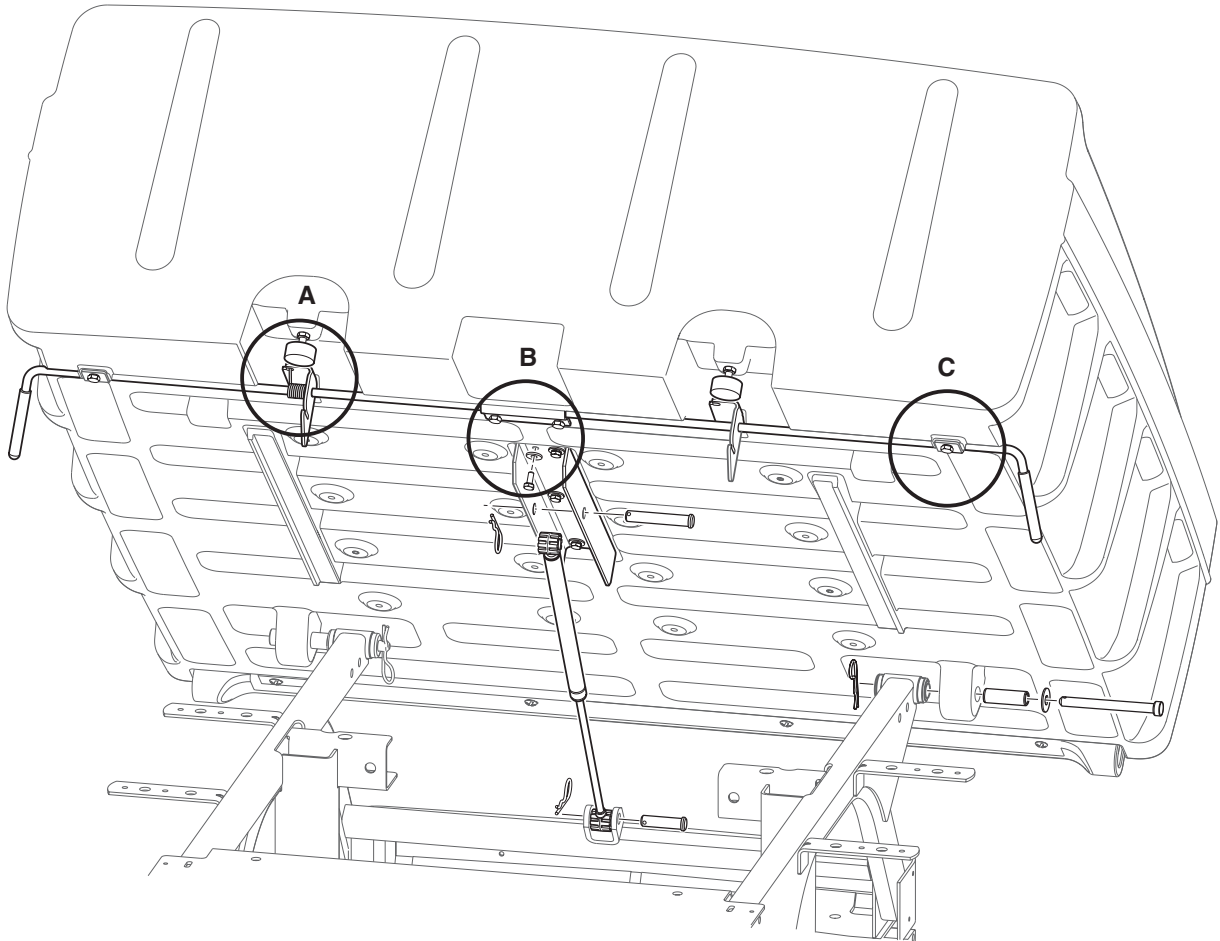


Fig. 6 Metal Truckbed

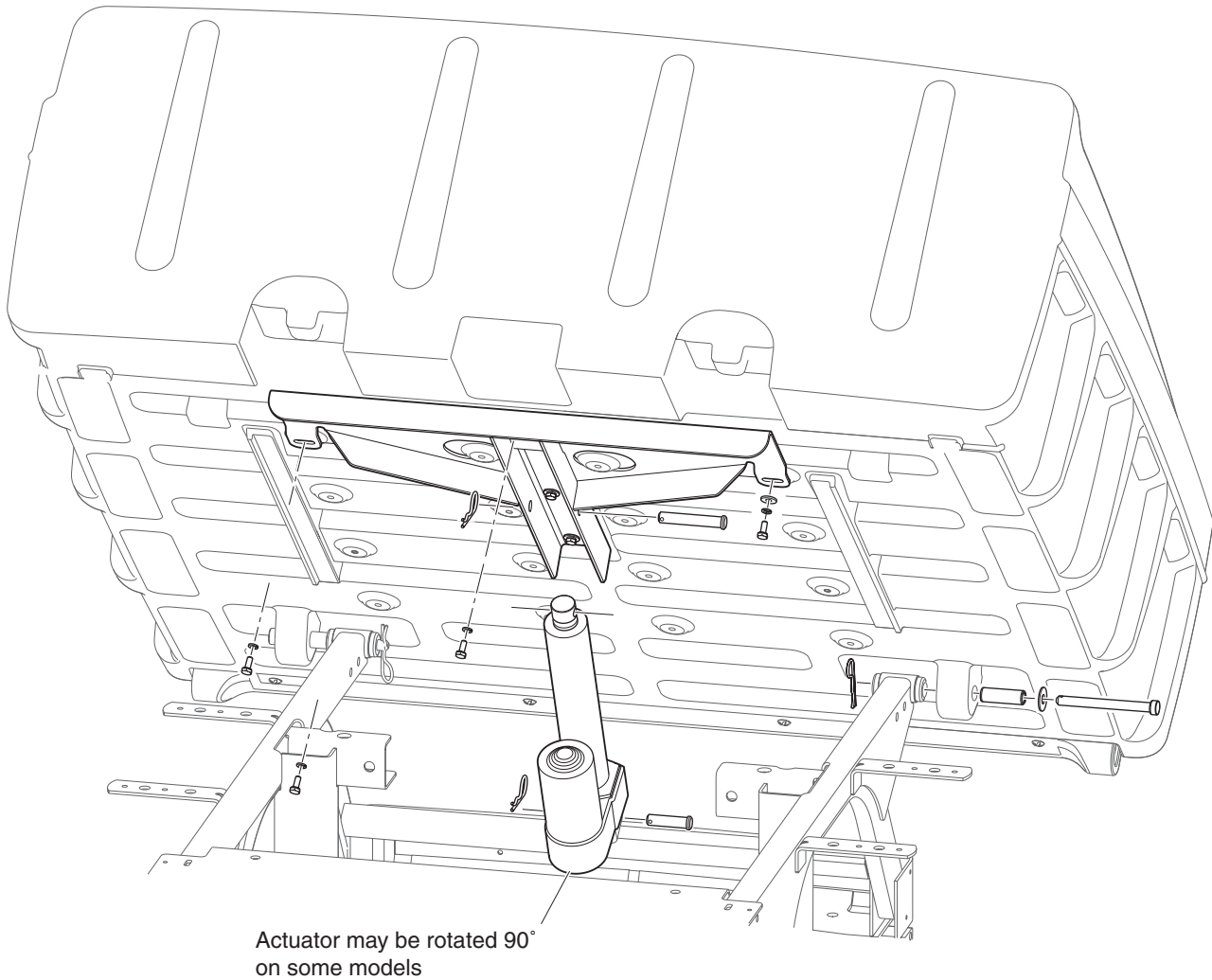
Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings



**Fig. 7 Plastic Truckbed**

## BODY

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings



**Fig. 8 Electric Dump**



# WHEELS AND TIRES



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# WHEELS AND TIRES

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

## WHEEL AND TIRE SERVICE

Tools List	Qty. Required
Lug wrench, 3/4" .....	1
Impact wrench, 1/2" drive.....	1
Impact socket, 3/4", 1/2" drive.....	1
Torque wrench, 1/2" drive, ft. lbs. ....	1

**⚠ WARNING ⚠** *To prevent injury caused by a broken socket, use only sockets designed for impact wrench use. Never use a conventional socket.*

Tire condition should be inspected on a daily basis. Inflation pressures should be checked on a weekly basis when tires are cool. When removing wheels with an impact wrench, use only impact sockets. Regular sockets are not designed for impact pressures exerted by power tools.

**⚠ WARNING ⚠** *A tire explosion can cause severe injury or death. Never exceed inflation pressure rating on tire sidewall.*

*To prevent tire explosion, pressurize tire with small amount of air applied intermittently to seat beads. Never exceed the tire manufacturer's recommendation when seating a bead. Protect face and eyes from escaping air when removing valve core.*

*Use caution when inflating tires. Due to the low volume of these small tires, overinflation can occur in a matter of seconds. Overinflation could cause the tire to separate from the wheel or cause the tire to explode, either of which could cause personal injury.*

Use caution when inflating tires. Due to the low volume of these small tires, overinflation can occur in a matter of seconds. Overinflation could cause the tire to separate from the rim or cause the tire to explode, either of which could cause personal injury.

Tire inflation should be determined by the condition of the terrain. See GENERAL SPECIFICATIONS section for recommended tire inflation pressure. For outdoor applications with major use on grassy areas, the following should be considered. On hard turf, it is desirable to have a **slightly** higher inflation pressure. On very soft turf, a lower pressure prevents tires from cutting into the turf. For vehicles being used on paved or hard surfaces, tire

inflation pressure should be in the higher allowable range, but under no condition should inflation pressure be higher than recommended on tire sidewall. **All four tires** should have the same pressure for optimum handling characteristics. Be careful not to overinflate. Due to the low volume of these small tires, overinflation can occur in a matter of seconds. Be sure to install the valve dust cap after checking or inflating.

### Tire Repair

The vehicle is fitted with low pressure tubeless tires mounted on one piece rims.

Generally, the most cost effective way to repair a flat tire resulting from a puncture in the tread portion of the tire is to use a commercial tire plug.

**NOTE** *Tire plug tools and plugs are available at most automotive parts outlets and have the advantage of not requiring the tire be removed from the wheel.*

If the tire is flat, remove the wheel and inflate the tire to the maximum recommended pressure for the tire. Immerse the tire in water to locate the leak and mark with chalk. Insert tire plug in accordance with manufacturer's specifications.

If tire is to be removed or mounted, the tire changing machine manufacturer's recommendations must be followed in order to minimize possibility of personal injury.

**⚠ WARNING ⚠** *To prevent injury, be sure mounting/demounting machine is anchored to floor. Wear OSHA approved safety equipment when mounting/demounting tires.*

Follow all instructions and safety warnings provided by the mounting/demounting machine manufacturer.

### Wheel Installation

**CAUTION** Do not tighten lug nuts to more than 85 ft. lbs. (115 Nm) torque.

**NOTE** *It is important to follow the 'cross sequence' pattern when installing lug nuts. This will assure even seating of the wheel against the hub.*

With the valve stem to the outside, mount the wheel onto the hub with lug nuts. Finger tighten lug nuts as shown (Ref Fig. 1 on page D-2). Then, tighten lug nuts to 50 - 85 ft. lbs. (70 - 115 Nm) torque in 20 ft. lbs. (30 Nm) increments following the same pattern.

# WHEELS AND TIRES

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Wheel and/or Tire style may vary

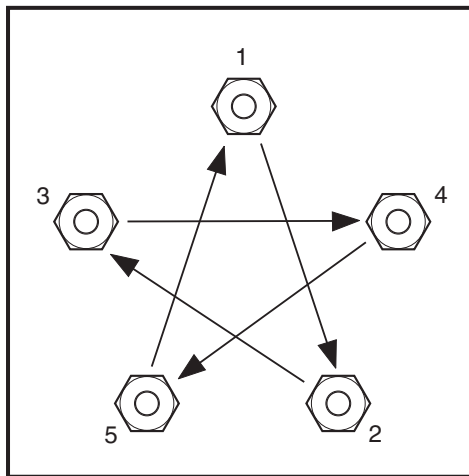
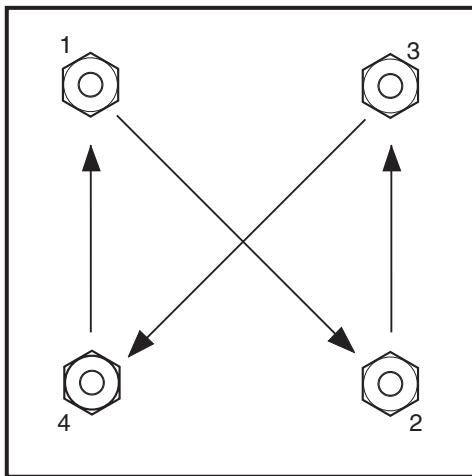
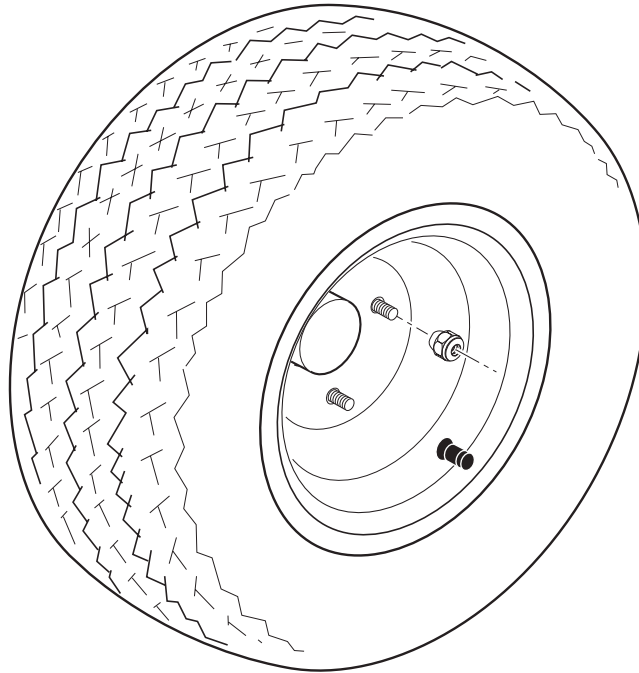


Fig. 1 Wheels and Tires

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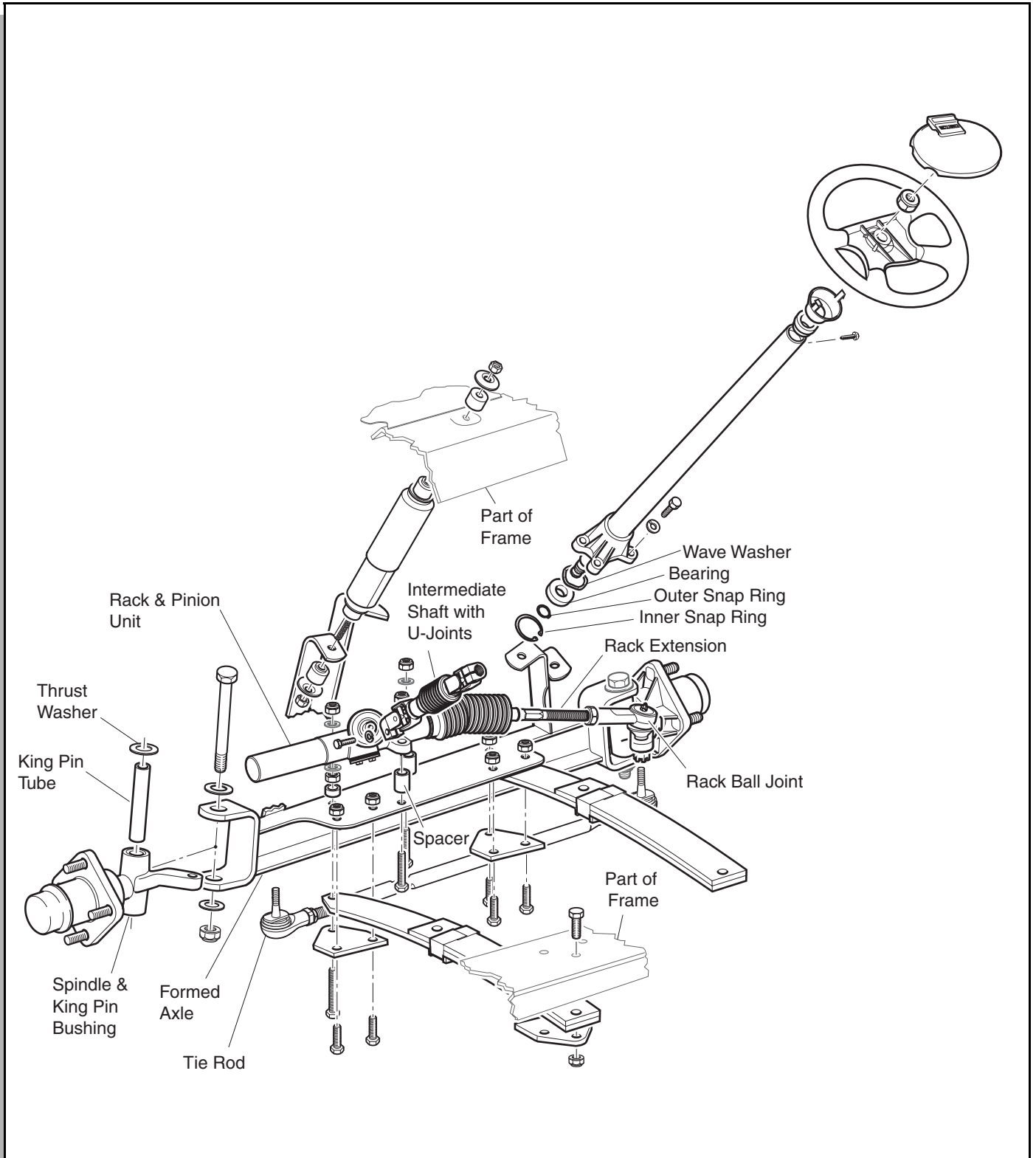
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# FRONT SUSPENSION AND STEERING



Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings



**Fig. 1 Axle Mounted Steering and Front Suspension**

# FRONT SUSPENSION AND STEERING

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## MAINTENANCE

**NOTE** In the following text, there are references to removing/installing bolts etc. Additional hardware (nuts, washers etc.) that is removed must always be installed in its original position unless otherwise specified. Non-specified torque specifications are as shown in the table contained in Section A.

Routine maintenance of the front suspension and steering consists of:

- periodic inspections for loose, worn or damaged components
- alignment checks
- lubrication of ball joints and wheel bearings

See Lubrication Chart and Periodic Service Schedule in Section A. Be sure to use only the recommended lubricants. Maintain correct adjustment of front bearings and repack in accordance with the Periodic Service Schedule or if a bearing replacement is required. Routine examination of tires will provide indications if an alignment is required.

## Lubrication

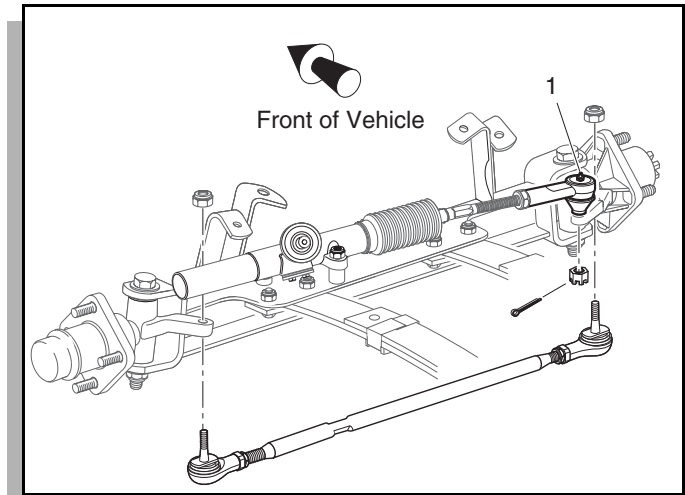
Tool List	Qty. Required
Grease gun.....	1
Shop towels.....	AR

Grease the rack ball joint (1) (Ref Fig. 2 on page E-2) per Periodic Service Schedule in Section A. Wipe off old grease and dirt from grease fitting and do not use more than three (3) pumps of grease in any grease fitting. Wipe off any grease that is forced out of rubber boot.

**CAUTION** Do not use more than three (3) pumps of grease in any grease fitting at any one time. Excess grease may cause grease seals to fail or grease migration into areas that could damage components.

## Wheel Bearing and King Pin Bushing Inspection

**WARNING** To prevent possible injury or death resulting from a vehicle falling from a jack, follow the lifting procedure in Section B of this manual. Be sure vehicle is on a firm and level surface. Never get under a vehicle while it is supported by a jack. Use jack stands and test stability of vehicle on stands before starting any repair procedure. Always place chocks in front and behind wheels not being raised. Use extreme care since the vehicle is extremely unstable during the lifting process.



**Fig. 2 Lubrication Points**

Lift the front of the vehicle and support on jack stands as per SAFETY section. Rotate the front wheel and feel for any roughness. While holding spindle with one hand, grasp bottom of tire with other hand and rock tire back and forth on spindle.

**NOTE** Some minor rocking movement of tire is normal.

If excess movement is detected, the wheel bearing may require repacking and adjusting or replacement. See 'Wheel Bearing Packing' on page E-2. See 'Wheel Bearing Adjustment' on page E-3.

If the wheel bearing is satisfactory, a worn spindle bearing, which is not a serviceable item, is indicated and the spindle must be replaced. See 'Spindle Replacement' on page E-13.

## Wheel Bearing Packing

Tool List	Qty. Required
Grease gun.....	1
Bearing packer (Recommended).....	1

Remove hub from spindle and disassemble. See 'Wheel Bearing and Race Replacement' on page E-8.

Clean all bearings, grease seal, hub and dust cap in solvent and dry thoroughly. Inspect for signs of damage. Pitting or a blue coloration of the rollers will require replacement of the bearing. If the roller portion of the bearing is to be replaced, the race must also be replaced. See 'Wheel Bearing and Race Replacement' on page E-8.

The front wheel bearings are tapered roller type and must be packed with grease at installation or any time



# FRONT SUSPENSION AND STEERING

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the bearing is removed for inspection. It is recommended that a bearing packer attached to a grease gun be used; however, manual packing is acceptable if done correctly. To pack a bearing manually requires that a dab of grease be placed in the palm of the hand and the bearing be dipped in the grease. Force the grease up through and around all of the rollers until the entire bearing is saturated in grease.

Assemble hub and install on spindle. See 'Hub Replacement' on page E-8.

**NOTE** Once hub is placed onto spindle and before outer wheel bearing is installed, fill the area between the inner and outer wheel bearings about 1/2 - 3/4 full with grease.

## Wheel Bearing Adjustment

Tool List	Qty. Required
Socket, 1 1/2", 1/2" drive.....	1
Ratchet, 1/2" drive.....	1
Torque wrench, 1/2" drive, ft. lbs.....	1
Adapter, 3/8" drive to 1/2".....	1
Torque wrench, 3/8" drive, in. lbs.....	1

If performing a wheel bearing adjustment only, lift and support front of vehicle per SAFETY section. Remove dust cap (1) and cotter pin (2) and loosen castellated nut (3).

If performing a wheel bearing adjustment as part of another procedure, make sure wheel is mounted to hub hand tight with lug nuts (4) and hub is loosely retained on spindle (5) with castellated nut (Ref Fig. 3 on page E-3).

Seat bearings by rotating wheel while tightening castellated nut until slight resistance is felt.

Rotate the wheel 2 - 3 more turns to displace excess grease. If required, tighten castellated nut (3) again until slight resistance is felt. If the cotter pin hole in the spindle (5) aligns with a slot in the castellated nut, insert a new cotter pin (2). If the hole does not align, the castellated nut must be **loosened** to align with the **closest available** slot in the nut.

Check for smooth and free rotation of the wheel and an absence of play when the wheel is grasped by the outside of the tire. Bend the cotter pin (2) against the flats of the castellated nut (3).

Replace the dust cap (1) and lower vehicle per SAFETY section.

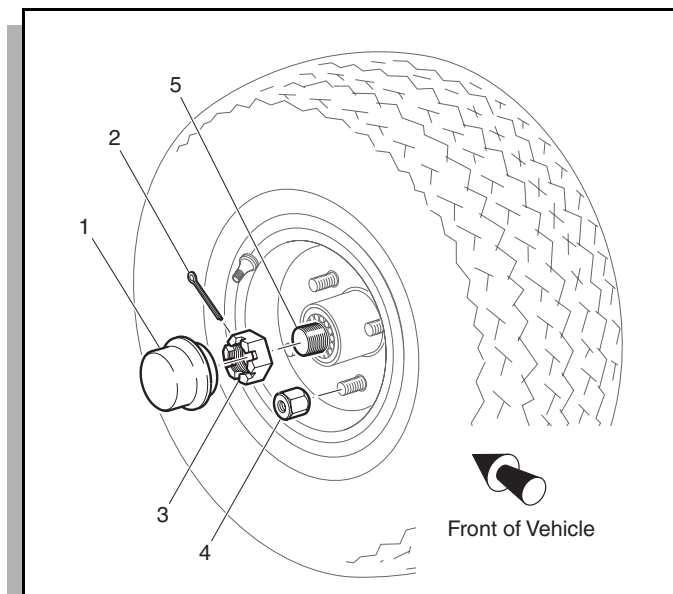


Fig. 3 Bearing Adjustment

If completing a wheel bearing adjustment as part of another procedure, tighten front wheels per WHEELS AND TIRES section.

## Wheel Alignment

Tool List	Qty. Required
Tape measure.....	1
Chalk.....	1
Wrench, 9/16".....	1
Wrench, 3/4".....	1
Crowfoot socket, 3/4", 1/2" drive.....	1
Torque wrench, 1/2" drive, ft. lbs.....	1
Socket, 13 mm, 3/8" drive.....	1
Ratchet, 3/8" drive.....	1
Torque wrench, 3/8" drive, in. lbs.....	1

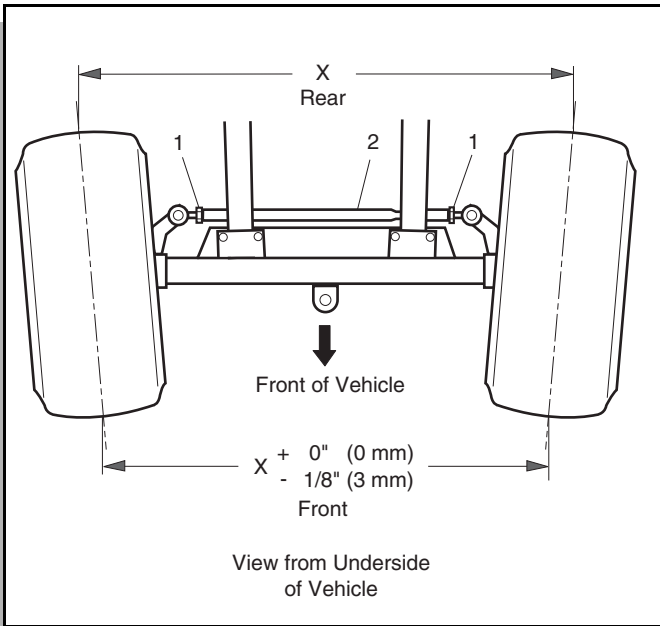
Lift the front of the vehicle and support on jack stands as per SAFETY section. Confirm the alignment of the front springs. See 'Front Spring Replacement' on page E-6.

Rotate each wheel and scribe a chalk line around the circumference of the tire at the center of the tread pattern. Lower vehicle and, with tires in the straight ahead position, roll it forward approximately five feet in order to allow the tires to take their normal running position.

Measure the distance between the chalk lines at both the front and rear of the tires (Ref Fig. 4 on page E-4). The measurement taken at the front of the tires should be 0" - 1/8" (0 - 3 mm) less than the rear.

# FRONT SUSPENSION AND STEERING

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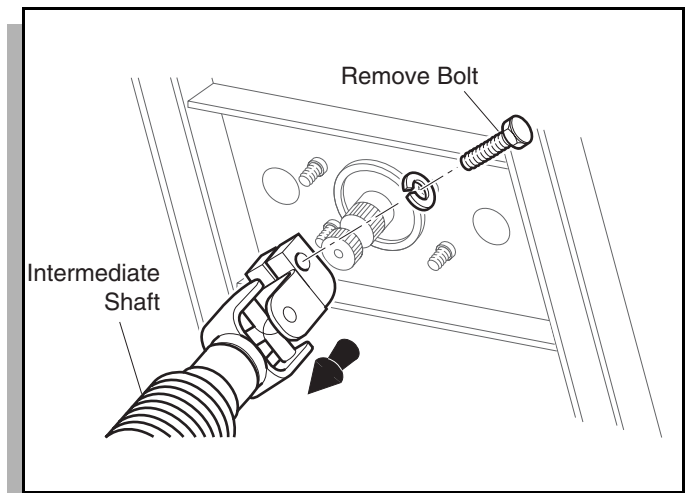
**Fig. 4 Wheel Alignment**

**NOTE** To hold threaded tube while loosening jam nut, use a wrench on the center, flat section of tube.

The tie rod has different threads on each end. The end **with** the flat area on the threaded tube has left hand threads (clockwise to loosen) while the end **without** the flat has conventional right hand threads (counter-clockwise to loosen).

To adjust wheel alignment, loosen tie rod jam nuts (1) and turn tie rod (2) until correct alignment is achieved. Tighten jam nuts to 36 - 40 ft. lbs. (49 - 54 Nm) torque.

Test drive vehicle and confirm steering wheel is correctly centered. If it is not centered, disconnect intermediate shaft from steering shaft and center steering wheel (Ref Fig. 5 on page E-4). Reconnect intermediate shaft and tighten bolt to 155 - 215 in. lbs. (180 - 250 kg cm) torque.

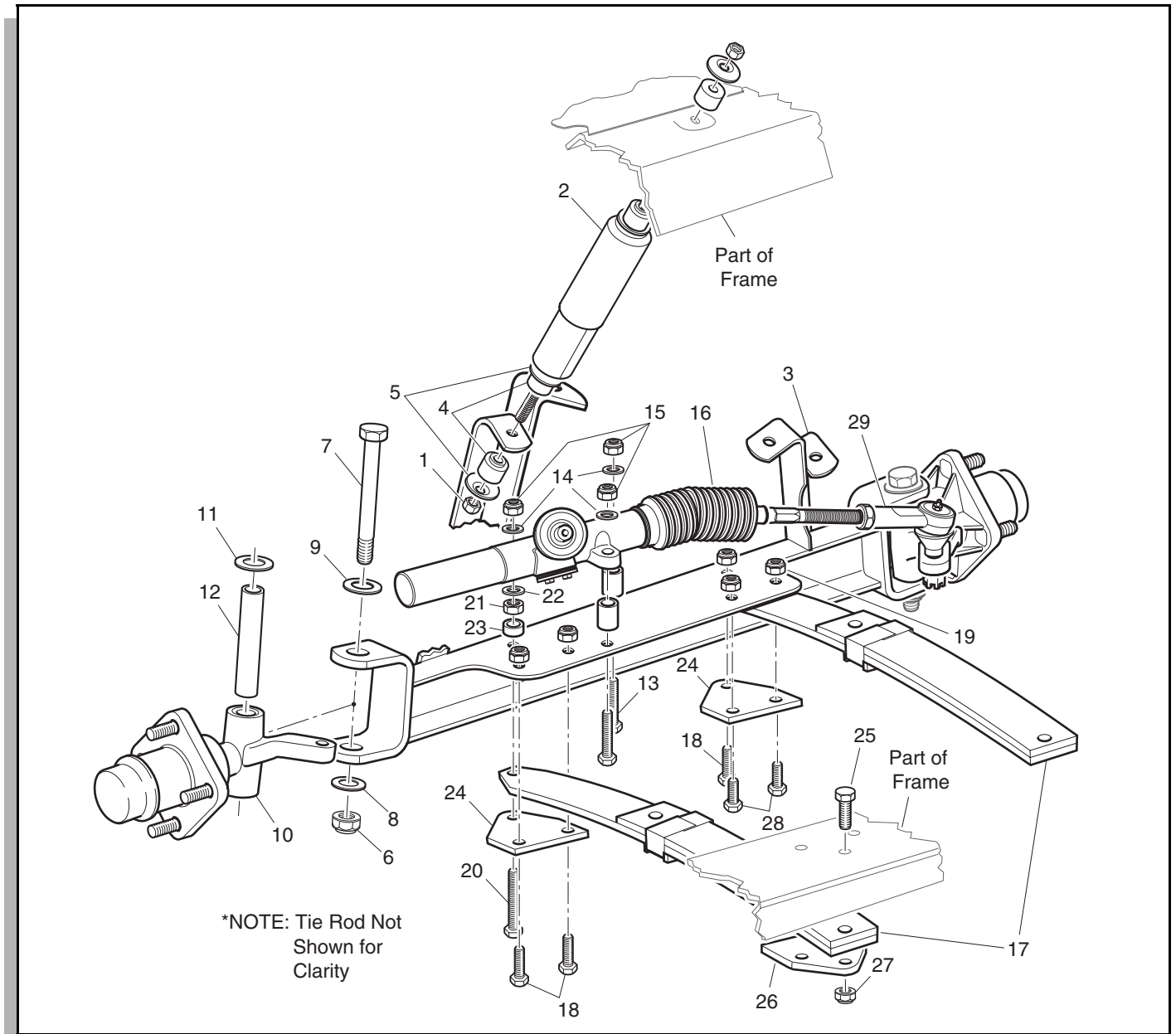


**Fig. 5 Disconnect Intermediate Shaft to Center Steering Wheel**

# FRONT SUSPENSION AND STEERING

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## FRONT SUSPENSION



**Fig. 6 Front Suspension Components**

### Front Shock Absorber Replacement

Tool List	Qty. Required
Wrench, 9/16" .....	1
Remove the nut (1) from the bottom of the shock absorber (2) at the front axle (3) (Ref Fig. 6 on page E-5).	
Compress shock absorber to clear the mounting bracket.	

Loosen the nut securing the top of the shock absorber to the vehicle frame and then rotate the shock absorber while holding the nut in place with a wrench.

Remove the shock absorber.

Installation of shock absorber is reverse of disassembly. Mounting nuts should be tightened until rubber bushings (4) expand to diameter of shock absorber washers (5).

# FRONT SUSPENSION AND STEERING

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## Front Axle Replacement

Tool List	Qty. Required
Ratchet, 1/2" drive .....	1
Socket, 3/4", 1/2" drive .....	1
Wrench, 9/16" .....	1
Wrench, 3/4" .....	1
Plastic faced hammer .....	1
Shop towels .....	AR
Wire .....	AR
Wrench, 5/8" .....	1
Wrench, 11/16" .....	1
Socket, 9/16", 1/2" drive .....	1
Socket, 5/8", 1/2" drive .....	1
Torque wrench, 1/2" drive, ft. lbs. ....	1

Loosen front wheels. Lift and support front of vehicle per SAFETY section and remove front wheels.

Remove hardware (1, 4, 5) securing shock absorbers (2) to front axle (3) (Ref Fig. 6 on page E-5).

On the driver side, remove lock nut (6) and washer (8) from bolt (7) and discard nut. Pull bolt (7) and washer (9) from spindle (10) and separate spindle from axle. Remove thrust washer (11) and king pin tube (12) from spindle, wrap towel around spindle and let spindle rest on ground.

Repeat at passenger side letting rack ball joint (29) rest on front spring to support spindle.



**WARNING** To prevent possible injury from falling steering components, secure rack and pinion unit (16) to front springs with wire. This will prevent the intermediate shaft connecting the rack and pinion unit to the steering column from pulling apart due to the weight of the steering system.



**NOTE** The intermediate shaft is assembled with the universal joints set 90° out of phase with each other.

Remove hardware (13 - 15) securing rack and pinion unit (16) to front axle and discard lock nuts (15). Move rack and pinion unit back to rest on top of front springs (17). Secure rack and pinion unit to spring with wire to prevent pulling apart intermediate shaft.

Remove the three 1 3/4" long bolts (18), two 1 1/2" long bolts (28), spring plate (24) and five lock nuts (19) securing axle to springs and discard lock nuts. At the 3 1/2" long bolt (20) securing front of left spring, note location of

washer (22) and remove it from end of bolt. Remove nut (21), 3 1/2" long bolt (20), spring plate (24) and spacer (23) and retain them for assembly at their original locations.

**CAUTION** To prevent stress and possible damage to the rack and pinion unit, the axle must first be mounted to the springs with the hardware (20 - 23) installed in its original location (Ref Fig. 6 on page E-5).

To prevent damage to bellows (16), the two 1 1/2" long bolts (28) must be installed in their original location.

Front axle installation is the reverse order of disassembly using new lock nuts (15, 19). All hardware (18 - 24, 28) must be installed in its original location (Ref Fig. 6 on page E-5).

Tighten leaf spring and rack and pinion unit hardware (13 - 15, 18 - 21, 28) to 35 - 50 ft. lbs (50 - 70 Nm) torque.

Install thrust washers (11), king pin tubes (12), spindles, washers (9) and bolts (7). Tighten new lock nuts (6) to 56 - 70 ft. lbs. (75 - 95 Nm) torque. Check that spindle turns freely on king pin tube after tightening.

Tighten shock absorber mounting hardware until rubber bushings expand to diameter of shock absorber washer.

Install front wheels per WHEELS AND TIRES section and lower vehicle per SAFETY section.

Check front wheel alignment and adjust if necessary. See 'Wheel Alignment' on page E-3.

## Axle Linkage Rod Replacement

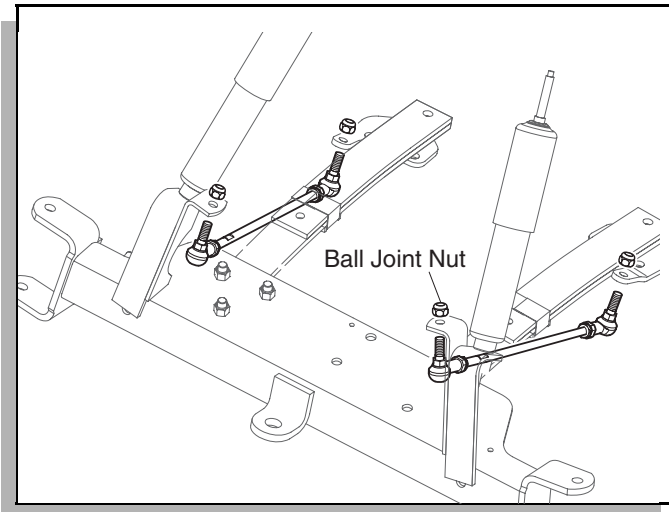
Raise the front of the vehicle (See Lifting Vehicle). Remove old axle linkage rod by removing each ball joint nut (Ref Fig. 7 on page E-7). Check axle alignment (Ref Fig. 8 on page E-7). Adjust length of new axle linkage rod until it will pass through and seat in the hole in the front axle assembly and the rear spring plate without resistance. Tighten the ball joint nuts to 20 - 25 ft. lbs. torque and rod jam nut to 20 - 25 ft. lbs torque. Lower the vehicle.

## Front Spring Replacement

Tool List	Qty. Required
Jack stands .....	4
Ratchet, 1/2" drive .....	1
Socket, 3/4", 1/2" drive .....	1
Socket, 5/8", 1/2" drive .....	1
Wrench, 5/8" .....	1
Torque wrench, 1/2" drive, ft. lbs. ....	1
Tape measure .....	1

# FRONT SUSPENSION AND STEERING

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**Fig. 7 Axle Linkage Rod Replacement**

**NOTE** Failure of a single spring will result in overstressing the other spring; therefore, replace front springs as a set.

The following procedure will replace one spring at a time.

Loosen front wheels. Lift and support front of vehicle per SAFETY section. In addition, support front axle with jack stands. Remove front wheels.

To detach driver side spring:

Fully loosen the two rack and pinion unit lock nuts (15), one near the bellows and one on the rear side of the rack and pinion unit, until only one thread is engaged (Ref Fig. 6 on page E-5). Remove the lock nut (15) and washer (14) from the long bolt (20) and discard lock nut. The rack and pinion unit is now loose.

Remove the two 1 3/4" long bolts (18) and lock nuts (19) securing driver side spring to axle and discard lock nuts (19).

Hold nut (21) with wrench and loosen long bolt (20). Note location of washer (22) and thread long bolt out as far as possible to remove the washer, nut and spacer (23). Then pull long bolt and spring plate (24) from axle and spring. Retain above items (20 - 24) for assembly at their original locations.

Pull upper driver side of floor mat out of plastic trim retainer and away from floor. Locate and remove hardware (25 - 27) securing rear of spring (17) to vehicle frame and discard lock nuts (27).

**CAUTION** To prevent stress and possible damage to the rack and pinion unit, the driver

side spring must be mounted to the axle with the hardware (20 - 23) installed in its original location (Ref Fig. 6 on page E-5).

Driver side spring installation is the reverse order of disassembly making sure to install the long bolt (20), spring plate (24), spacer (23), nut (21) and washer (22) in their original locations. Use new lock nuts (15, 19, 27) to secure the rack and pinion unit (16), two short bolts (18) and rear bolts (25).

To detach passenger side spring:

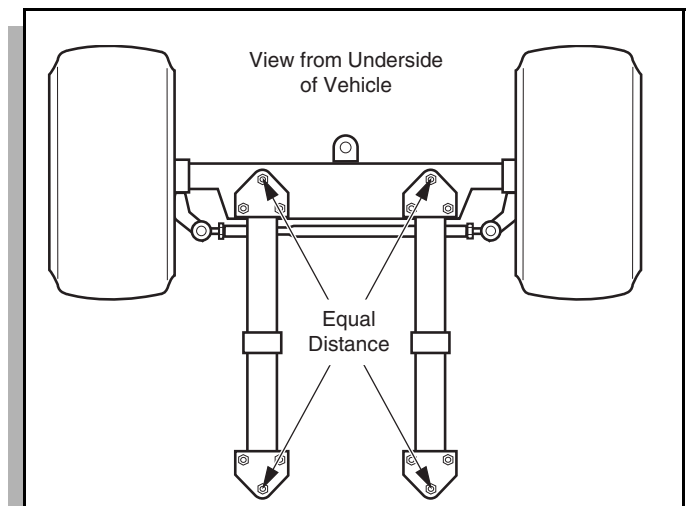
Remove the hardware (18, 19, 24, 28) securing the front of the passenger side leaf spring (17) to the axle (3) and discard lock nuts (19) (Ref Fig. 6 on page E-5).

Pull upper passenger side of floor mat out of plastic trim retainer and away from floor. Locate and remove hardware (25 - 27) securing rear of spring (17) to vehicle frame and discard lock nuts (27).

Using new lock nuts (19, 27), install passenger side spring in the reverse order of disassembly.

**NOTE** After the springs are replaced, the axle will need to be aligned to the frame. Unless the axle has been replaced, wheel alignment will not be affected; however, it is always good practice to check wheel alignment any time the front-end components are replaced or adjusted.

When front springs are replaced, the front axle must be aligned to the frame. The distance from the center bolt at rear of left spring to the center bolt at front of right spring must be the same as the distance from the center bolt at rear of right spring to the center bolt at front of left spring (Ref Fig. 8 on page E-7). Tighten the spring hardware (21, 19, 27) first and rack and pinion unit hardware (15) next to 35 - 50 ft. lbs. (50 - 70 Nm) torque.



**Fig. 8 Front Axle Alignment**

# FRONT SUSPENSION AND STEERING

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Replace upper portion of floor mat in plastic trim retainers. Install front wheels per WHEELS AND TIRES section and lower vehicle per SAFETY section.

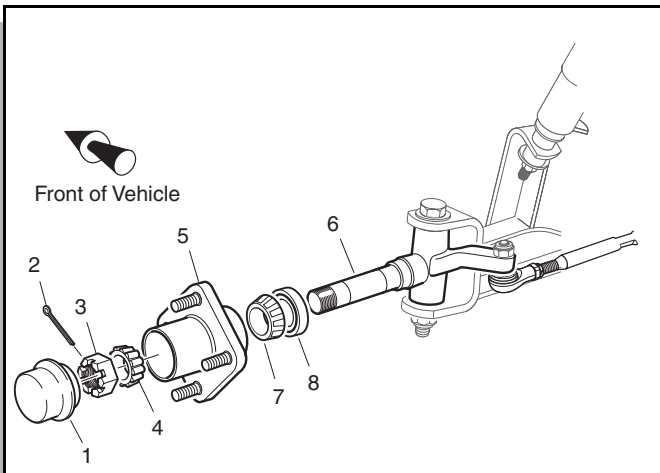
Check front wheel alignment and adjust if necessary. See 'Wheel Alignment' on page E-3.

## Hub Replacement

Tool List	Qty. Required
Socket, 3/4", 1/2" drive .....	1
Ratchet, 1/2" drive .....	1
Straight blade screwdriver .....	1
Ball peen hammer .....	1
Needle nose pliers.....	1
Socket, 1 1/2", 1/2" drive .....	1
Wheel bearing grease .....	AR
Seal driver .....	1

Loosen front wheel(s). Lift and support front of vehicle per SAFETY section and remove front wheel(s).

Remove the dust cap (1), cotter pin (2) and castellated nut (3) (Ref Fig. 9 on page E-8). While holding outer wheel bearing (4) in place, slide hub (5) from spindle (6) and discard.

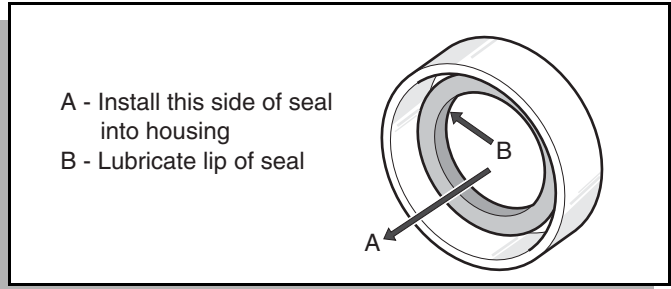


**Fig. 9 Hub Replacement**

Clean spindle and new hub thoroughly with solvent.

Pack new bearings with grease. See 'Wheel Bearing Packing' on page E-2.

Apply a light coat of grease to inner race and place inner wheel bearing (7) in hub. Orient new grease seal (8) so the flange side of the seal is facing into the bore. Tap gently into place until seal is flush with end of hub. Lubricate lips of seal and spindle with grease (Ref Fig. 10 on page E-8).



**Fig. 10 Seal Installation**

Place new hub onto spindle and fill the area between the two wheel bearings about 1/2 - 3/4 full with grease and apply a light coating to the outer bearing race.

Install outer wheel bearing (4) and secure hub loosely with castellated nut. Place wheel onto hub and hand tighten lug nuts.

Adjust bearing. See 'Wheel Bearing Adjustment' on page E-3.

Replace the dust cap (1).

Lower vehicle per SAFETY section and tighten front wheel(s) per WHEELS AND TIRES section.

## Wheel Bearing and Race Replacement

Tool List	Qty. Required
Non-ferrous punch .....	1
Ball peen hammer .....	1
Bearing driver .....	1

Remove hub (1) from spindle (Ref Fig. 11 on page E-9). See 'Hub Replacement' on page E-8.

Remove the grease seal (3), inner wheel bearing (4) and bearing races (5) by tapping, through the other side of hub, the bearing race using a hammer and a soft non-ferrous punch. Tap race in a circular pattern while moving from side to side to avoid damaging bore of hub.

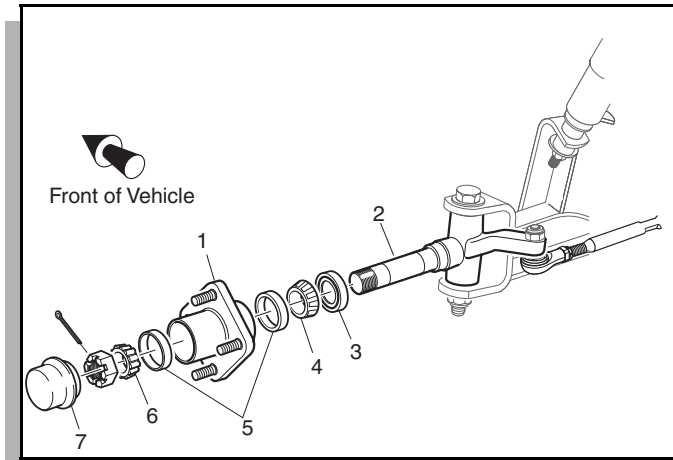
Clean outer wheel bearing (6), inner wheel bearing (4), hub and dust cap (7) in solvent and dry thoroughly. Inspect for signs of damage. Pitting or a blue coloration of the rollers requires replacement of the bearing. If the roller portion of the bearing is to be replaced, the race must also be replaced.

To install race (5), make sure bore of hub (1) is clean and place new race over bore of hub. Evenly tap with hammer and bearing driver to drive race fully in bore. Repeat on other side of hub.

Clean spindle (2) and pack new bearings with grease. See 'Wheel Bearing Packing' on page E-2.

## FRONT SUSPENSION AND STEERING

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings



**Fig. 11 Wheel Bearing Replacement**

Install inner wheel bearing (4) and new grease seal in hub and mount hub to spindle. See 'Hub Replacement' on page E-8. Adjust bearing. See 'Wheel Bearing Adjustment' on page E-3.

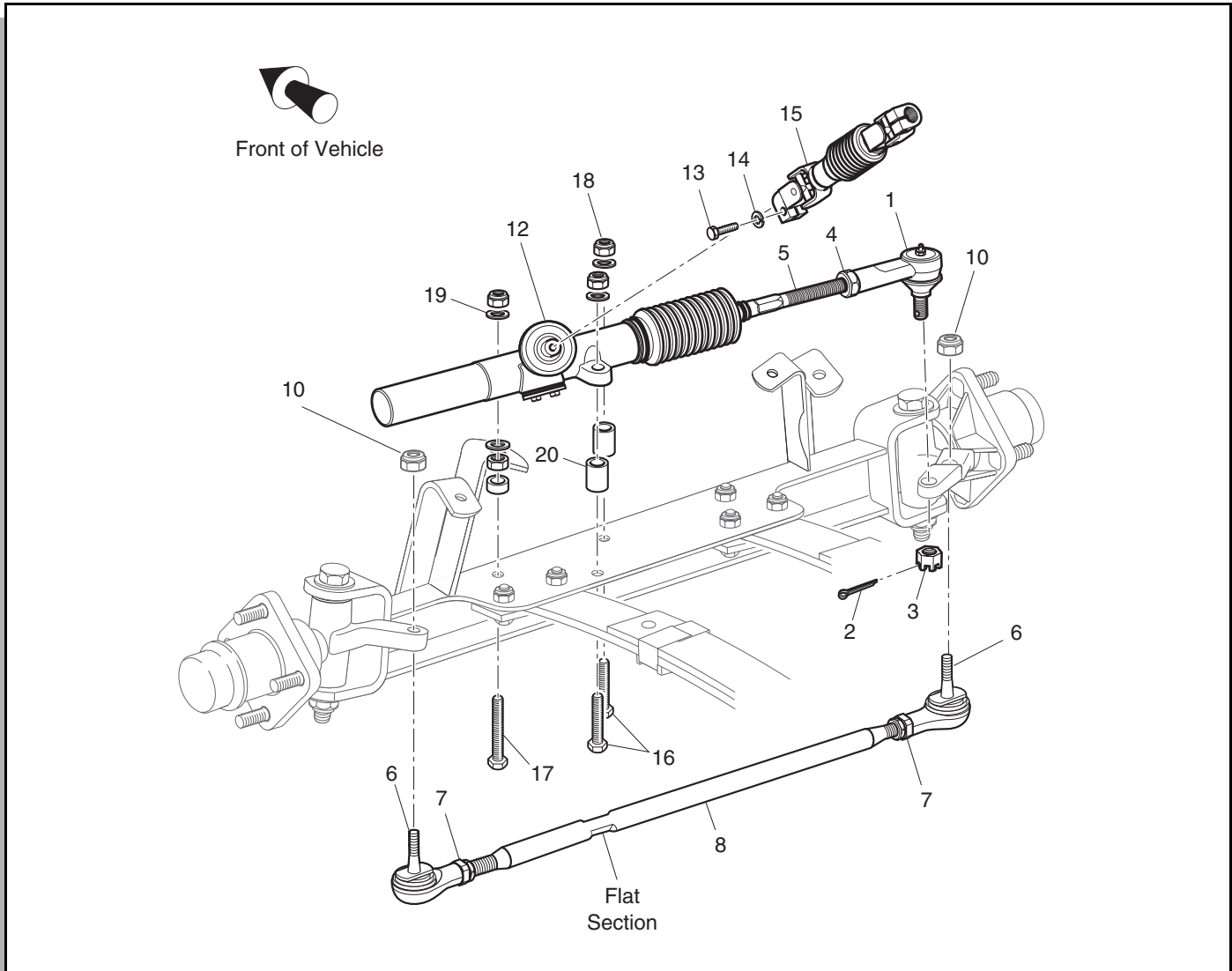
Replace the dust cap (7).

Lower vehicle per SAFETY section and tighten front wheel(s) per WHEELS AND TIRES section.

# FRONT SUSPENSION AND STEERING

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

## STEERING



**Fig. 12 Steering Components**

### Rack Ball Joint Replacement

#### Tool List

	<b>Qty. Required</b>
Needle nose pliers.....	1
Wrench, 11/16" .....	1
Ball joint separator.....	1
Plastic faced hammer .....	1
Tape measure.....	1
Wrench, 3/4" .....	1
Torque wrench, 1/2" drive, ft. lbs. ....	1
Socket, 11/16", 1/2" drive .....	1

To remove rack ball joint (1), loosen passenger side front wheel and lift and support front of vehicle per SAFETY section (Ref Fig. 12 on page E-10).

Remove passenger side front wheel and turn steering wheel fully to the left.

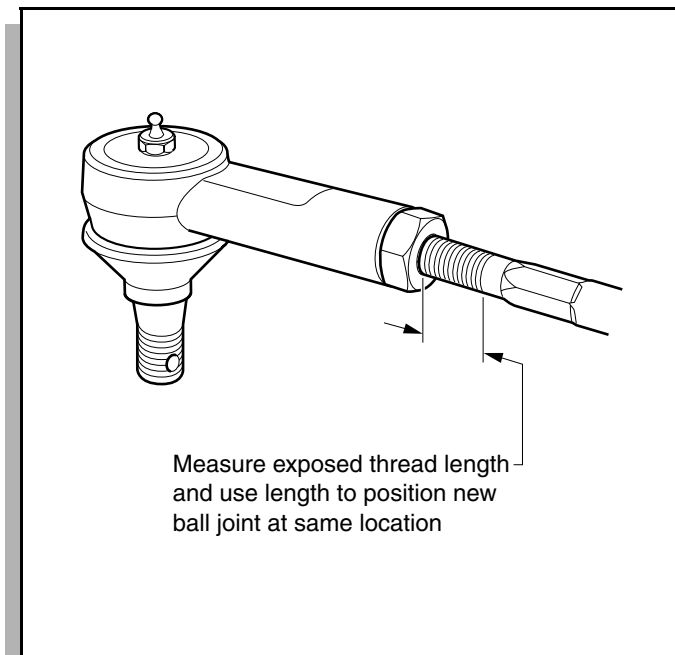
Remove the cotter pin (2) and loosen the castellated nut (3) until rack ball joint (1) threads are protected. Using a ball joint separator as a lever, apply pressure to ball joint and tap nut with plastic faced hammer to release ball joint from passenger side spindle arm. Remove nut from ball joint and ball joint from spindle arm.



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Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

To install new rack ball joint close to its correct position, measure amount of threads exposed from jam nut (Ref Fig. 13 on page E-11).



**Fig. 13 Rack Ball Joint Installation**

Loosen jam nut (4) and remove rack ball joint from rack extension (5).

Using measurement made earlier, thread jam nut and new rack ball joint to previous location on rack extension and set jam nut hand tight.

Attach rack ball joint to spindle arm. Tighten castellated nut (3) to 36 ft. lbs. (50 Nm) torque and continue to tighten as needed to insert new cotter pin (2). Maximum torque is 50 ft. lbs. (70 Nm).

**CAUTION** After replacing or servicing steering components, always verify that an 1/8" gap exists between large hex of rack extension and rack and pinion unit when steering is turned fully to the right forcing passenger spindle arm against front axle (Ref Fig. 21 on page E-16).

Check for proper rack extension-to-rack and pinion unit clearance before tightening jam nut (4) to 35 - 45 ft. lbs. (47 - 61 Nm) torque. See 'Checking/Adjusting Rack Extension-to-Rack and Pinion Unit Clearance' on page E-15.

Install passenger side front wheel per WHEELS AND TIRES section and lower vehicle per SAFETY section.

Check front wheel alignment and adjust if necessary. See 'Wheel Alignment' on page E-3.

## Tie Rod Inspection/Replacement

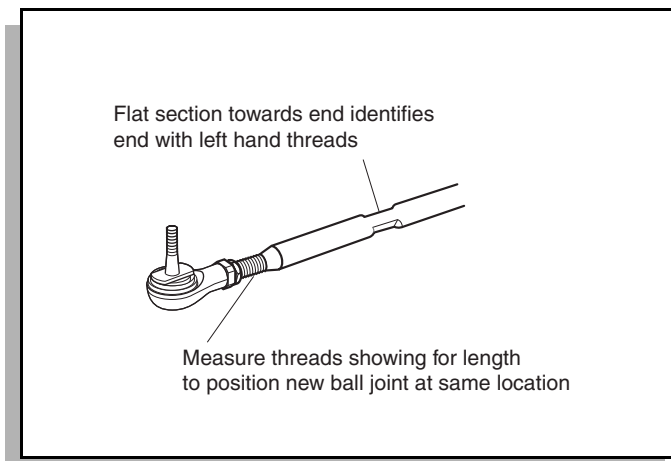
Tool List	Qty. Required
Tape measure.....	1
Wrench, 3/4".....	1
Wrench, 9/16".....	1
Needle nose pliers.....	1
Wrench, 11/16".....	1
Ball joint separator.....	1
Plastic faced hammer.....	1
Socket, 11/16", 1/2" drive.....	1
Torque wrench, 1/2" drive, ft. lbs.....	1
Crowfoot socket, 3/4", 1/2" drive.....	1

Grasp the tie rod (8) at ball joints (6) and check for any vertical motion which would indicate a worn condition and require replacement (Ref Fig. 12 on page E-10).

To remove tie rod, loosen wheel(s) and lift and support front of vehicle per SAFETY section.

Remove front wheel.

To install new tie rod ball joint close to its correct position, measure the exposed thread length from jam nut (Ref Fig. 14 on page E-11).



**Fig. 14 Tie Rod Replacement**

Loosen jam nut (7) at threaded tube (8).

**NOTE** To hold threaded tube while loosening jam nut, use a wrench on the center, flat section of tube (Ref Fig. 12 on page E-10).

The tie rod has different threads on each end. The end **with** the flat area on the threaded tube has left hand threads (clockwise to loosen) while the end **without** the flat has conventional right hand threads (counter-clockwise to loosen) (Ref Fig. 14 on page E-11).

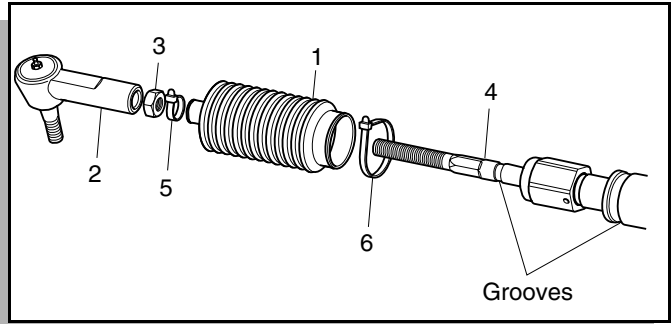
# FRONT SUSPENSION AND STEERING

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

Remove lock nut (10) until tie rod ball joint (6) threads are protected. Using a ball joint separator as a lever, apply pressure to ball joint and tap nut with plastic faced hammer to release tie rod from spindle arm. Remove nut to drop tie rod from spindle arm.

Unscrew tie rod ball joint and jam nut from threaded tube.

To install ball joint, first thread on new jam nut and then, using measurement made earlier, screw ball joint to previous location in threaded tube. Set jam nut hand tight.



**Fig. 15 Bellows Replacement**

**NOTE** The distance to center of tie rod ball joint from jam nut on both ends of threaded tube should be the same.

Attach tie rod to spindle. The lock nut (10) should be tightened to a **minimum** of 36 ft. lbs. (50 Nm) torque. Maximum torque is 50 ft. lbs. (70 Nm).

Install front wheel(s) per WHEELS AND TIRES section and lower vehicle per SAFETY section.

A worn tie rod is likely to have caused incorrect wheel alignment. Check front wheel alignment and adjust if necessary. See 'Wheel Alignment' on page E-3.

Jam nut should be tightened to 36 - 40 ft. lbs. (49 - 54 Nm) torque.

## Bellows Replacement

Tool List	Qty. Required
Needle nose pliers.....	1
Wrench, 11/16".....	1
Ball joint separator.....	1
Plastic faced hammer.....	1
Tape measure.....	1
Wrench, 3/4".....	1
Wire cutters.....	1
Wire tie, 8" long.....	1
Torque wrench, 1/2" drive, ft. lbs. ....	1
Socket, 11/16", 1/2" drive.....	1

To replace bellows (1) (Ref Fig. 15 on page E-12), first loosen passenger side front wheel and lift and support front of vehicle per SAFETY section.

Remove passenger side front wheel and turn steering wheel fully to the left.

Remove rack ball joint (2) and jam nut (3) from rack extension (4). See 'Rack Ball Joint Replacement' on page E-10.

Cut wire ties (5,6) and slide bellows off rack extension. Install new bellows aligning small end over groove in rack extension and secure with new wire tie (5). Leave large

end loose until rack extension-to-rack and pinion unit clearance is checked or adjusted.

Install jam nut (3) and rack ball joint (2) on rack extension (4) and reattach to spindle arm. See 'Rack Ball Joint Replacement' on page E-10.

**CAUTION** After replacing or servicing steering components, always verify that an 1/8" gap exists between large hex of rack extension and rack and pinion unit when steering is turned fully to the right forcing passenger spindle arm against front axle.

Check for proper rack extension-to-rack and pinion unit clearance before tightening jam nut (3) to 35 - 45 ft. lbs. (47 - 61 Nm) torque. See 'Checking/Adjusting Rack Extension-to-Rack and Pinion Unit Clearance' on page E-15.

Install passenger side front wheel per WHEELS AND TIRES section and lower vehicle per SAFETY section.

Check front wheel alignment and adjust if necessary. See 'Wheel Alignment' on page E-3.

## Pinion Seal Replacement

Tool List	Qty. Required
Vice.....	1
Straight blade screwdriver, small.....	1
Ball peen hammer.....	1
Sandpaper, 600 grit.....	AR
Shop towel.....	AR
Wheel bearing grease.....	AR
Socket, 1 1/2", 1/2" drive.....	1

**CAUTION** Secure rack and pinion unit in vice by the mounting ears only. The rack and pinion unit is made of aluminum and can be damaged if held otherwise.

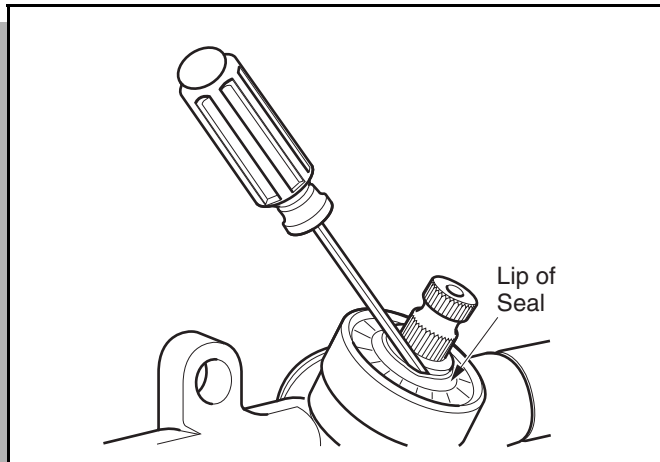
To access the pinion seal, remove rack and pinion unit from vehicle. See 'Rack and Pinion Unit Replacement' on

# FRONT SUSPENSION AND STEERING

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

page E-15. Anchor in vice by clamping on the mounting ears of the rack and pinion unit.

Slide a small straight blade screwdriver between lip of seal and pinion and pry top portion of seal up to remove (Ref Fig. 16 on page E-13).



**Fig. 16 Pinion Seal Replacement**

Use screwdriver to lift inner portion of seal up and off pinion.

Check pinion surface for roughness and sand lightly if needed.

Wipe bore clean and lubricate pinion and lip of seal with grease.

**NOTE** *The bore has a positive stop to correctly locate the seal during installation.*

Place seal over pinion and tap carefully with socket and hammer to start seal straight in bore. Drive seal fully into bore until it stops and wipe clean of any excess grease.

Attach rack and pinion unit to front axle. See 'Rack and Pinion Unit Replacement' on page E-15.

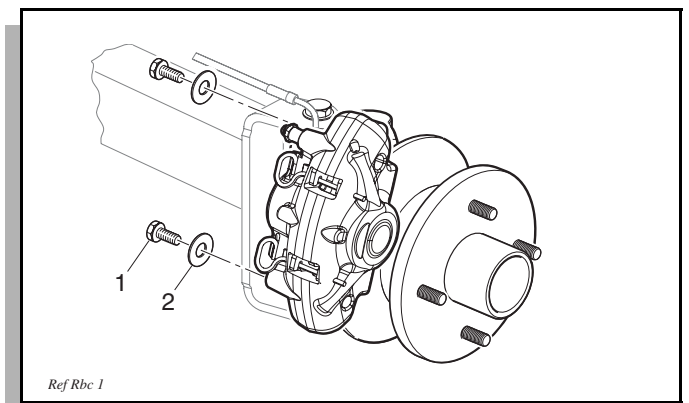
## Spindle Replacement

Tool List	Qty. Required
Needle nose pliers .....	1
Wrench, 11/16" .....	1
Ball joint separator .....	1
Plastic faced hammer .....	1
Wrench, 3/4" .....	1
Socket, 3/4", 1/2" drive .....	1
Socket, 11/16", 1/2" drive .....	1
Torque wrench, 1/2" drive, ft. lbs. ....	1

**CAUTION** The spindle bearings are designed to be used "dry". Lubrication attracts dirt and will ruin the bearings. Do not apply grease to the spindle bearings.

Loosen front wheel. Lift and support front of vehicle per SAFETY section and remove front wheel.

If vehicle is equipped with front disc brakes, remove caliper by removing bolts (1) and washers (2). Secure the caliper with a length of wire, cord or wire tie to relieve any tension that would be created by the caliper hanging from the brake line (Ref Fig. 17 on page E-13).



**Fig. 17 Removing Brake Caliper**

To remove tie rod, loosen lock nut (2) until tie rod ball joint (3) threads are protected (Ref Fig. 18 on page E-14). Using a ball joint separator as a lever, apply pressure to ball joint and tap nut with plastic faced hammer to release tie rod from spindle arm (4). Remove nut from tie rod and tie rod from spindle arm.

If removing passenger side spindle, repeat previous step for rack ball joint.

Remove lock nut (5) and washer (7) from bolt (6) and discard nut. Pull bolt (6) and washer (8) from spindle and separate spindle from axle. Remove thrust washer (9) and king pin tube (10) from spindle.

Spindle installation is the reverse order of disassembly.

**NOTE** *The thrust washer (9) is located on top of spindle between spindle and front axle.*

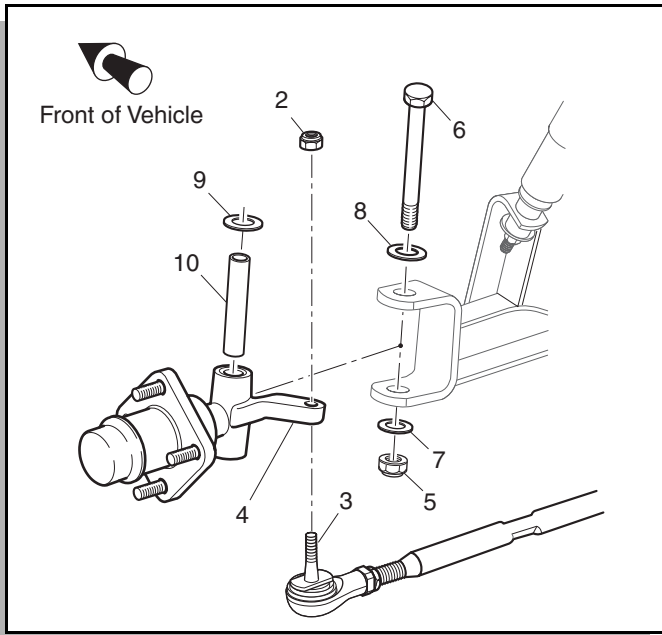
Tighten new lock nut (5) to 56 - 70 ft. lbs. (75 - 95 Nm) torque. Check that spindle turns freely on king pin tube after tightening.

Tighten lock nut (2) to 36 ft. lbs. (50 Nm). Maximum torque is 50 ft. lbs. (70 Nm).

Install front wheels per WHEELS AND TIRES section and lower vehicle per SAFETY section.

# FRONT SUSPENSION AND STEERING

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings



**Fig. 18 Spindle Replacement**

Check front wheel alignment and adjust if necessary. See 'Wheel Alignment' on page E-3.

## Rack and Pinion Unit Disassembly and Inspection

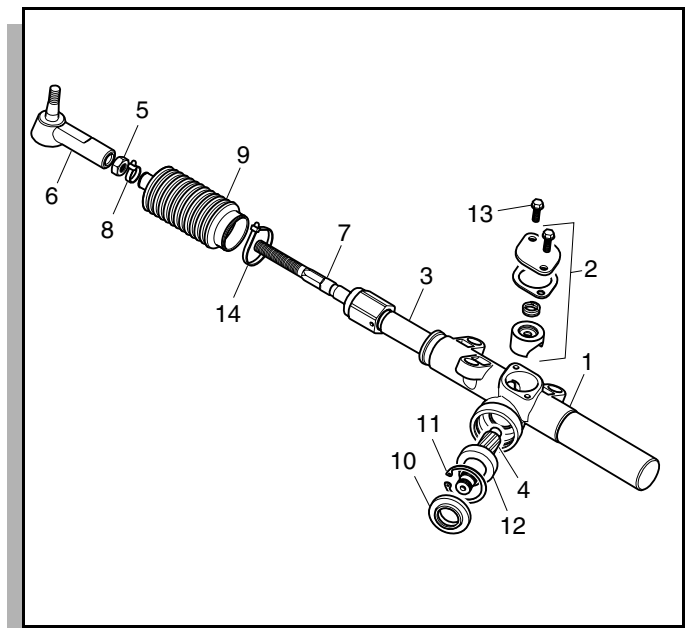
Tool List	Qty. Required
Vice .....	1
Socket, 3/8", 3/8" drive .....	1
Ratchet, 3/8" drive .....	1
Wrench, 11/16" .....	1
Wrench, 3/4" .....	1
Wire cutter .....	1
Retaining ring pliers .....	1
Shop towel.....	AR
CITGO Lithoplex MP No. 2 grease.....	AR
Wire tie, 8" long .....	1
Wire tie, 10" long .....	1
Torque wrench, 3/8" drive, in. lbs. ....	1

**NOTE** The rack and pinion gears are not serviceable items. If they are found to be damaged or excessively worn, a new rack and pinion unit must be installed.

**CAUTION** Secure rack and pinion unit in vice by the mounting ears only. The rack and pinion unit is made of aluminum and can be damaged if held otherwise.

Remove rack and pinion unit from vehicle. See 'Rack and Pinion Unit Replacement' on page E-15. Anchor in vice by clamping on the mounting ears of the unit.

Disassemble rack and pinion unit (1) by first removing screw (13) and tensioner (2) to relieve pressure on rack (3) and pinion (4) (Ref Fig. 19 on page E-14). Loosen jam nut (5) and remove rack ball joint (6) from rack extension (7). Cut wire ties (8, 14) securing bellows (9) and slide bellows off rack extension. Pull rack (3) from unit (1). Remove pinion seal (10). See 'Pinion Seal Replacement' on page E-12. Remove internal retaining ring (11) from rack and pinion unit and pull out pinion (4) and ball bearing (12) as an assembly.



**Fig. 19 Rack and Pinion Unit Disassembly**

Clean rack, pinion and housing. Inspect gear teeth, bearing surfaces and grease seal surfaces of rack and pinion for excessive wear or damage. If any is found, the rack and pinion unit **must be** replaced as an assembly. See 'Rack and Pinion Unit Replacement' on page E-15.

If rack and pinion pass inspection, clean them, tensioner and housing thoroughly and lubricate for assembly. Use grease specified in tool list.

Assemble rack and pinion unit by first installing pinion in reverse order of removal making sure to lubricate pinion seal lip prior to installing seal. See 'Pinion Seal Replacement' on page E-12. Insert rack into rack and pinion unit. Turn pinion clockwise to help pull rack in if necessary. Install bellows and secure to rack extension with wire tie (8). **Do not** secure large end of bellows to rack and pin-

# FRONT SUSPENSION AND STEERING

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

ion unit until instructed to do so after setting proper rack extension-to-rack and pinion unit clearance. Install tensioner and tighten bolts (13) to 100 - 120 in. lbs. (115 - 138 kg cm) torque. Thread jam nut and rack ball joint to original location on rack extension and set jam nut hand tight.

Install rack and pinion unit on vehicle. See 'Rack and Pinion Unit Replacement' on page E-15.

**CAUTION** After replacing or servicing steering components, always verify that an 1/8" gap exists between large hex of rack extension and rack and pinion unit when steering is turned fully to the right forcing passenger spindle arm against front axle.

Set proper rack extension-to-rack and pinion unit clearance. See 'Checking/Adjusting Rack Extension-to-Rack and Pinion Unit Clearance' on page E-15.

## Rack and Pinion Unit Replacement

Tool List	Qty. Required
Socket, 13 mm, 3/8" drive .....	1
Ratchet, 3/8" drive.....	1
Needle nose pliers .....	1
Wrench, 11/16".....	1
Ball joint separator .....	1
Plastic faced hammer .....	1
Wrench, 5/8" .....	1
Socket, 5/8", 1/2" drive.....	1
Ratchet, 1/2" drive.....	1
Torque wrench, 1/2" drive, ft. lbs. ....	1
Socket, 11/16", 1/2" drive .....	1
Torque wrench, 3/8" drive, in. lbs. ....	1

To remove rack and pinion unit (12) (Ref Fig. 12 on page E-10), loosen front wheels and lift and support front of vehicle per SAFETY section. Remove front wheels.

Remove bolt (13) and washer (14) securing intermediate shaft (15) to rack and pinion unit (12).

Remove cotter pin (2) and loosen castellated nut (3) until rack ball joint (1) threads are protected. Using a ball joint separator as a lever, apply pressure to ball joint and tap nut with plastic faced hammer to release ball joint from passenger side spindle arm. Remove nut from ball joint and ball joint from spindle arm.

Remove the three lock nuts (18) securing rack and pinion unit to front axle and discard nuts. The rack and pinion unit can now be removed from vehicle. Retain washers (19), spacers (20) and the two bolts (16) for assembly.

Replace rack and pinion unit in reverse order of removal. Use new lock nuts (18) and tighten them to 35 - 50 ft. lbs. (50 - 70 Nm) torque.

Tighten castellated nut (3) to 36 ft. lbs. (50 Nm) torque and continue to tighten as needed to insert new cotter pin. Maximum torque is 50 ft. lbs. (70 Nm).

Tighten bolt (13) securing intermediate shaft to pinion to 155 - 215 in. lbs. (180 - 250 kg cm) torque.

**CAUTION** After replacing or servicing steering components, always verify that an 1/8" gap exists between large hex of rack extension and rack and pinion unit when steering is turned fully to the right forcing passenger spindle arm against front axle.

Set proper rack extension-to-rack and pinion unit clearance. See 'Checking/Adjusting Rack Extension-to-Rack and Pinion Unit Clearance' on page E-15.

Install front wheels per WHEELS AND TIRES section and lower vehicle per SAFETY section.

Check front wheel alignment and adjust if necessary. See 'Wheel Alignment' on page E-3.

## Checking/Adjusting Rack Extension-to-Rack and Pinion Unit Clearance

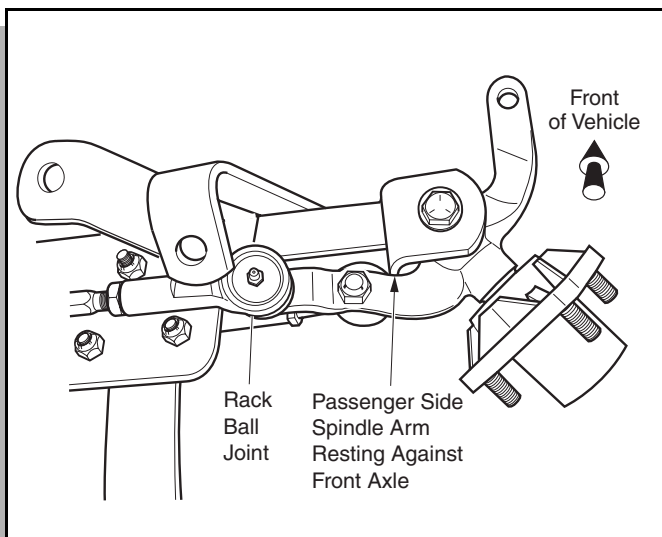
Tool List	Qty. Required
Wrench, 11/16" .....	1
Wrench, 3/4" .....	1
Wrench, 1/2" .....	1
Wire cutter .....	1
Washer, 1/8" thick.....	1
Crowfoot socket, 3/4", 1/2" drive .....	1
Torque wrench, 1/2" drive, ft. lbs. ....	1
Wire tie, 10" long .....	1

Check for proper rack extension-to-rack and pinion unit clearance by first turning steering wheel fully to the right. The rear spindle arm on the passenger side **must rest against** the front axle (Ref Fig. 20 on page E-16). If it does not, all adjustment is made at the rack ball joint (6) (Ref Fig. 19 on page E-14). Loosen jam nut (5) at rack ball joint and use wrench to thread shaft of rack extension (7) further into rack ball joint. This will provide more travel for the steering wheel to be turned to the right.

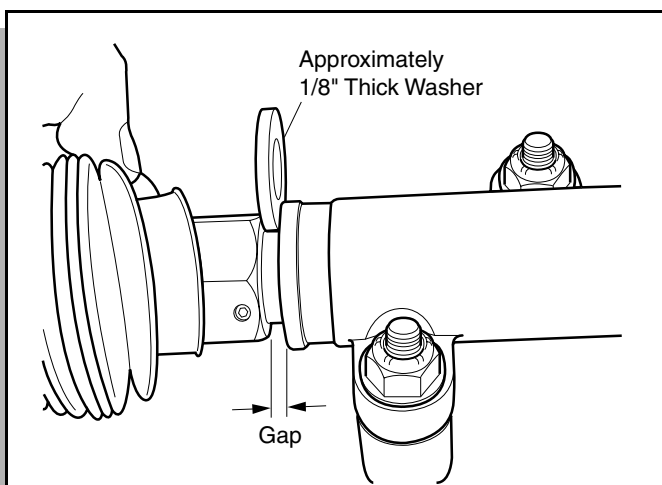
With spindle arm resting against front axle, cut wire tie (14) securing bellows (9) to rack and pinion unit (1) and slide bellows away from rack and pinion unit to see large hex of rack extension. An 1/8" gap should exist between the large hex and the end of the rack and pinion unit.

# FRONT SUSPENSION AND STEERING

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings



**Fig. 20 Spindle Contact with Front Axle**



**Fig. 21 Checking Gap**

Adjust, using an 1/8" thick washer as a gauge, by turning shaft of rack extension with wrench to create the 1/8" gap. Tighten jam nut (5) to 35 - 45 ft. lbs. (47 - 61 Nm) torque. Secure bellows to rack and pinion unit with new wire tie (14).

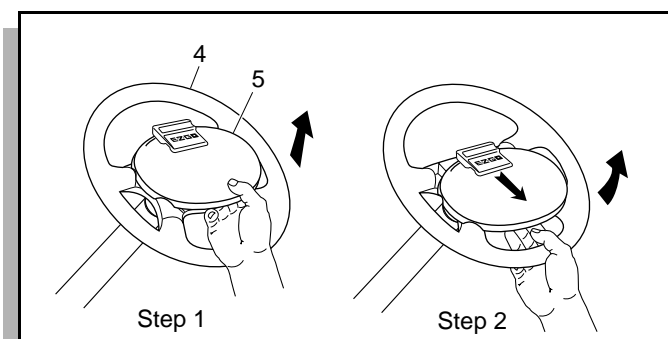
## Steering Wheel Replacement

Tool List	Qty. Required
Socket, 15/16", 1/2" drive .....	1
Ratchet, 1/2" drive .....	1
Plastic faced hammer .....	1
Ball peen hammer .....	1
Anti-seize compound .....	1
Torque wrench, 1/2" drive, ft. lbs. ....	1

**NOTE** To maintain correct orientation when replacing steering wheel, first turn wheels straight ahead.

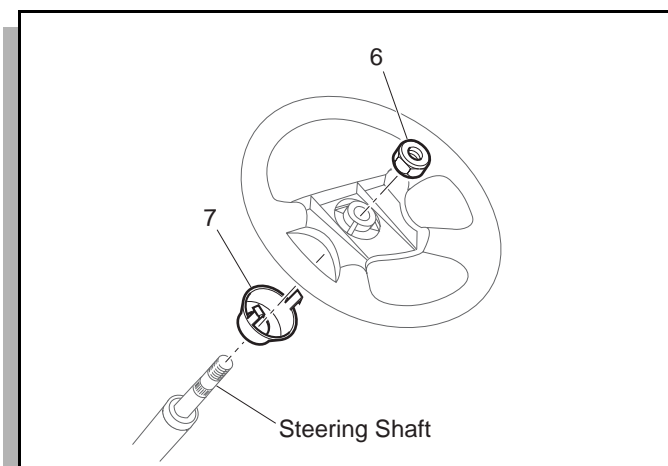
**CAUTION** To prevent damage to the clipboard, perform the following removal procedure. Do not use a screwdriver to push or pry the retaining tabs.

From the front side of the steering wheel (4), remove the clipboard (5) by first pulling straight up on the bottom of the clipboard to release the two bottom retaining tabs. Then, using thumb for leverage as shown, reach from behind steering wheel with fingertips to first pull down, and then push up to release the two top clipboard retaining tabs (Ref Fig. 22 on page E-16).



**Fig. 22 Clipboard Removal**

Loosen the steering wheel retaining nut (6) two to three turns (Ref Fig. 23 on page E-16). DO NOT REMOVE NUT AT THIS TIME. Apply upward pressure to the steering wheel. Place a plastic faced hammer against the steering wheel nut and strike plastic faced hammer sharply with a ball peen hammer.



**Fig. 23 Steering Wheel Replacement**

**CAUTION** Do not strike steering nut or end of steering shaft directly with ball peen

# FRONT SUSPENSION AND STEERING

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

hammer. Internal damage to rack and pinion unit can result.

When steering wheel is loosened, remove retaining nut and remove steering wheel.

Prior to replacement, assemble the replacement steering wheel by aligning the retaining tabs on the rear collar hub (7) with slots in back of steering wheel. Squeeze tabs to allow insertion of hub. **Do not force.** Squeeze hub on top and bottom to fully seat.

Replace steering wheel by first lightly coating the splines of the steering shaft with a commercially available anti-seize compound. With the vehicle wheels in the straight ahead position, align the steering wheel on the steering shaft and slide wheel on shaft. Tighten the steering wheel nut (6) to 15 - 20 ft. lbs. (20 - 27 Nm) torque.

Inspect the four retaining tabs on the clipboard (5) for white stress lines (Ref Fig. 22 on page E-16). If stress lines are present, replace clipboard. Install by carefully pressing, first the top two, then the bottom two retaining tabs into the matching slots in steering wheel.

## Steering Shaft and Column Replacement

Tool List	Qty. Required
Ratchet, 1/2" drive.....	1
Socket, 3/4", 1/2" drive.....	1
Socket, 13 mm, 3/8" drive.....	1
Ratchet, 3/8" drive.....	1
Socket, 9/16", 1/2" drive.....	1
Snap ring pliers.....	1
Bearing separator.....	1
Gear puller.....	1
Arbor press.....	1
Bearing driver set.....	1
Torque wrench, 1/2" drive, ft. lbs.....	1
Torque wrench, 3/8" drive, in. lbs.....	1
Wheel bearing grease.....	AR

To remove steering shaft (4) (Ref Fig. 24 on page E-17), remove the steering wheel. See 'Steering Wheel Replacement' on page E-16.

Loosen front wheels. Lift and support front of vehicle per SAFETY section and remove front wheels.

Remove the bolt (1) and washer (2) that secures the intermediate shaft (3) to the steering shaft (4).

Remove the four bolts (5) and washers (6) that secure the steering column (7) to the chassis and remove the column.

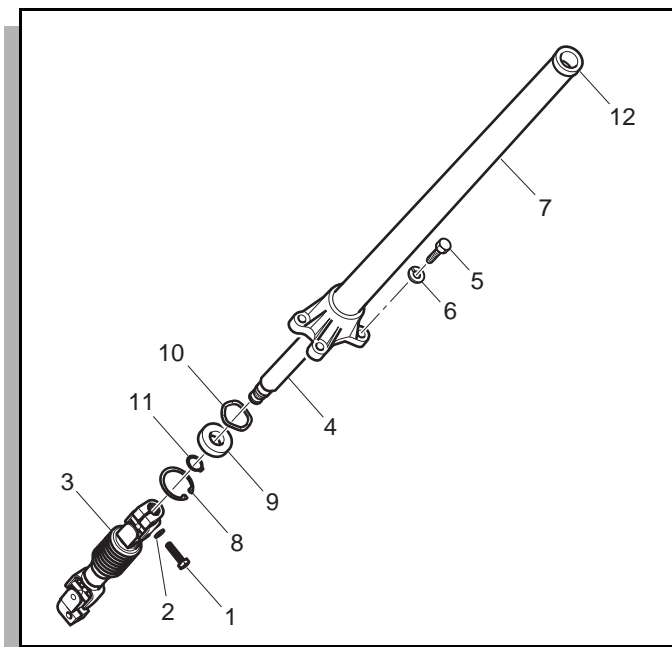


Fig. 24 Steering Shaft and Column

Remove large retaining ring (8) on bottom end of column and pull shaft and bearing (9) out as an assembly. Slide wave washer (10) out bottom end of steering column and keep for reuse.

Remove small retaining ring (11) and press bearing from steering shaft.

To assemble steering shaft, first press new bearing onto shaft until it stops against shoulder. Then, with small retaining ring oriented with arch up, slide ring onto shaft as far as possible using snap ring pliers (Ref Fig. 25 on page E-18). Use fingers to push retaining ring fully into groove.

Slide wave washer into base of steering column.

To install steering shaft and bearing assembly, apply wheel bearing grease to lip of seal in bushing (12) at top of column and press steering shaft and bearing assembly into column base. Secure with large retaining ring making sure it is fully seated in groove of column.

Place steering column on vehicle and tighten column bolts (5) to 29 ft. lbs. (39 Nm) torque.

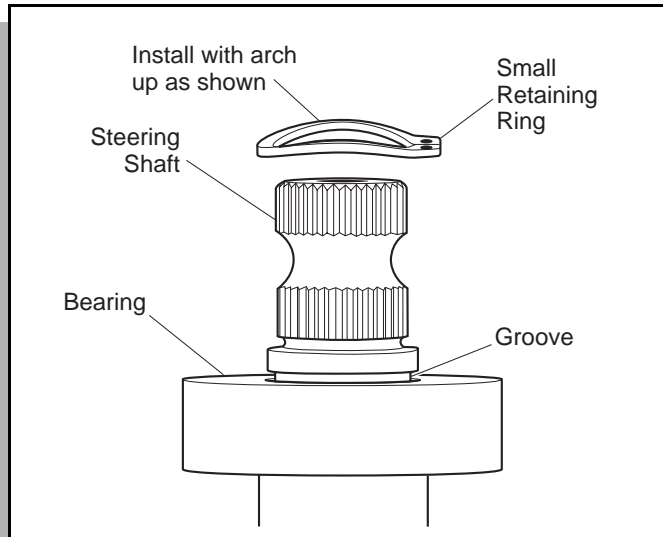
Tighten bolt (1) securing intermediate shaft to steering shaft to 156 - 216 in. lbs. (180 - 250 kg cm) torque.

Install front wheel(s) per WHEELS AND TIRES section and lower vehicle per SAFETY section

Install steering wheel. See 'Steering Wheel Replacement' on page E-16.

## FRONT SUSPENSION AND STEERING

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings



**Fig. 25 Small Retaining Ring Orientation**



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# ELECTRONIC SPEED CONTROL (36V AND 48 V)

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## ELECTRONIC SPEED CONTROL (36V)

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

### GENERAL

The Electronic Speed Control system consists of two separate units, the pedal box and the controller.

#### Pedal Box

The Pedal Box assembly is a modularized unit that contains the accelerator pedal, return spring and an enclosed box that contains the pedal position micro switch and a solid state Inductive Throttle Sensor (ITS) that is activated by a moving plunger attached to the accelerator pedal.

To access the pedal box, remove the rocker panel, lift the floor mat, and remove the access cover from the floor (Ref Fig. 1 on page F-1). The ITS and plunger are accessed by removing the top cover from the enclosed pedal box.

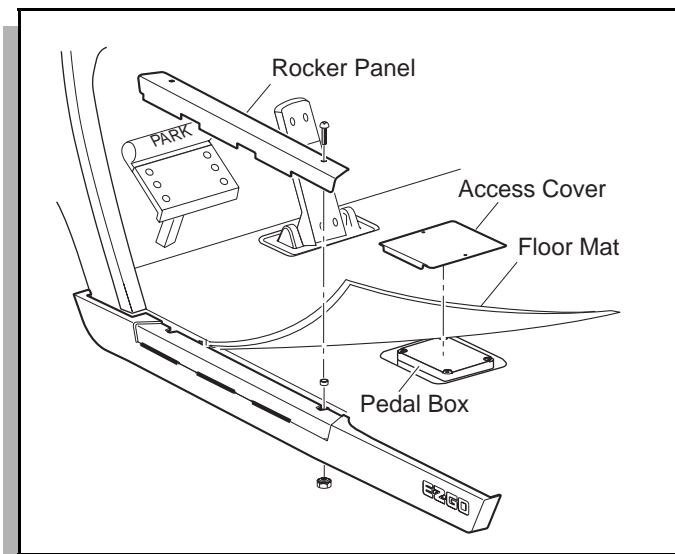


Fig. 1 Access to Pedal Box

#### Controller

The Controller is a solid state unit activated by a solenoid. Both are located under the seat on the passenger side of the vehicle.

A diode is positioned between the two coil terminals of the solenoid. Its orientation is critical. The cathode side of the diode, identified with a silver band, is oriented to the solenoid terminal with the red wire attached (Ref Fig. 2 on page F-1).

**CAUTION** If the diode is incorrectly oriented, the pedal box micro switch and the direction selector micro switch may be permanently damaged.

The pedal box and controller are connected by a four pin connector that is located under the seat within the black plastic environmental cover.

The controller is wired to the batteries and develops a regulated power supply for the ITS. The plunger position relative to the ITS varies the voltage which is fed back to the controller which interprets the change in voltage and supplies the appropriate power to the motor.

The ITS unit and the controller are both solid state units that contain no user serviceable parts. **The testing procedures are designed to test the basic functionality of the power and control wiring systems.** Once the functionality of the wiring has been confirmed, the remaining tests are used to identify which of the components (controller or ITS) must be replaced.

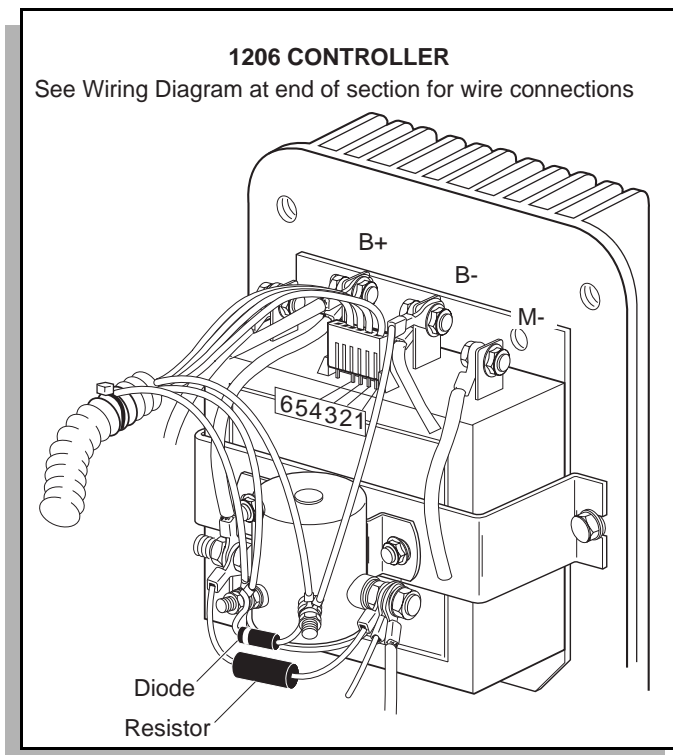


Fig. 2 Controller and Solenoid

### GENERAL TROUBLESHOOTING

Tool List	Qty. Required
Floor jack.....	1
Jack stands .....	2
Wheel chocks .....	4
Jumper wire (with alligator clips) .....	1
DVOM.....	1

# ELECTRONIC SPEED CONTROL (36V)

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

Socket, 3/8", 3/8" drive .....	1
Ratchet, 3/8" drive .....	1
Torque wrench, in. lbs., 3/8" drive .....	1
Torque wrench, ft. lbs., 3/8" drive .....	1
Extension, 6", 3/8" drive .....	1
Insulated wrench, 9/16" .....	1
Wrench, 1/2" .....	1
Wrench, 7/16" .....	1
Phillips screwdriver, large .....	1
Phillips screwdriver, small .....	1
Shop towel.....	1
Allen wrench, .050" .....	1

## Symptoms

Vehicle does not operate, operates poorly or intermittently.

## Testing

It is unlikely that the mechanical adjustment of the pedal box has changed, therefore the initial tests will be conducted with a digital volt ohm meter (DVOM) to identify the failed component.

A typical DVOM is shown in illustrations. A recommended DVOM is available through the E-Z-GO Service Parts Department as P/N 27481-G01. Any DVOM may be used; however, the accuracy, controls, displays and features may vary depending on the make and model. Always follow the meter manufacturer's recommendations and instructions for the use and care of the meter.

To assure accurate readings, be sure to set the meter to the closest voltage reading above the expected voltage.



**To prevent injury resulting from unexpected movement of the vehicle,**

**always raise the rear wheels before conducting any tests.**

**To prevent possible motor damage, never operate vehicle at full throttle for more than 4-5 seconds while vehicle is in a "no-load" condition.**

Raise the rear wheels of the vehicle and support on jack stands (Refer to the Lifting Procedure in Section 'B' Safety). Test the vehicle stability before proceeding.

Place the direction selector in 'F' and turn the key switch to 'ON'. Depress the accelerator pedal until the micro switch in the pedal box activates which should cause the solenoid to make an audible click.

## Testing Battery Voltage

It is important to determine the condition of the battery set before proceeding with any electrical troubleshooting. An open voltage test is of little use since a battery that has deteriorated to the point of requiring replacement can still show six volts or higher in an open voltage test. If there is any doubt as to the adequacy of the battery set, charge the batteries and perform a load test using a discharge machine following manufacturers instructions. If batteries are satisfactory, recharge battery set.

With the adequacy of the batteries confirmed, use a DVOM connected directly to the battery terminal posts to determine the open voltage of the set (Ref Fig. 3 on page F-2). In the following tests, this voltage level will be used as a reference. Some loss due to resistance or wires and connectors may be indicated by readings that could be up to one volt less than the reference voltage. No reading indicates an "open" condition and the battery wires should be inspected for a broken or disconnected wire or component.

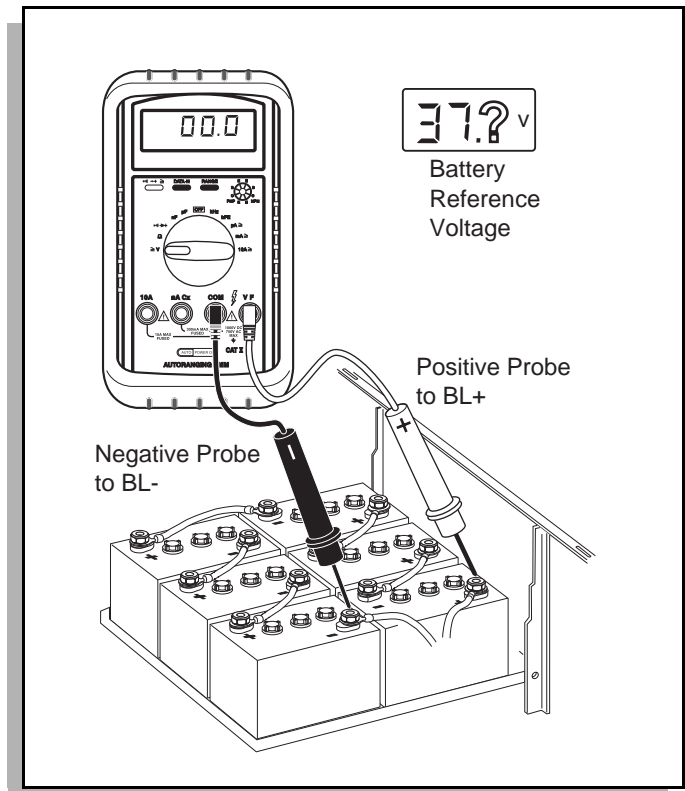


Fig. 3 Battery Reference Voltage

# ELECTRONIC SPEED CONTROL (36V)

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

## Continuity Check



**WARNING** To prevent possible injury or death resulting from a battery explosion, use an insulated wrench and remove the B+ wire from the battery to disconnect electrical power to vehicle.

Before attempting to perform a continuity check, turn the key switch to 'OFF' and place the direction selector in neutral.

If the solenoid does not function, the pedal micro switch, neutral micro switch (direction selector switch), solenoid, key switch and four pin connector should be checked for continuity.

Turn the key switch to 'OFF' and place the direction selector in neutral before disconnecting power by removing the B+ connection to the battery. **Always use insulated wrenches when working on batteries.** To check for continuity, set the DVOM to the K $\Omega$  setting and select 'Continuity'. The meter will give an audible signal when it detects continuity. If the meter does not have a continuity setting, set it to K $\Omega$ , the meter will indicate "0" when it detects continuity.

## Testing a Switch for Continuity

Place one probe on one contact of the switch, place the second probe on the second terminal of the switch (Ref Fig. 4 on page F-3).

Actuating a normally open (NO) switch will cause the DVOM to show "0" or give an audible indication when the switch is operated. A normally closed (NC) switch will cause the meter to show "0" or give an audible indication when the probes are attached without activating switch. The audible indicator will stop and the meter display will indicate a value greater than "0" when the switch is activated.

The change in display or audible indicator demonstrates that the switch is functioning.

## Testing a Solenoid for Continuity

Place one probe on one of the large terminals and the other probe on the second large terminal (Ref Fig. 5 on page F-3). If the meter shows "0" or gives an audible indication, the solenoid terminals are "welded" closed and **the solenoid must be replaced.**

If the continuity test indicates that contacts are not "welded" and the wiring to the solenoid coil is good, the coil has failed and **the solenoid must be replaced.**

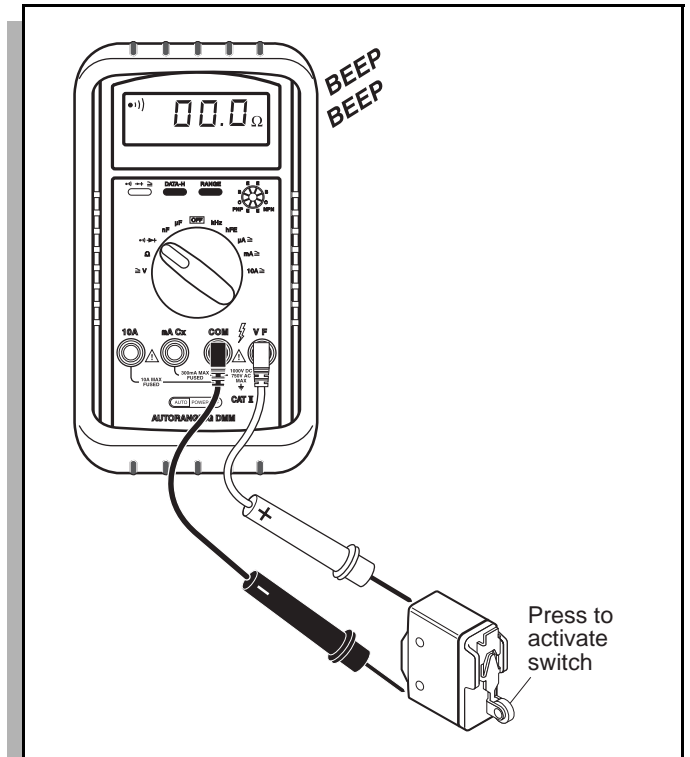


Fig. 4 Continuity Check of Switch

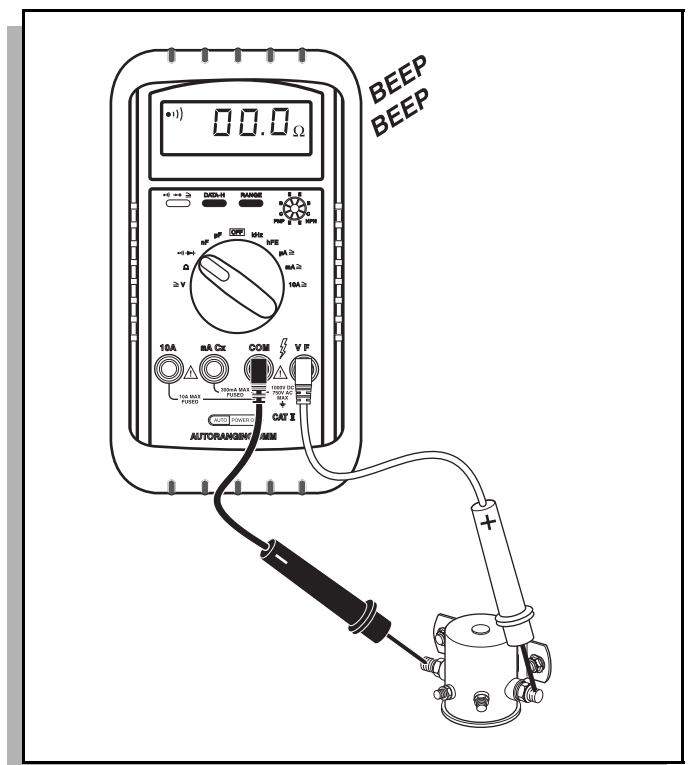


Fig. 5 Continuity Check of Solenoid

# ELECTRONIC SPEED CONTROL (36V)

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

## TROUBLESHOOTING DIAGRAMS

The simplified troubleshooting diagram is a quick ESC diagnosis (Ref Fig. 6 on page F-4). Use this diagram to perform initial troubleshooting. Follow the indicated step

numbers to the information in the detailed troubleshooting diagram.

It is vital to the safety of the technician and assistants that all warnings and safety procedures in this section be followed.

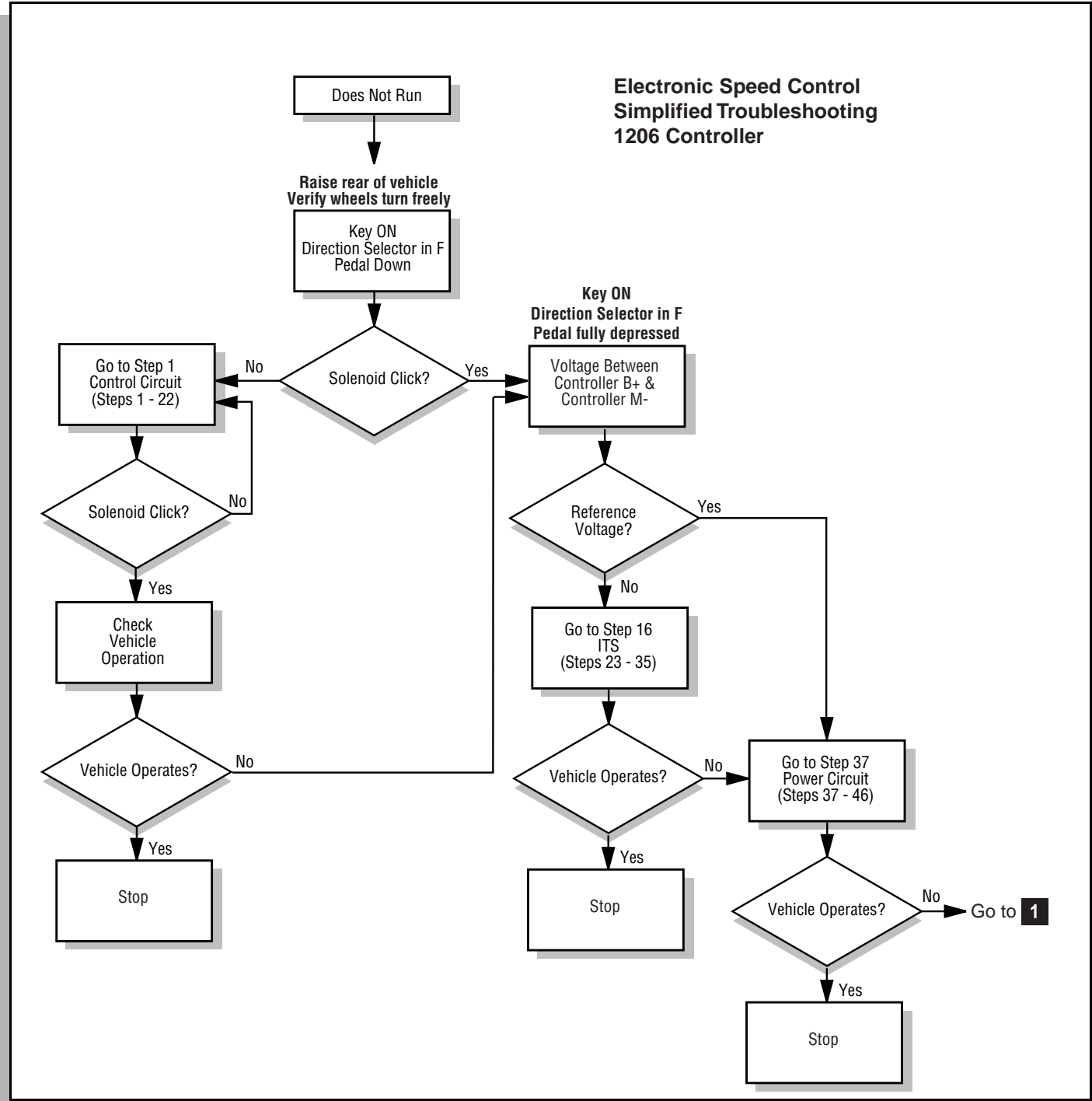


Fig. 6 Simplified Troubleshooting Diagram

# ELECTRONIC SPEED CONTROL (36V)

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

## Electronic Speed Control Diagnostic Procedure 1206 Controller

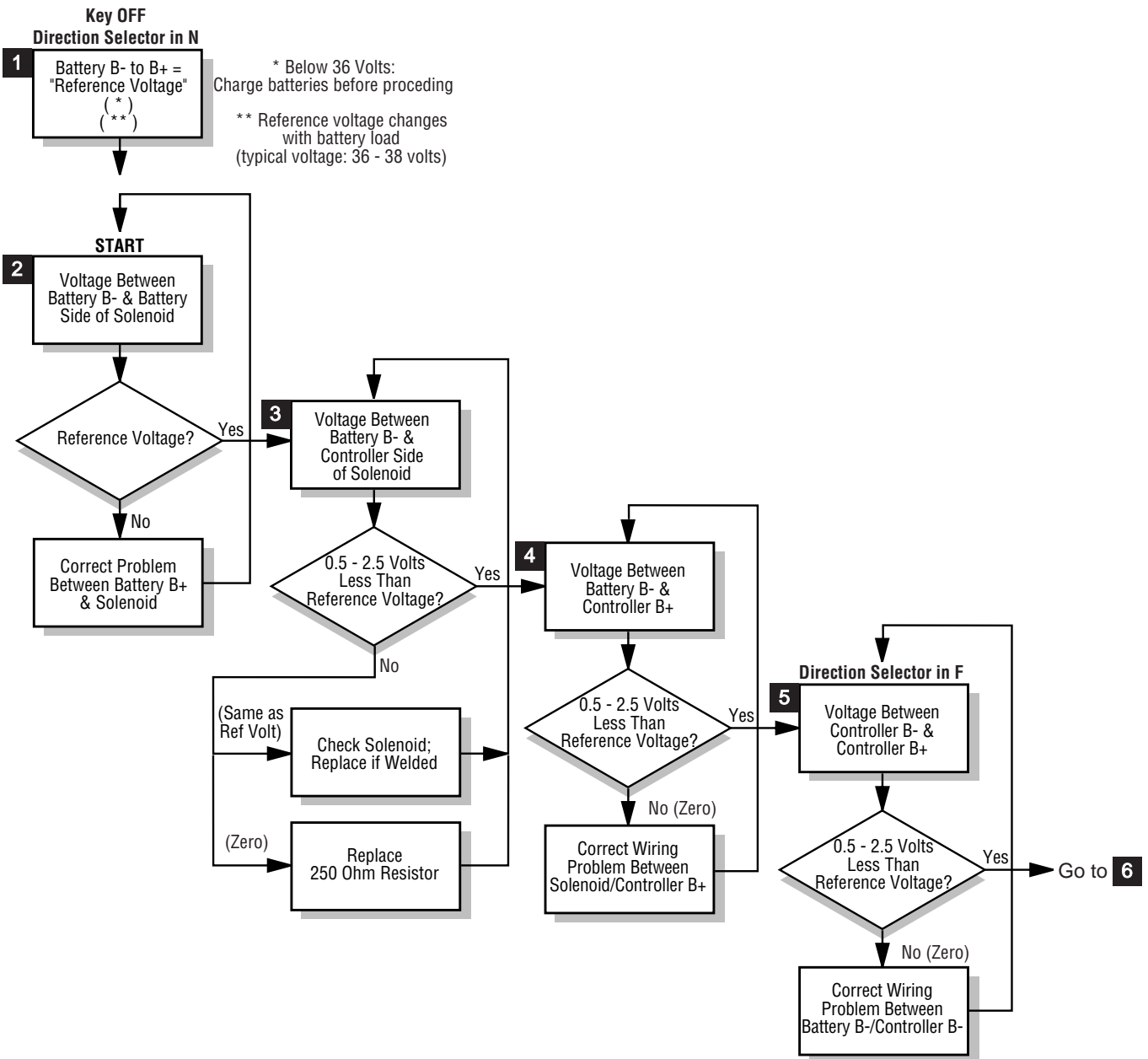


Fig. 7 Detailed Troubleshooting Diagram (Sheet 1 of 8)

# ELECTRONIC SPEED CONTROL (36V)

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

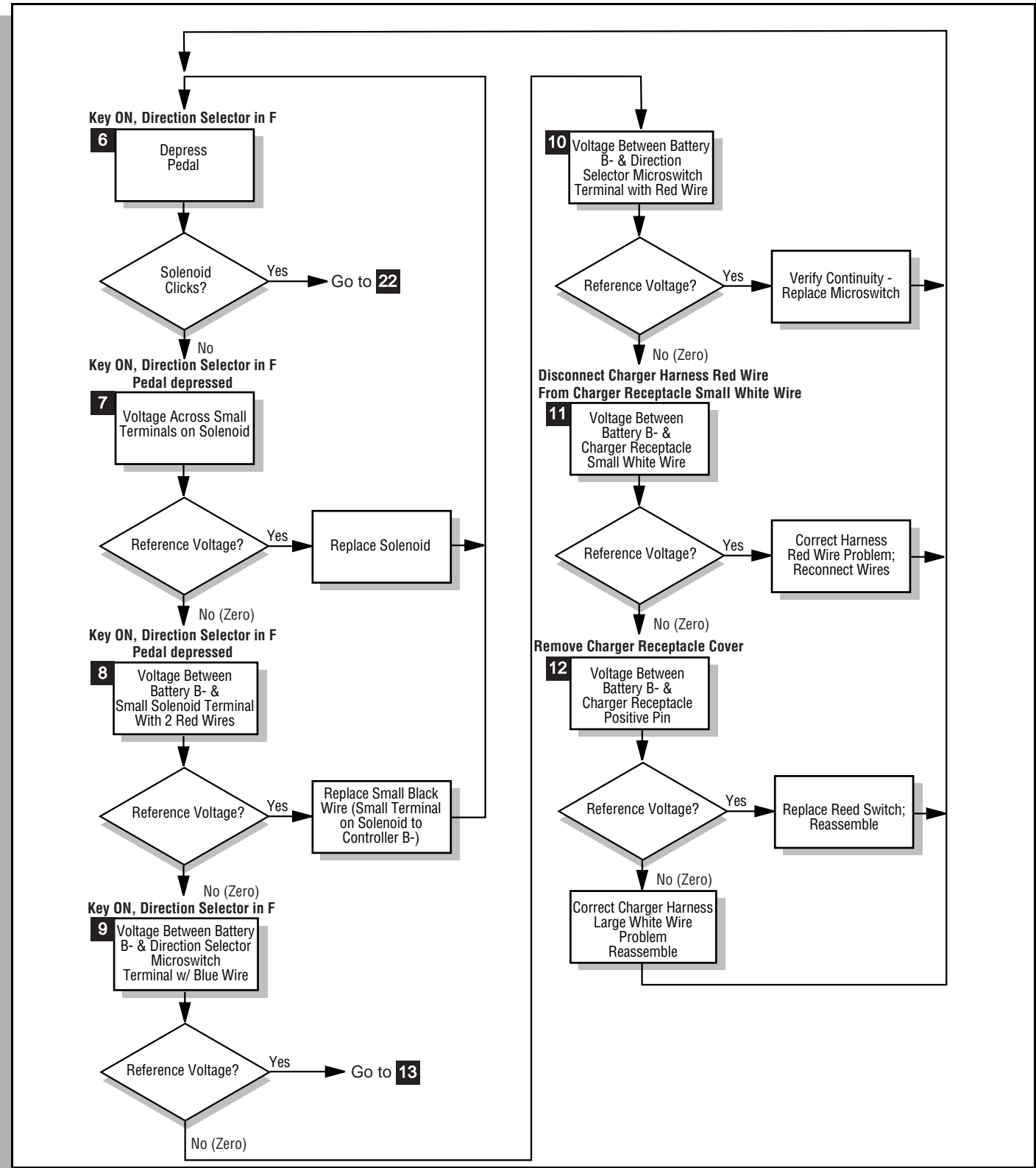
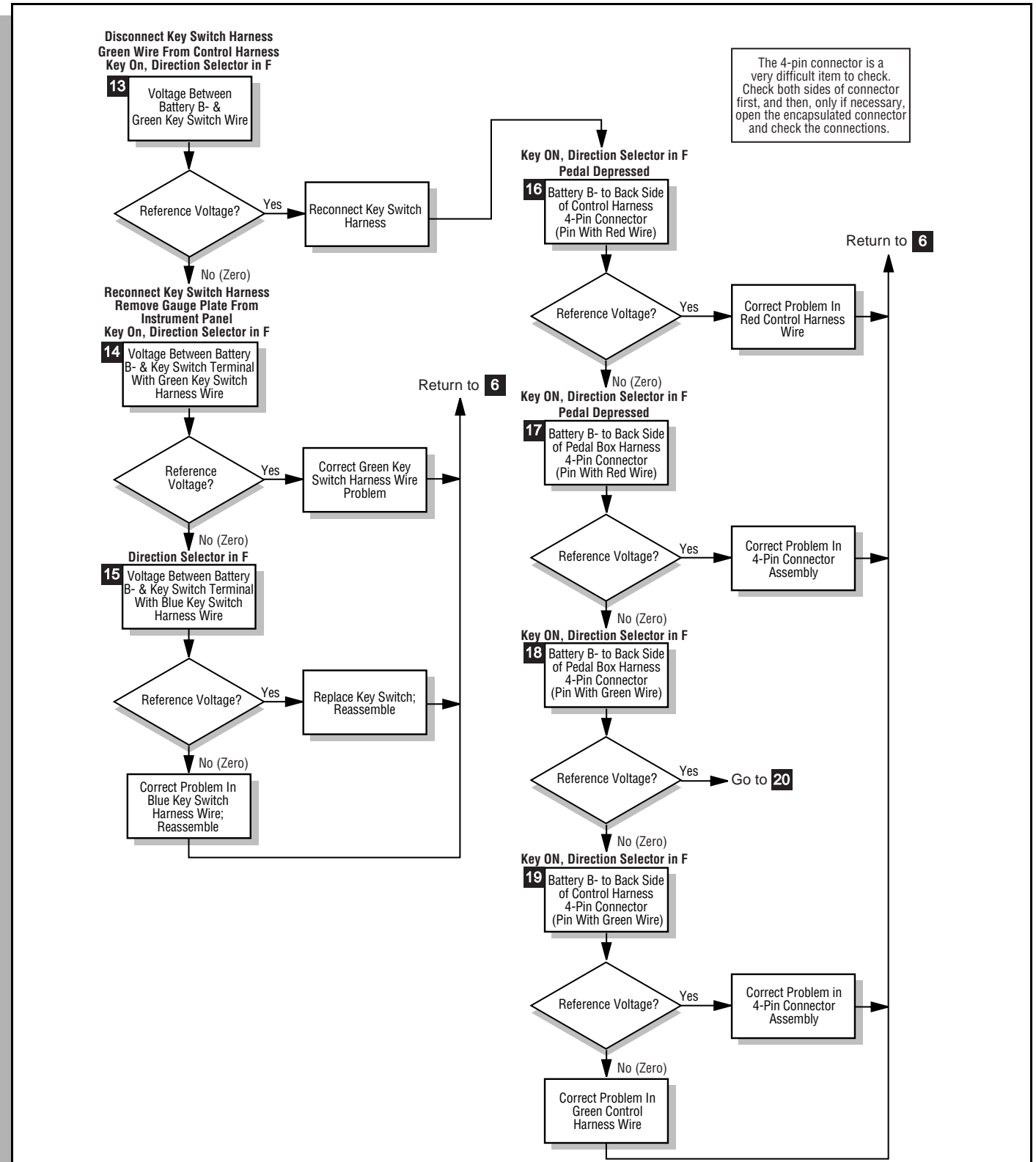


Fig. 8 Detailed Troubleshooting Diagram (Sheet 2 of 8)



# ELECTRONIC SPEED CONTROL (36V)

*Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings*



**Fig. 9 Detailed Troubleshooting Diagram (Sheet 3 of 8)**

# ELECTRONIC SPEED CONTROL (36V)

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

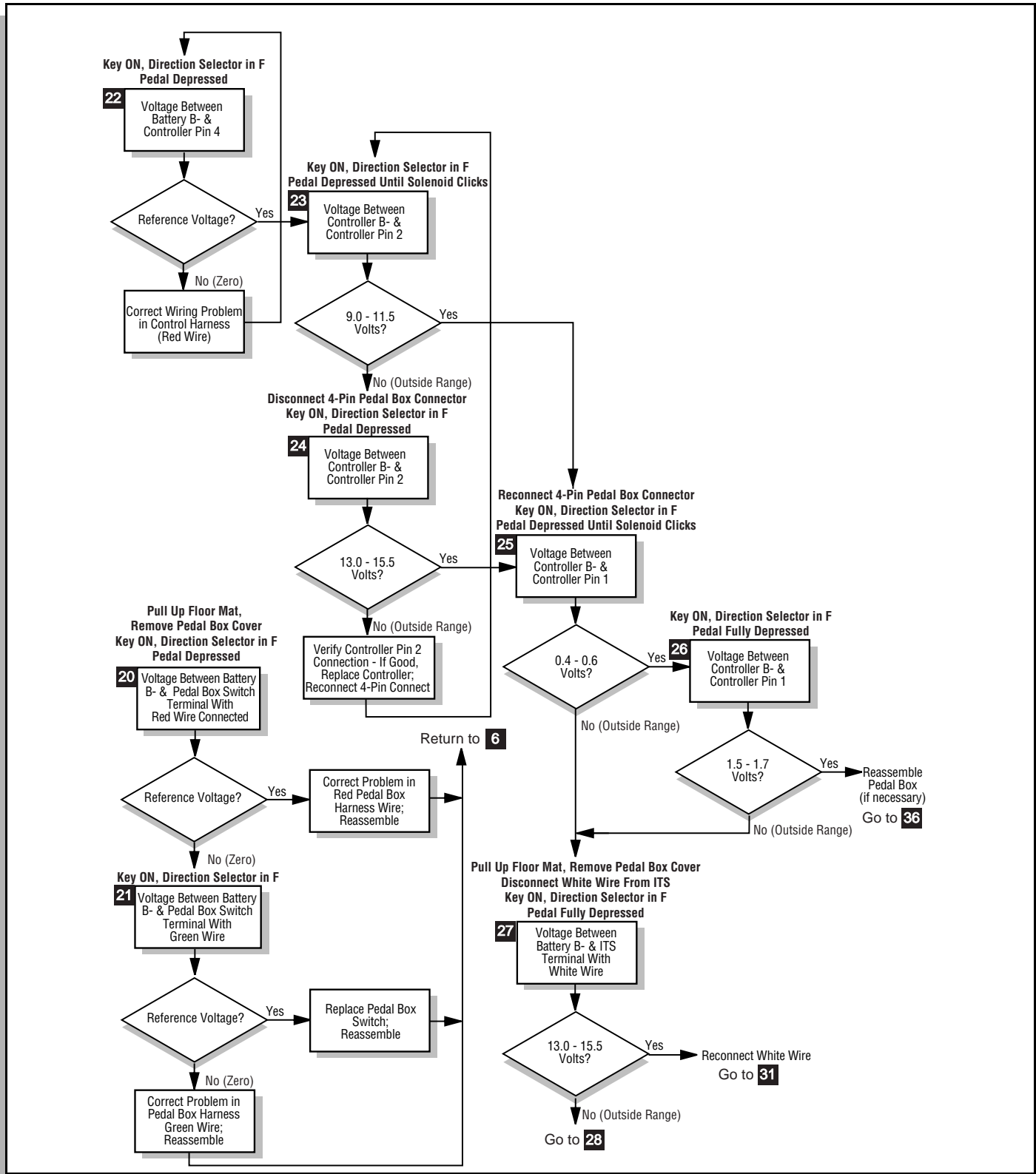
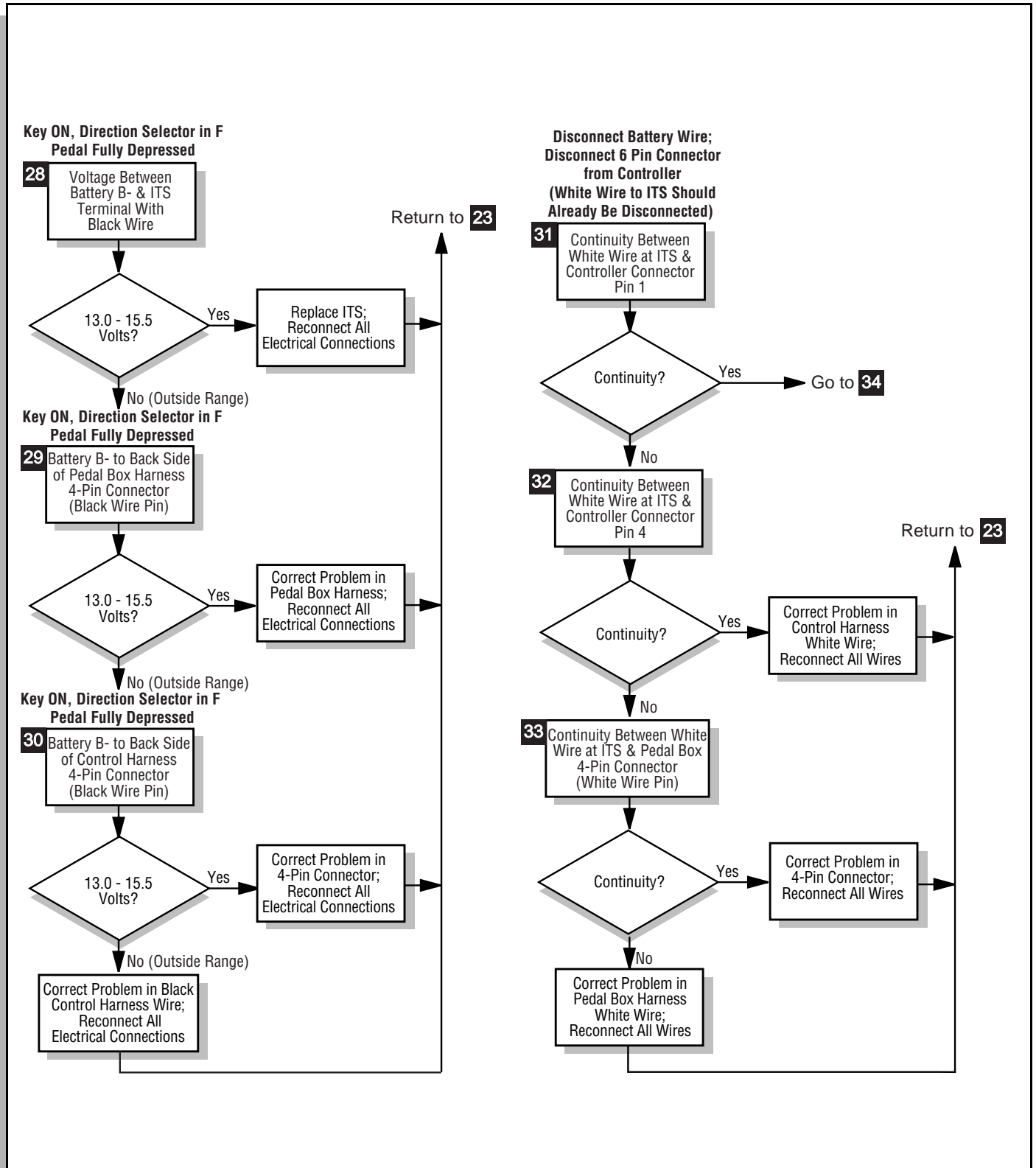


Fig. 10 Detailed Troubleshooting Diagram (Sheet 4 of 8)

# ELECTRONIC SPEED CONTROL (36V)

*Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings*



**Fig. 11 Detailed Troubleshooting Diagram (Sheet 5 of 8)**

# ELECTRONIC SPEED CONTROL (36V)

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

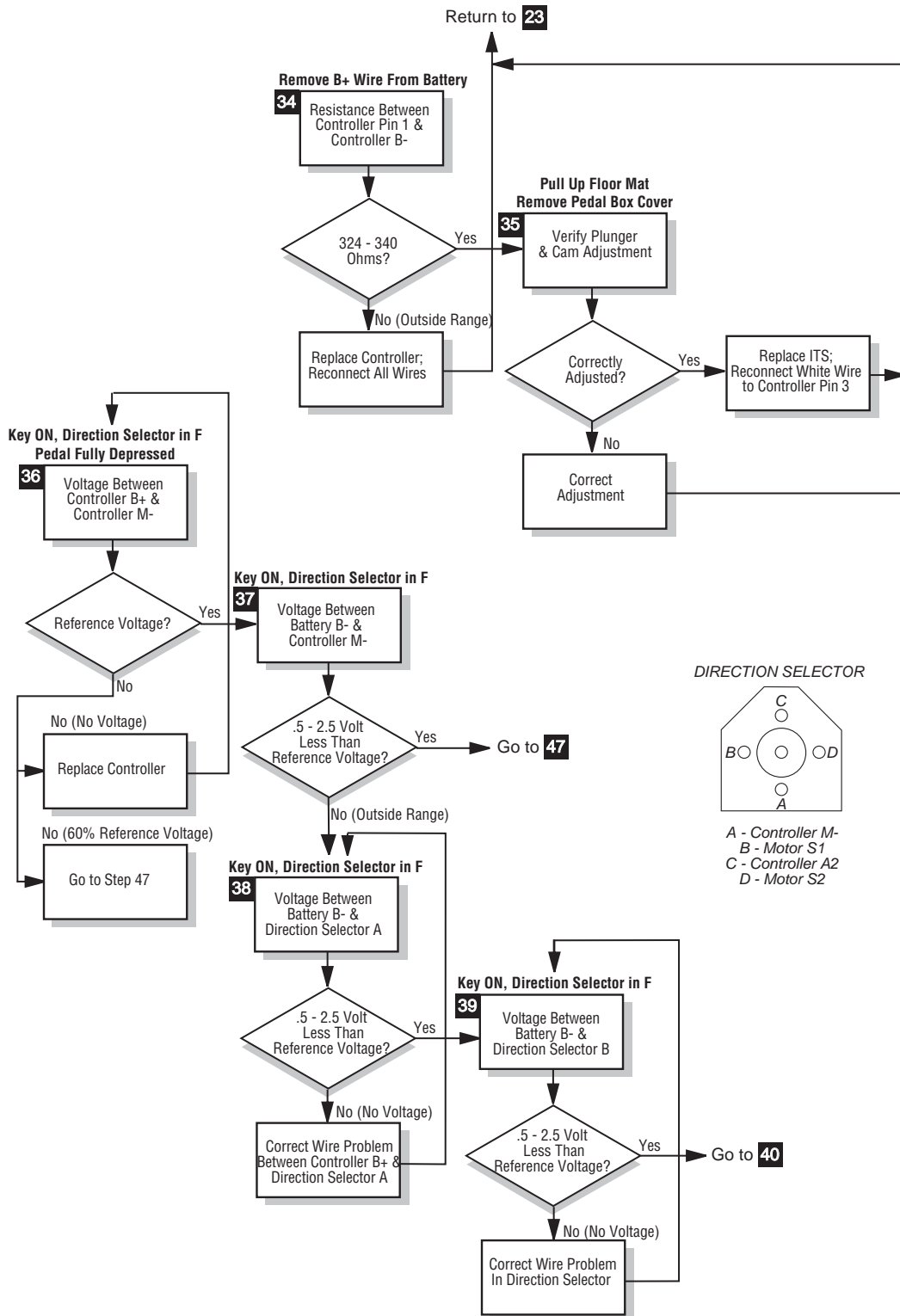
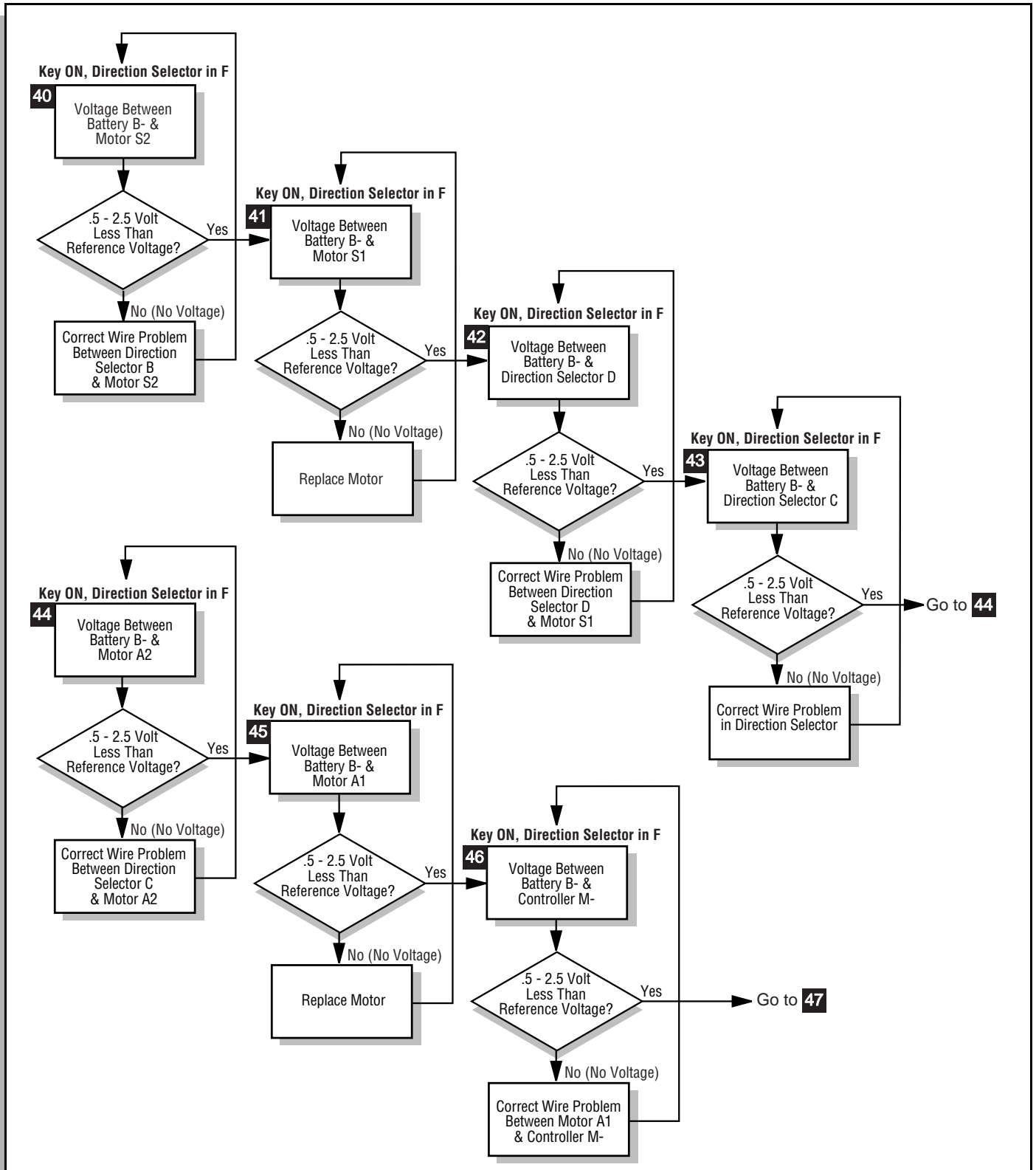


Fig. 12 Detailed Troubleshooting Diagram (Sheet 6 of 8)

# ELECTRONIC SPEED CONTROL (36V)

*Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings*



**Fig. 13 Detailed Troubleshooting Diagram (Sheet 7 of 8)**

# ELECTRONIC SPEED CONTROL (36V)

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

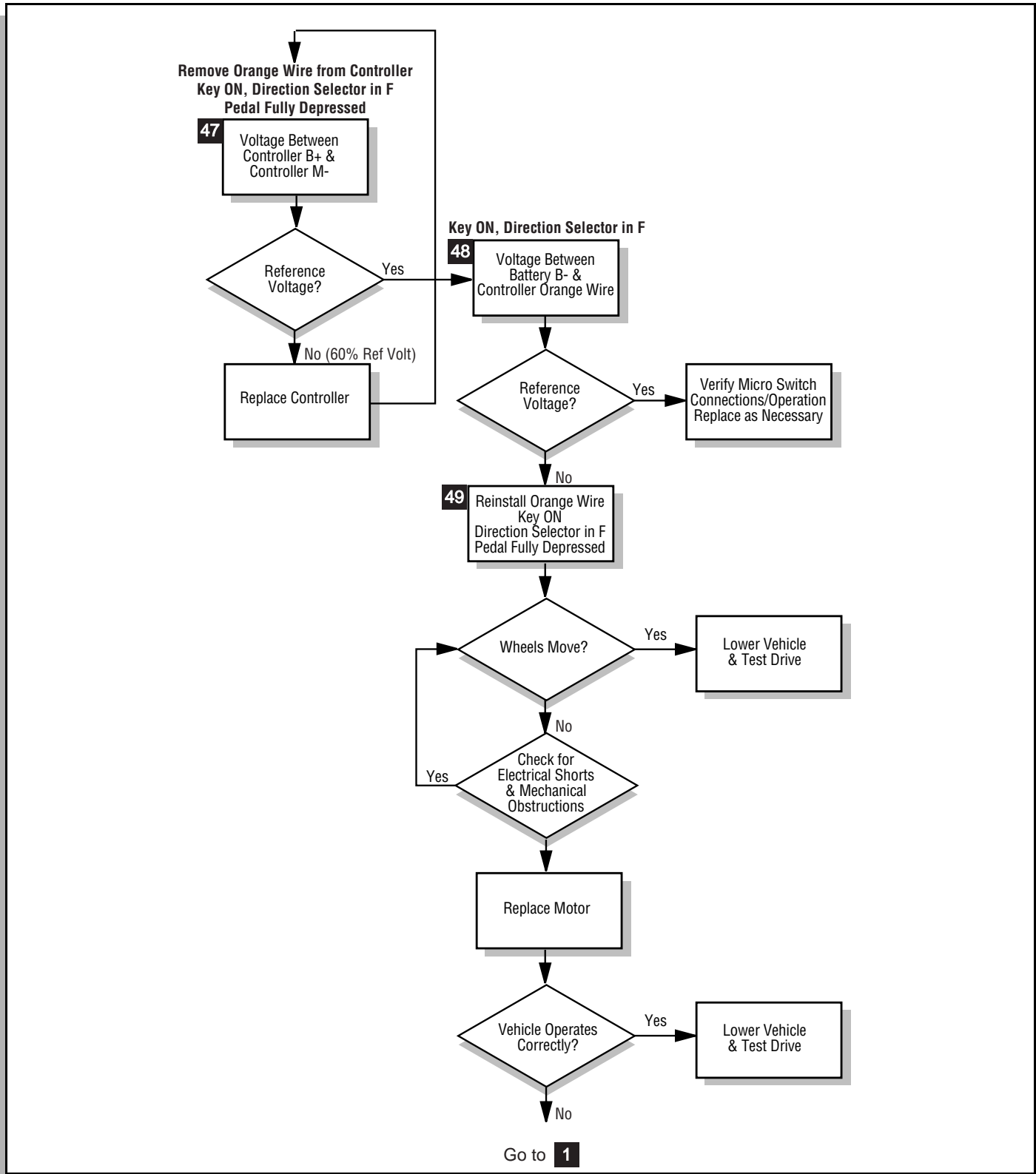


Fig. 14 Detailed Troubleshooting Diagram (Sheet 8 of 8)

# ELECTRONIC SPEED CONTROL (36V)

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

## INDUCTIVE THROTTLE SENSOR (ITS) TESTING AND REPLACEMENT

Tool List	Qty. Required
Phillips screwdriver .....	1
Wrench, 7/16" .....	1
Nut driver, 7/16" .....	1
Drill bit, 17/64" .....	1
DVOM .....	1

Raise the rear wheels of the vehicle and support the vehicle on jack stands (Refer to Lifting Procedure in Section 'B' Safety). Test the vehicle stability before proceeding.

Remove the driver's side rocker panel insert and pull the floormat forward to expose the metal cover to the pedal box (Ref Fig. 15 on page F-13).

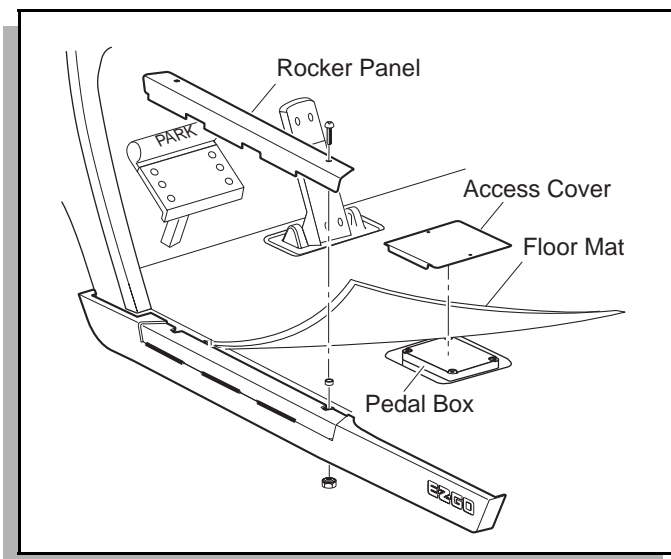


Fig. 15 Access to Pedal Box

Remove the cover and remove the four screws securing the plastic cover to the pedal box (Ref Fig. 16 on page F-13).

Set the parking 'PARK' brake. With the DVOM set to volts, probe the white wire at the ITS with the positive probe and attach the negative probe to the B- at battery. Place the direction selector in 'F' and turn the key switch to 'ON'. Depress the accelerator pedal. As the solenoid clicks the meter should read between 0.4 - 0.6 volts. The

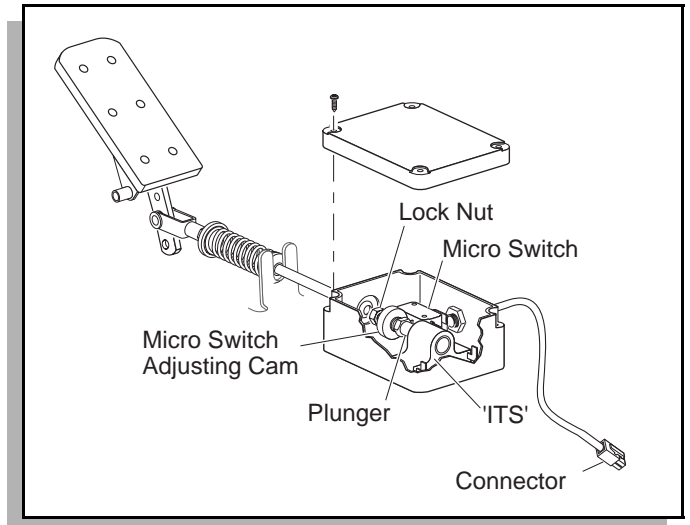


Fig. 16 ITS and Plunger

meter should read 1.5 - 1.7 volts at full pedal (Ref Fig. 18 on page F-15). If the reading is out of specification, **the ITS sensor must be replaced.**

**CAUTION** The 'ITS' attaches to the plastic pedal box using two plastic studs and two speed nuts. Use care not to overtighten the nuts which could strip the plastic studs while tightening the nuts enough to prevent movement of the 'ITS'.

Carefully remove the two wires that attach to the ITS and carefully remove the nuts securing the ITS to the plastic pedal box studs.

Install a new ITS being careful to align the ITS and not to overtighten the retaining nuts. Attach the wiring.

With the accelerator pedal in the full up position, insert a 17/64" drill bit between the plunger and the face of the ITS. The drill bit should be used to verify and adjust the distance between the face of the ITS and the face of the plunger (Ref Fig. 17 on page F-14). **If the plunger needs adjustment**, loosen the lock nut and rotate the plunger until the desired dimension is achieved. Firmly tighten the jam nut.

Replace the plastic cover and press it firmly into place before tightening the cover screws.

Replace the metal cover, floormat and rocker panel insert.

# ELECTRONIC SPEED CONTROL (36V)

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

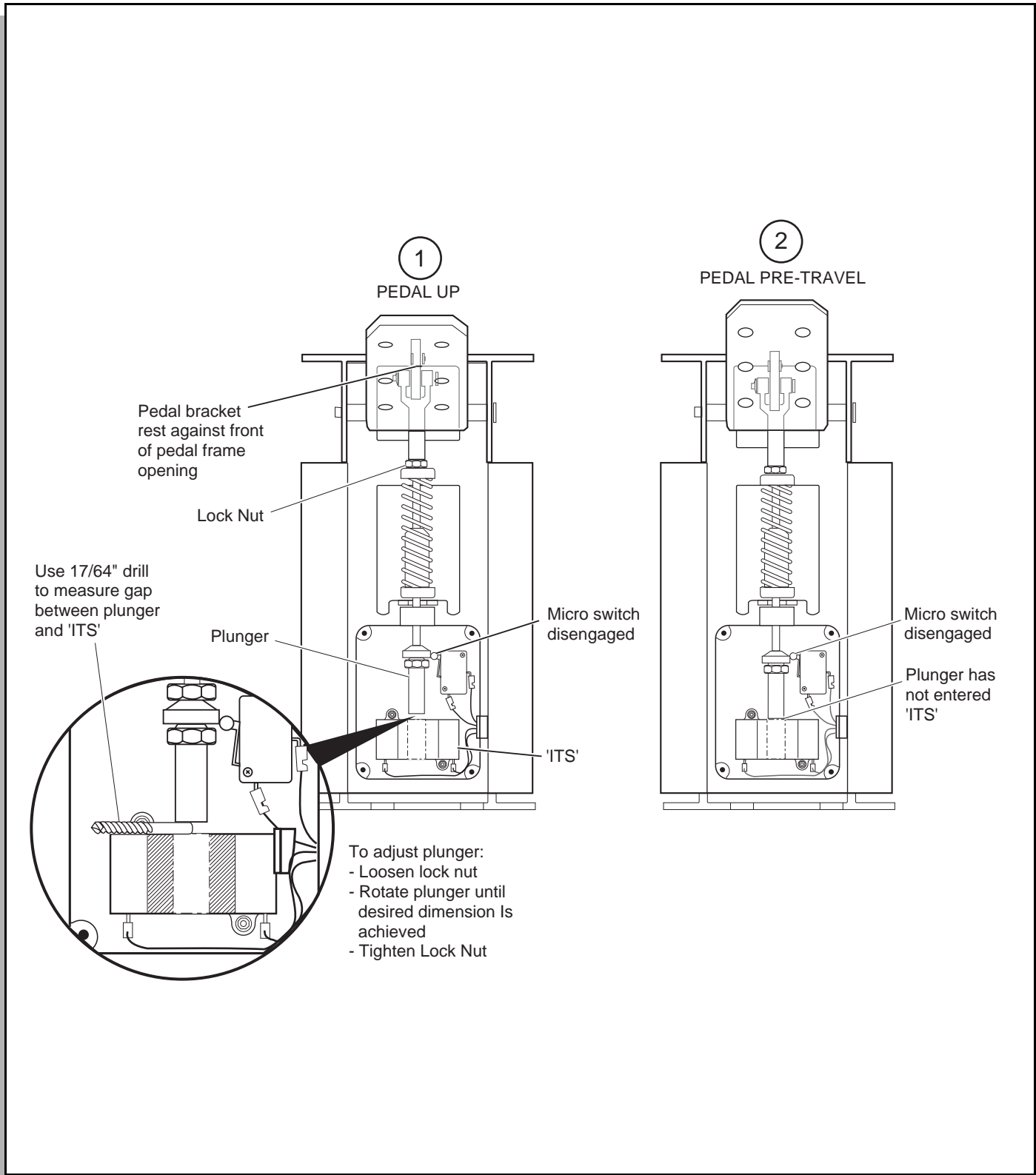


Fig. 17 ITS Adjustment (Sheet 1 of 2)



# ELECTRONIC SPEED CONTROL (36V)

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

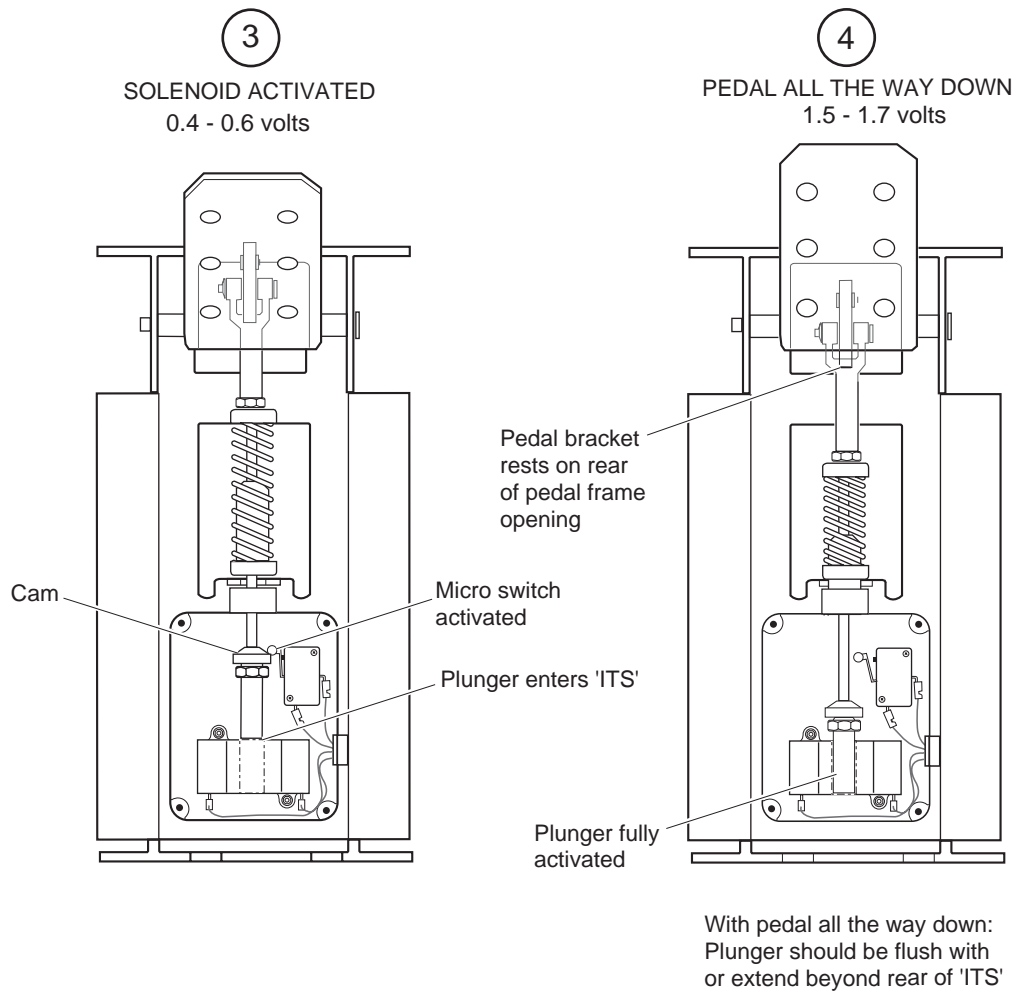


Fig. 18 ITS Adjustment (Sheet 2 of 2)

# ELECTRONIC SPEED CONTROL (36V)

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

## CONTROLLER REPLACEMENT

Tool List	Qty. Required
Socket, 3/8", 3/8" drive .....	1
Socket, 7/16", 3/8" drive .....	1
Socket, 1/2", 3/8" drive .....	1
Ratchet, 3/8" drive .....	1
Extension, 6", 3/8" drive .....	1
Insulated wrench, 9/16" .....	1
Shop towel.....	1
Torque wrench, 3/8" drive, in. lbs. ....	1
Torque wrench, 3/8" drive, ft. lbs. ....	1
Large screwdriver.....	1

Remove the seat.



*To prevent electrical shock, the BL- wire must be removed before discharging the controller by shorting the B+ and B- terminals of the controller with a large screwdriver. Be sure to hold screwdriver by the insulated portion.*

Using an insulated wrench, remove the BL- wire from the battery and cover the direction selector switch with a shop towel.

Remove the environmental cover.



*Note the location of the wiring on the controller before removing wiring from controller (Ref Fig. 2 on page F-1).*

Remove the controller mounting bolts and remove the controller.

Mount new controller and reconnect wiring. Tighten the controller mounting bolts to 108 - 132 in. lbs. (12 - 15 Nm) torque and the terminal bolts to 11 - 14 ft. lbs. (15 - 19 Nm) torque.

Replace the environmental cover and tighten the mounting bolts to 108 - 132 in. lbs. (12 - 15 Nm) torque.

Reconnect the BL- battery cable and replace the seat.

## SOLENOID REPLACEMENT

Tool List	Qty. Required
Socket, 3/8", 3/8" drive .....	1
Socket, 7/16", 3/8" drive .....	1
Socket, 1/2", 3/8" drive .....	1
Ratchet, 3/8" drive .....	1
Extension, 6", 3/8" drive .....	1
Insulated wrench, 9/16" .....	1
Shop towel.....	1
Torque wrench, 3/8" drive, in. lbs. ....	1
Torque wrench, 3/8" drive, ft. lbs. ....	1
Large screwdriver .....	1

Remove the seat.



*To prevent electrical shock, the BL- wire must be removed before discharging the controller by shorting the B+ and B- terminals of the controller with a large screwdriver. Be sure to hold screwdriver by the insulated portion.*

Using an insulated wrench, remove the BL- wire from the battery and cover the direction selector switch with a shop towel.

Remove the environmental cover.



*Note the location of the wiring on the solenoid before removing wiring from solenoid (Ref Fig. 2 on page F-1).*

Remove the solenoid mounting bolts and remove the solenoid.

Mount new solenoid and reconnect wiring. Tighten the solenoid mounting nuts to 68 - 82 in. lbs. (8 - 9 Nm) torque, the #10 terminal nuts to 15 - 20 in. lbs. (2 Nm) and the 5/16" terminal nuts to 50 - 55 in. lbs (6 Nm) torque.

Replace the environmental cover and tighten the mounting bolts to 108 - 132 in. lbs. (12 - 15 Nm) torque.

Reconnect the BL- battery cable and replace the seat.

# ELECTRONIC SPEED CONTROL (36V)

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

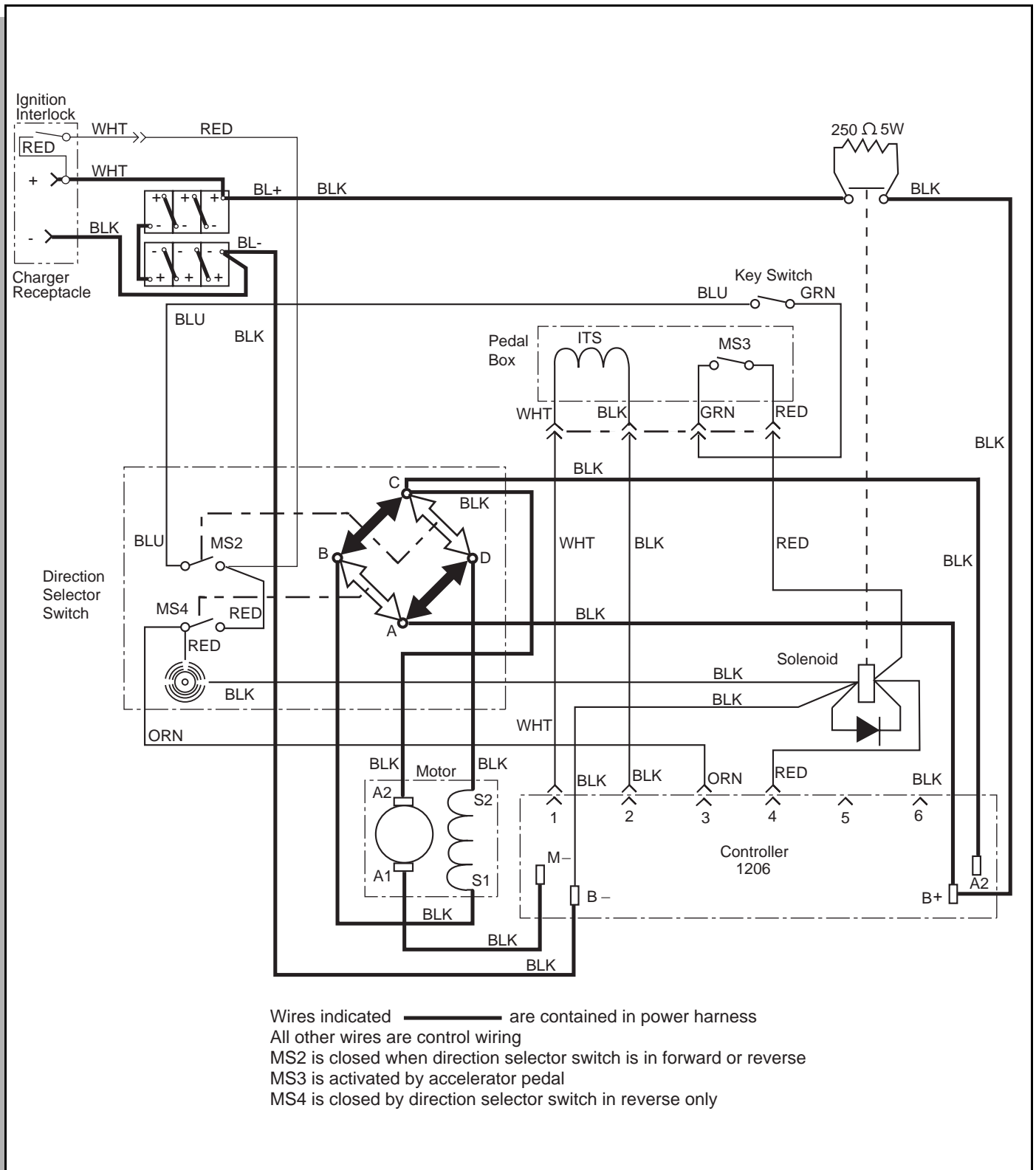


Fig. 19 Wiring Diagram

# ELECTRONIC SPEED CONTROL (36V)

*Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings*

**Notes:** \_\_\_\_\_

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# ELECTRONIC SPEED CONTROL (48V)



Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

## 48 VOLT SYSTEM VEHICLES GENERAL

48 Volt vehicles are operated in one of four modes or "performance options". The option of the vehicle is determined by which performance plug is installed in the Electronic Speed Control Assembly. The options are defined as follows:

1. The 'No Plug' performance option: The motor's speed is sensed and regulated to 13.5 mph (22 kph) directly by the controller, the vehicle's flat ground speed will not change with different ground surfaces. The speed sensor also allows for precise control of the downhill vehicle speed during compression braking. Compression braking occurs when the throttle is released while the vehicle is moving. The motor will electrically retard the motion of the vehicle until the throttle is depressed again or the vehicle stops. This is the strongest of the two compression braking options. As the vehicle crests a hill and begins to descend, the speed will be smoothly regulated to 13.5 mph (22 kph). This option is enabled when there is a blank plug installed.
2. The 'Blue Plug' performance option: This option includes all of the driving features of the 'No Plug' option except that the compression braking feel is milder.
3. The 'Yellow Plug' performance option: This option includes all of the driving features of the 'No Plug' option, except the flat ground compression braking speeds are 15 mph (24 kph) instead of 13.5 mph (22 kph).
4. The 'Red Plug' performance option: This option includes all of the driving features of the 'Blue Plug' option except that the flat ground and downhill compression braking speeds are 15 mph (24 kph) instead of 13.5 mph (22 kph).

Performance options of the Precision Drive System include:

- Anti-Roll back to limit backward motion of the vehicle down an incline to less than 2 mph (3 kph)
- Walk-Away to limit vehicle movement without driver input, slowing the vehicle to 2 mph (3 kph) and sounding an audible alarm (reverse beeper)
- Anti-Stall protection to prevent commutator damage from stalling the vehicle against an object or on a hill
- High pedal disable to prevent undesired acceleration if the direction selector lever is changed, or the key is turned on while the accelerator is depressed
- Diagnostic light indicator to ease troubleshooting

## PERFORMANCE OPTIONS & DIAGNOSTICS

Performance Option	Top Speed	Compression Braking Strength	Anti-Stall Protection
No Plug	13.5 mph ( 22 kph)	Heavy	Yes
Blue Plug	13.5 mph (22 kph)	Mild	Yes
Yellow Plug	15 mph (24 kph)	Heavy	Yes
Red Plug	15 mph (24 kph)	Mild	Yes

### Changing Performance Options

The performance option may be changed if the existing option is not compatible with the terrain that the vehicle will be operated.

1. Raise the seat and move the Run-Tow/Maintenance switch to the 'TOW/MAINTENANCE' position.
2. Locate the 5-pin performance option plug emanating from the J-1 connector and remove the option plug.
3. Replace the existing performance option plug with the desired new plug.
4. Move the Run-Tow/Maintenance switch to 'RUN'.

(To activate a newly installed performance option plug, cycle the Run-Tow/Maintenance switch by moving switch to 'Tow/Maintenance' once again, and back to Run'.)

# ELECTRONIC SPEED CONTROL (48V)

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

At monthly intervals, test the 48 volt system by allowing the vehicle to roll down an incline with the accelerator pedal released. Braking force should be felt at approximately 2 mph (3 kph) indicating that the 48 volt system is functioning. If vehicle speed continues to rise, apply the service brake to control speed and proceed with diagnostic check.

The 48 volt vehicle has the ability to diagnose and report several common vehicle fault modes. These faults are reported through a light emitting diode on the face of the controller through a sequence of blinks.

The faults are reported as a series of blinks followed by a pause and then another series of blinks. The number of blinks in each series constitute the fault code. For example: three short blinks followed by a pause, and then two more short blinks would indicate fault code 3-2.

The two-position 'Run-Tow/Maintenance' switch is located under the passenger seat (Ref Fig. 1 on page F-20).

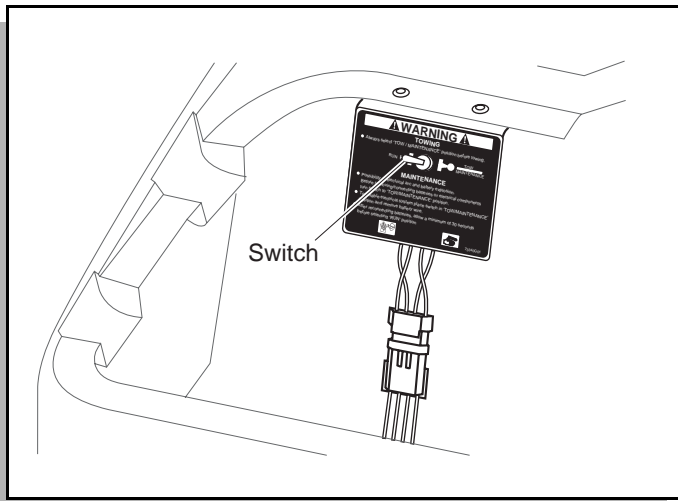


Fig. 1 Run-Tow/Maintenance Switch

## OPERATION

With the switch in 'TOW/MAINTENANCE' position:

- the controller is deactivated
- the electronic braking system is deactivated which allows the vehicle to be towed or roll freely
- the reverse warning beeper is deactivated

With the switch in 'RUN' position:

- the controller is activated
- the electronic braking system and reverse warning beeper features are activated

**NOTE** 48 volt vehicles operate only in the 'RUN' position.

If all of the following events occur with the switch in 'RUN' position

- a) the vehicle has been stopped for more than one second
- b) the accelerator pedal has been released for more than one second
- c) the vehicle begins to roll above 2 mph (3 kph)

the electronic braking will limit speed to approximately 2 mph (3 kph) and the warning beeper will sound. When the accelerator pedal is depressed, the electronic braking and warning beeper will be overridden and normal vehicle operation resumes. Any unusual situation sensed by the 48 volt system will cause a similar response. The system functions in all key switch positions.

**⚠ WARNING ⚠** *The 48 volt system is not a substitute for the service brake which should be used to control speed and reduce possibility of injury.*

If all of the following events occur with the switch in 'RUN' position

- a) the vehicle is being driven down a slope
- b) the vehicle speed exceeds the designed speed with the accelerator pedal depressed **or** released (except options equipped with compression braking)

the electronic braking will limit the speed of the vehicle to the designed speed range (the warning beeper will **not** sound). When the electronic braking system is activated by this sequence of events, the motor generates power which is returned to the batteries. 48 volt models are equipped with a regenerative motor control system.

The motor's speed is sensed and regulated directly by the controller. As a vehicle begins to accelerate while descending a hill, the speed sensor will cause the motor to electrically retard the speed of the vehicle through regenerative braking.

If the operator attempts to override the electronic braking feature by moving the direction selector or key switch to another position, the warning beeper will sound and the vehicle will brake **rapidly** until it reaches the speed of approximately 2 mph (3 kph).

The 48 volt system also incorporates an anti-stall protection feature that prevents commutator damage from stalling the vehicle against an obstacle or ascending a hill.

# ELECTRONIC SPEED CONTROL (48V)

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

The electrical power to the motor will be interrupted intermittently allowing the vehicle to roll a short distance, thereby allowing the internal components of the motor to move before damage can be done.

The No Plug option (See chart on page 1) features a different degree of compression breaking that takes place any time that accelerator pedal is released. The No Plug option will rapidly slow the vehicle to a stop unless the accelerator pedal is depressed. The three other options will slow the vehicle to a stop at different rates unless the accelerator pedal is depressed.

The 48 volt system is a low power consumption unit but it will drain the vehicle batteries over a period of time. If the vehicle is to be stored for a prolonged period of time, the 48 volt system should be disconnected from the batteries by selecting the 'TOW/MAINTENANCE' position on the Run-Tow/Maintenance switch located under the passenger seat.

The Electronic Speed Control system consists of three separate units, a pedal box, speed sensor and controller.

## Pedal Box

The pedal box assembly is a modularized unit that contains the accelerator pedal, return spring and an enclosed box that contains the pedal position micro switch and a solid state Inductive Throttle Sensor (ITS) that is activated by a moving plunger attached to the accelerator pedal. To access the pedal box, remove the rocker panel, lift the floor mat, and remove the access cover from the floor (Ref Fig. 2 on page F-21). The ITS and plunger are accessed by removing the four screws and top cover from the enclosed pedal box.

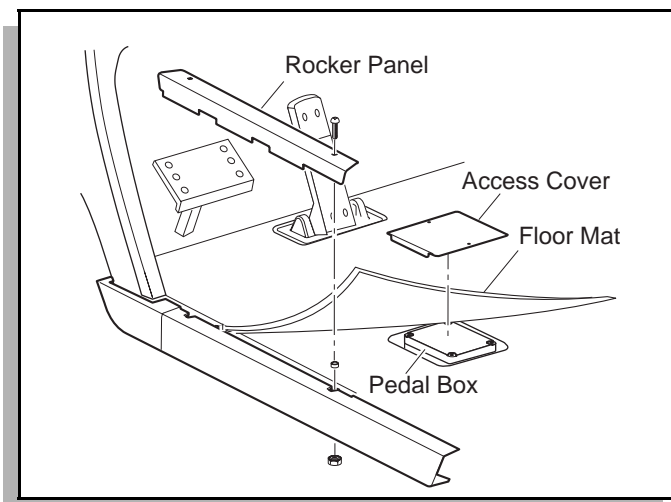


Fig. 2 Access to Pedal Box

## Speed Sensor

The speed sensor uses a sealed sensor to read the impulses of a ring magnet attached to the armature shaft of the motor. Magnetic pulses are converted into electrical signals which the controller uses to determine the motor speed.

## Controller

The controller is a solid state unit that activates a solenoid and controls the function of the vehicle by responding to inputs from the ITS and motor speed sensor. The controller and solenoid are located under the front seat on the passenger side of the vehicle (Ref Fig. 3 on page F-21).

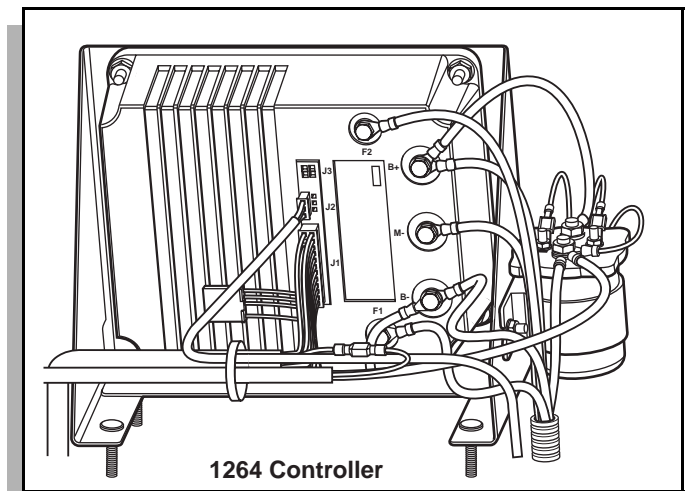


Fig. 3 Controller and Solenoid

The pedal box is connected to the controller through a 24-pin plug at J1 on the controller. The speed sensor is connected to the controller through a three-pin plug at J2 (Ref Fig. 8 on page F-26).

The controller is wired to the batteries and develops a regulated power supply for the ITS. The plunger position relative to the ITS varies the voltage which is fed back to the controller which interprets the change in voltage and supplies the appropriate power to the motor.

The ITS unit and the controller are both solid state units that contain no user serviceable parts. **The testing procedures are designed to test the basic functionality of the power and control wiring systems.** Once the functionality of the wiring has been confirmed, the remaining tests are used to identify which of the components (controller or ITS) must be replaced.

# ELECTRONIC SPEED CONTROL (48V)

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

## GENERAL TROUBLESHOOTING

Tool List	Qty. Required
Floor jack.....	1
Jack stands .....	2
Wheel chocks .....	4
Jumper wire (with alligator clips) .....	1
DVOM.....	1
Socket, 3/8", 3/8" drive .....	1
Ratchet, 3/8" drive .....	1
Torque wrench, in. lbs., 3/8" drive .....	1
Torque wrench, ft. lbs., 3/8" drive .....	1
Extension, 6", 3/8" drive .....	1
Insulated wrench, 9/16" .....	1
Wrench, 1/2" .....	1
Wrench, 7/16" .....	1
Phillips screwdriver, large .....	1
Phillips screwdriver, small .....	1
Shop towel.....	1
Allen wrench, .050" .....	1
Drill bit, 7/32" .....	1

### Symptoms

Vehicle does not operate, operates poorly or intermittently.

### Testing

A maintenance feature of the 48 volt controller is the ability to diagnose electrical faults preventing the vehicle to operate at its fullest potential. A light on the controller face will blink informing the technician to the cause of the vehicle malfunction.

A series of blinks will indicate the fault code (one, two, three, four or five followed by a pause and one, two, three, four or five more blinks). By reading the decal attached near the controller, or by reading the 48 volt Diagnostic Mode Fault Code chart (Ref Fig. 7 on page F-25), the fault, its symptom(s) and corrective action to be taken can be found.

It is unlikely that the mechanical adjustment of the pedal box has changed, therefore the initial tests will be conducted with a digital volt ohm meter (DVOM) to identify the failed component.

A typical DVOM is shown in illustrations. A recommended DVOM is available through the E-Z-GO Service Parts Department as P/N 27481-G01. Any DVOM may be used; however, the accuracy, controls, displays and

features may vary depending on the make and model. Always follow the meter manufacturer's recommendations and instructions for the use and care of the meter.

To assure accurate readings, be sure to set the meter to the closest voltage reading above the expected voltage.



**To prevent injury resulting from unexpected movement of the vehicle, always raise the rear wheels before conducting any tests.**

**To prevent possible motor damage, never operate vehicle at full throttle for more than 4-5 seconds while vehicle is in a "no-load" condition.**

For static tests, raise the rear wheels of the vehicle and support the vehicle on jack stands (Refer to the Lifting Procedure in Section 'B' Safety). Test the vehicle stability before proceeding.

Place the direction selector in 'F' and turn the key switch to 'ON'. Depress the accelerator pedal until the micro switch in the pedal box activates which should cause the solenoid mounted to the controller to make an audible click. If the solenoid does not click, test the batteries.

### Testing Battery Voltage

It is important to determine the condition of the battery set before proceeding with any electrical troubleshooting. An open voltage test is of little use since a battery that has deteriorated to the point of requiring replacement can still show six volts or higher in an open voltage test. If there is any doubt as to the adequacy of the battery set, charge the batteries and perform a load test using a discharge machine following manufacturer's instructions. If batteries are satisfactory, recharge battery set.

With the adequacy of the batteries confirmed, use a DVOM connected directly to the battery terminal posts to determine the open voltage of the set (Ref Fig. 4 on page F-23). In the following tests, this voltage level will be used as a reference. Some loss due to resistance of wires and connectors may be indicated by readings that could be up to one volt less than the reference voltage. No reading indicates an "open" condition and the battery wires should be inspected for a broken or disconnected wire or component.



# ELECTRONIC SPEED CONTROL (48V)

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

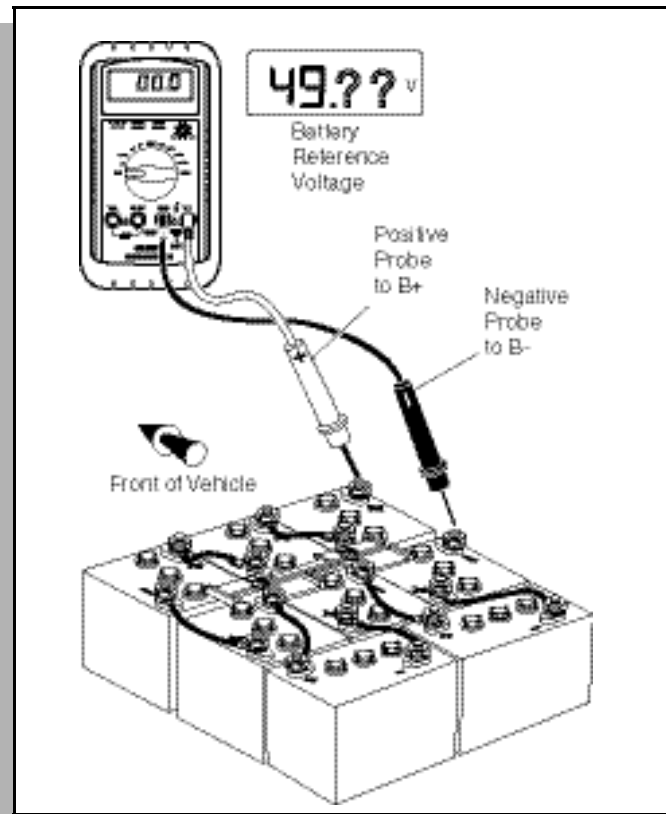


Fig. 4 Battery Reference Voltage

## Continuity Check

**⚠ WARNING ⚠** To prevent possible injury or death resulting from a battery explosion, use an insulated wrench and remove the BL-wire from the battery to disconnect electrical power to vehicle.

Before attempting to perform a continuity check, turn the key switch to 'OFF' and place the direction selector in neutral.

**CAUTION** Before any electrical service is performed on 48 volt model vehicles, the Run-Tow/Maintenance switch must be placed in the 'Tow/Maintenance' position.

If a power wire (battery, motor or controller) is disconnected for any reason on the 48 volt model vehicle, the Run-Tow/Maintenance switch must be left in the 'Tow/Maintenance' position for at least 30 seconds after the circuit is restored.

Turn the key switch to 'OFF' and place the direction selector in neutral before disconnecting power by removing the BL- connection to the battery. **Always use insu-**

**lated wrenches when working on batteries.** To check for continuity, set the DVOM to the  $K\Omega$  setting and select 'Continuity'. The meter will give an audible signal when it detects continuity. If the meter does not have a continuity setting, set it to  $K\Omega$ , the meter will indicate "0" when it detects continuity.

## Testing a Switch for Continuity

Place one probe on one contact of the switch, place the second probe on the second terminal of the switch (Ref Fig. 5 on page F-23).

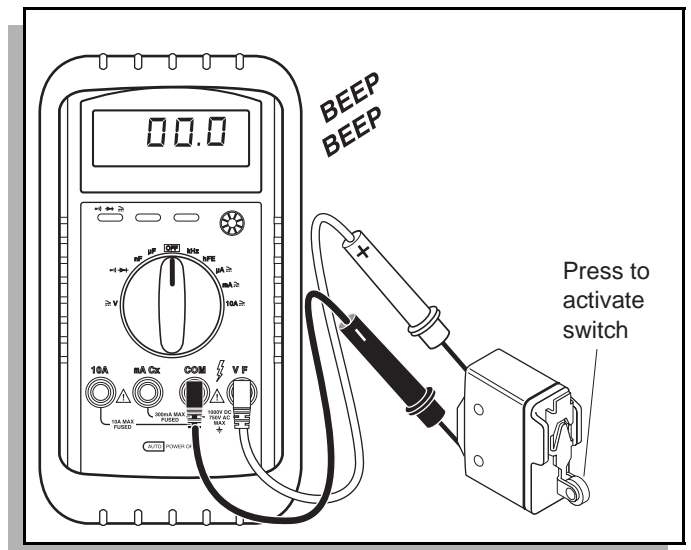


Fig. 5 Continuity Check of Switch

Actuating a normally open (NO) switch will cause the DVOM to show "0" or give an audible indication when the switch is operated. A normally closed (NC) switch will cause the meter to show "0" or give an audible indication when the probes are attached without activating switch. The audible indicator will stop and the meter display will indicate a value greater than "0" when the switch is activated.

The change in display or audible indicator demonstrates that the switch is functioning.

## Testing a Solenoid for Continuity

Place one probe on one of the large terminals and the other probe on the second large terminal (Ref Fig. 6 on page F-24). If the meter shows "0" or gives an audible indication, the solenoid terminals are "welded" closed and **the solenoid must be replaced.**

If the continuity test indicates that contacts are not "welded" and the wiring to the solenoid coil is good, the coil has failed and **the solenoid must be replaced.**

## ELECTRONIC SPEED CONTROL (48V)

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

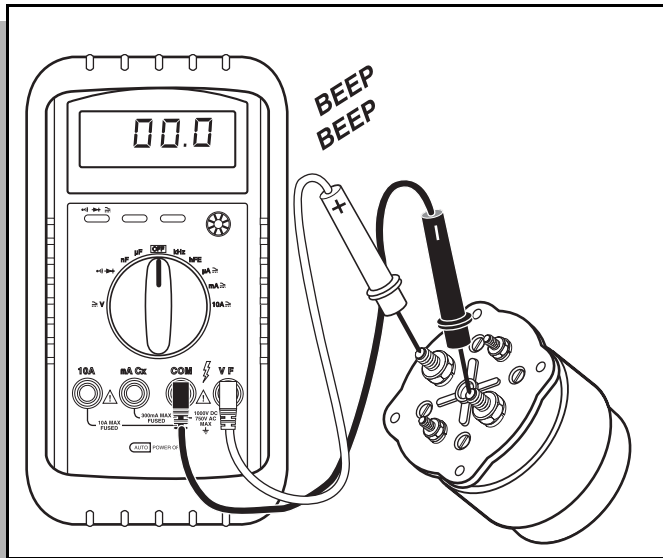


Fig. 6 Continuity Check of Solenoid

### TROUBLESHOOTING DIAGRAMS

The following diagrams will assist in servicing the vehicle. By utilizing the Fault Codes, considerable time will be saved in determining the probable vehicle operating malfunction. The vehicle power and control wiring diagram is included for your convenience in tracing the electrical wiring (Ref Fig. 9 on page F-27). The following 6 flow charts will assist in diagnosing and correcting problems not diagnosed through the Fault Codes.

# ELECTRONIC SPEED CONTROL (48V)

*Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings*

Fault Code	Fault	Vehicle Operation Change	Corrective Action
- - -	Direction Selector Fault	Vehicle Operates in One Direction Only	<ul style="list-style-type: none"> <li>• At Direction Selector check wiring</li> <li style="padding-left: 20px;">Bad - Replace/repair wiring; Good - Replace selector switch</li> </ul>
- - -	No Buzzer	Buzzer Inoperative	<ul style="list-style-type: none"> <li>• Verify Run-Tow/Maintenance Switch is in 'RUN' position;</li> <li>• Verify 48 volts at J1 Pin 10; Repair/replace Pin 10 wire;</li> <li>• Verify 48 volts at J1 Pin 1; Repair/replace Logic Power;</li> <li>• (In Reverse) Verify 48 volts at J1 Pin 2; Repair/replace wire or micro switch in Direction Selector switch</li> </ul>
0 - 0	No Fault Codes	Vehicle Inoperative with Key ON	<ul style="list-style-type: none"> <li>• Open Pedal Box, verify micro switch wiring is connected &amp; is not damaged; Repair/replace as necessary;</li> <li>• Direction Selector Forward micro switch OPEN, verify switch is operational and wiring is connected &amp; not damaged; Repair/replace as necessary;</li> <li>• Verify Key Switch is operational; Repair/replace as necessary</li> </ul>
<b>The following codes require the rear wheels be raised before performing tests:</b>			
1 - 1	Hardware Failsafe	Vehicle will not run	<ul style="list-style-type: none"> <li>• Check motor wiring; Replace controller</li> </ul>
1 - 2	Throttle Fault 1	Vehicle will not run	<ul style="list-style-type: none"> <li>• Check pedal box adjustment, connections; Replace ITS</li> </ul>
1 - 3	Speed Sensor Fault	Vehicle runs slowly	<ul style="list-style-type: none"> <li>• Check speed sensor magnet, wire, sensor &amp; connector connections; Replace speed sensor if necessary</li> </ul>
1 - 4	High pedal disable	Vehicle will not run	<ul style="list-style-type: none"> <li>• Release and reapply pedal; Check pedal box, linkage, switch, key switch</li> </ul>
1 - 5	Motor stall	Vehicle stopped	<ul style="list-style-type: none"> <li>• Remove mechanical blockage</li> </ul>
2 - 1	Low Battery Voltage	Vehicle performance reduced	<ul style="list-style-type: none"> <li>• Perform discharge test; Charge batteries/replace bad batteries</li> </ul>
2 - 2	High Battery Voltage	Vehicle performance reduced	<ul style="list-style-type: none"> <li>• Verify that battery system is less than 48 volts</li> </ul>
2 - 3	Thermal Cutback	Vehicle performance reduced	<ul style="list-style-type: none"> <li>• Allow controller to cool and verify heat sink bolt tightness</li> </ul>
2 - 4	Main driver on	Vehicle runs slowly	<ul style="list-style-type: none"> <li>• Solenoid driver defective; Replace controller</li> </ul>
2 - 5	Volts direct current fault	Vehicle will not run	<ul style="list-style-type: none"> <li>• Replace controller</li> </ul>
3 - 1	Main driver off	Solenoid does not close	<ul style="list-style-type: none"> <li>• Replace controller</li> </ul>
3 - 2	Solenoid Welded	Vehicle runs slowly	<ul style="list-style-type: none"> <li>• Replace solenoid</li> </ul>
3 - 3	Precharge fault	Vehicle will not run	<ul style="list-style-type: none"> <li>• Check for additional electronics attached to B+; Replace controller</li> </ul>
3 - 4	Field missing	Solenoid closes, Vehicle will not run	<ul style="list-style-type: none"> <li>• Check wiring; Replace power harness and motor if required</li> </ul>
3 - 5	Field overcurrent	Vehicle will not run	<ul style="list-style-type: none"> <li>• Field windings or power harness shorted; Verify; Replace motor if necessary</li> </ul>

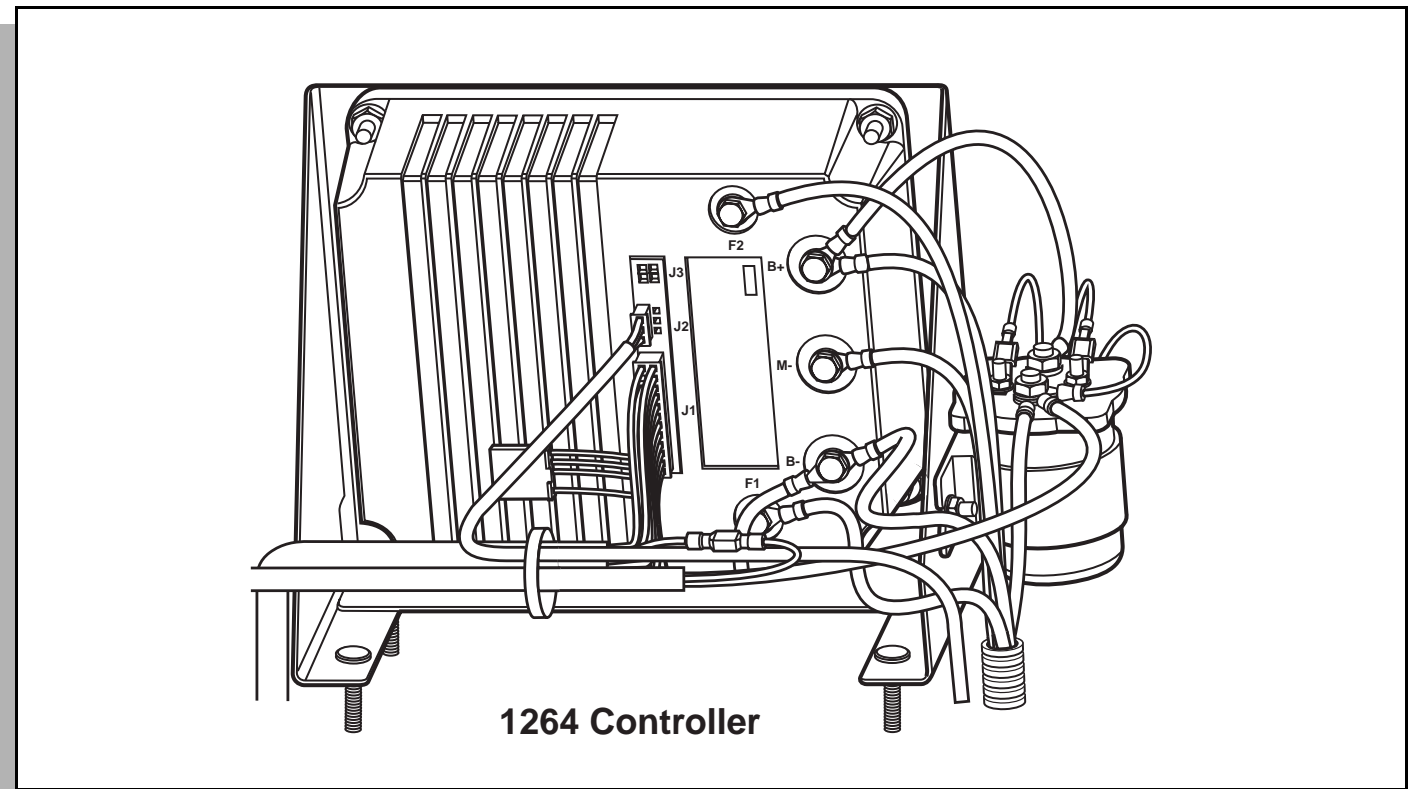
**Fig. 7 48 volt Fault Codes**

## ELECTRONIC SPEED CONTROL (48V)

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

4 - 1	Current sense fault	Vehicle will not run	<ul style="list-style-type: none"> <li>• Replace controller</li> </ul>
4 - 3	M- fault	Vehicle will not run	<ul style="list-style-type: none"> <li>• Check M- wiring and repair; Replace controller</li> </ul>
4 - 4	Auxiliary contact did not close	Vehicle will not run	<ul style="list-style-type: none"> <li>• Replace controller</li> </ul>
4 - 5	Welded auxiliary contact	Vehicle runs slowly	<ul style="list-style-type: none"> <li>• Replace controller</li> </ul>
5 - 1	EEprom failsafe	Vehicle will not run	<ul style="list-style-type: none"> <li>• Replace controller</li> </ul>
5 - 2	Main coil open	Vehicle will not run	<ul style="list-style-type: none"> <li>• Check coil connections/wiring; Replace solenoid if necessary</li> </ul>
5 - 3	Main contact did not close	Vehicle will not run	<ul style="list-style-type: none"> <li>• Check all solenoid wiring; Replace solenoid if necessary</li> </ul>
5 - 5	Missing contactor	Vehicle stops	<ul style="list-style-type: none"> <li>• Check all solenoid wiring; Replace solenoid if necessary</li> </ul>

**Fig. 7 48 volt Fault Codes**



**Fig. 8 Controller Connectors and Connections**

# ELECTRONIC SPEED CONTROL (48V)

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

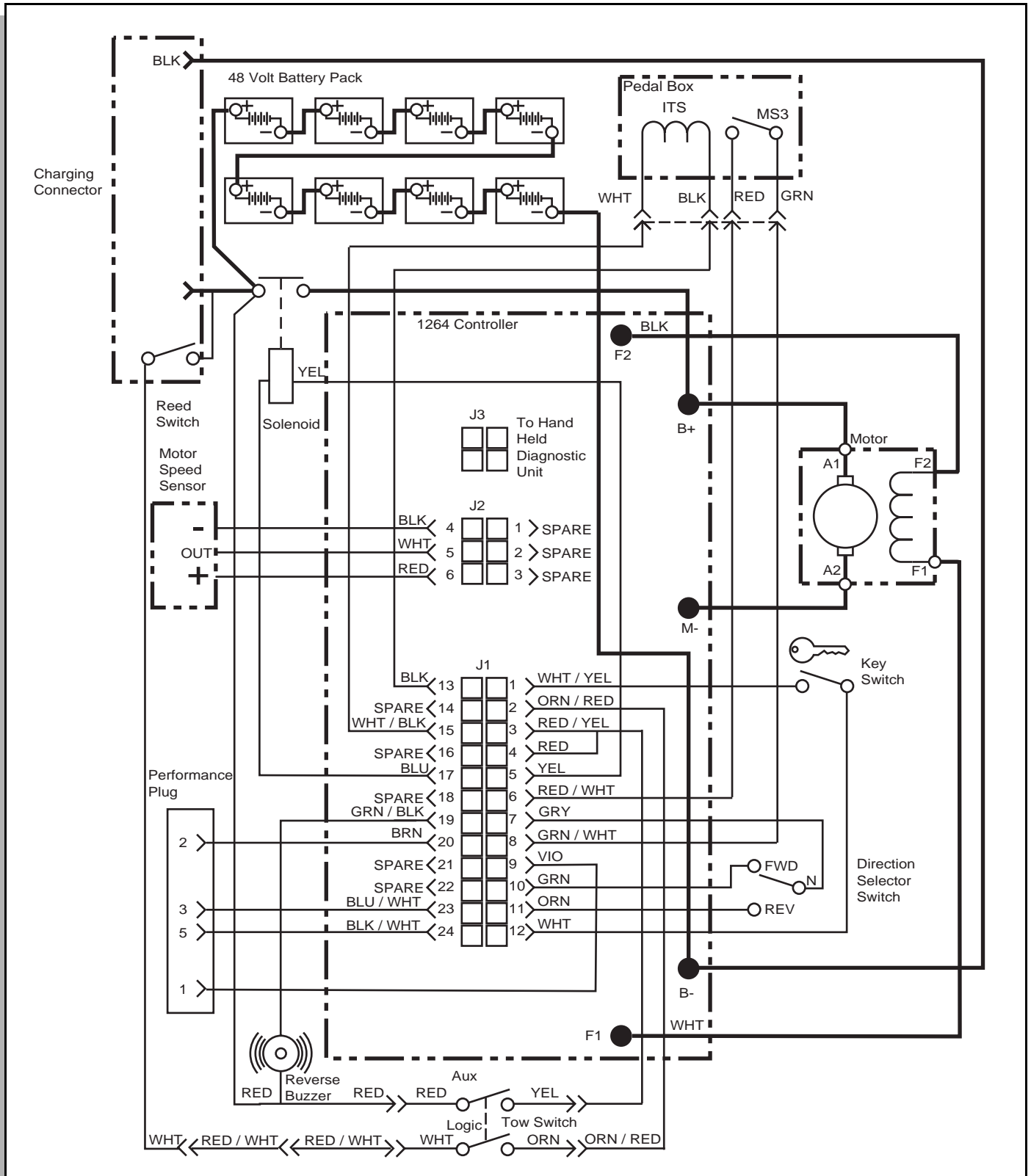


Fig. 9 48 Volt Wiring Diagram

# ELECTRONIC SPEED CONTROL (48V)

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

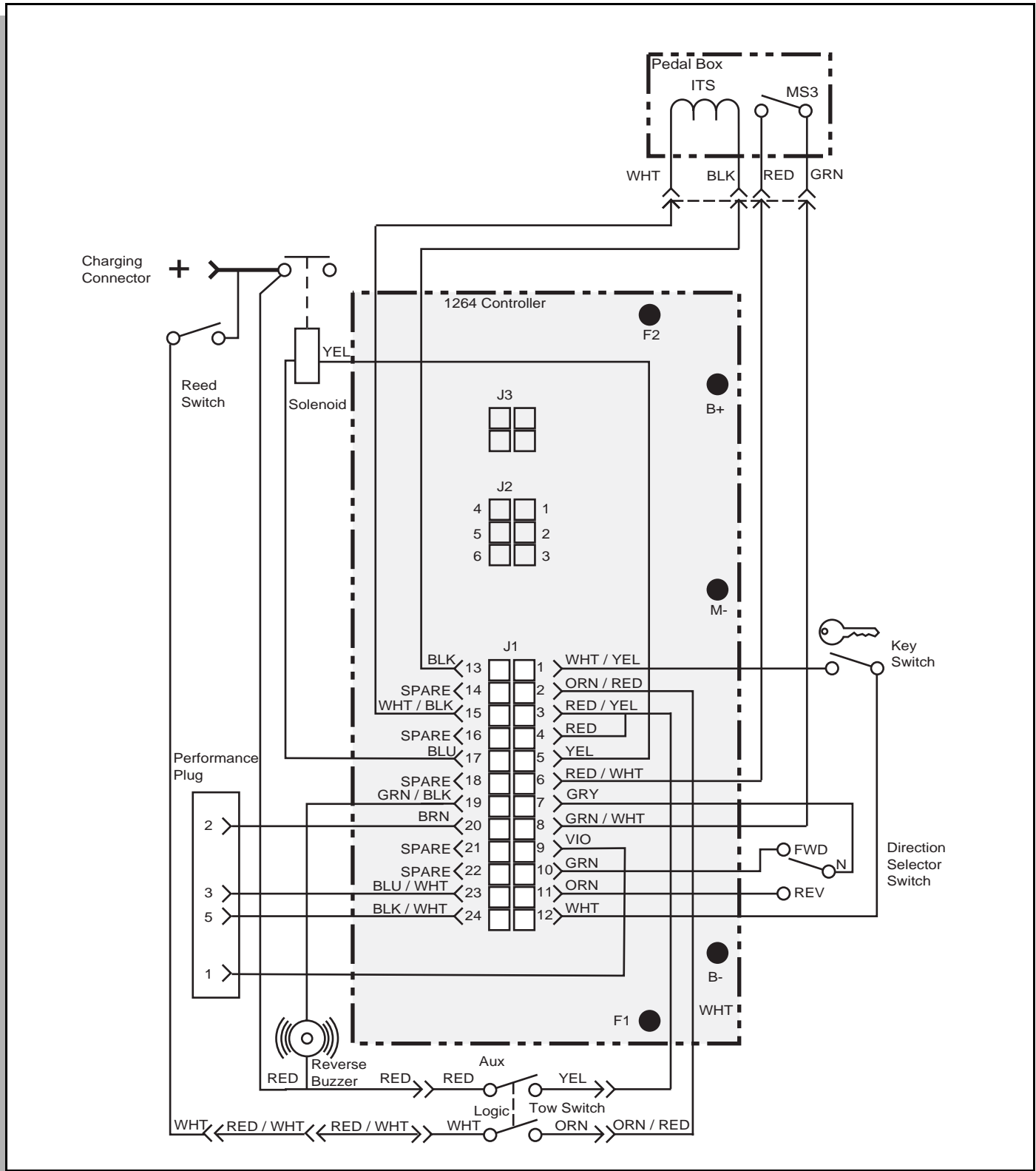


Fig. 10 J-1 Pin Connector Diagnostics

# ELECTRONIC SPEED CONTROL (48V)

*Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings*

All tests are to be performed with the negative lead of the DVOM connected to the negative side of battery pack voltage.

The positive lead of the DVOM is used to probe the controller/battery connections. Leave connections plugged in the controller

Verify the Battery Reference Voltage at the main battery pack leads. (should be around 48 volts in 8 battery applications) All pin connector checks are performed with the key 'ON' and the 'Tow/Maintenance' switch in the RUN position

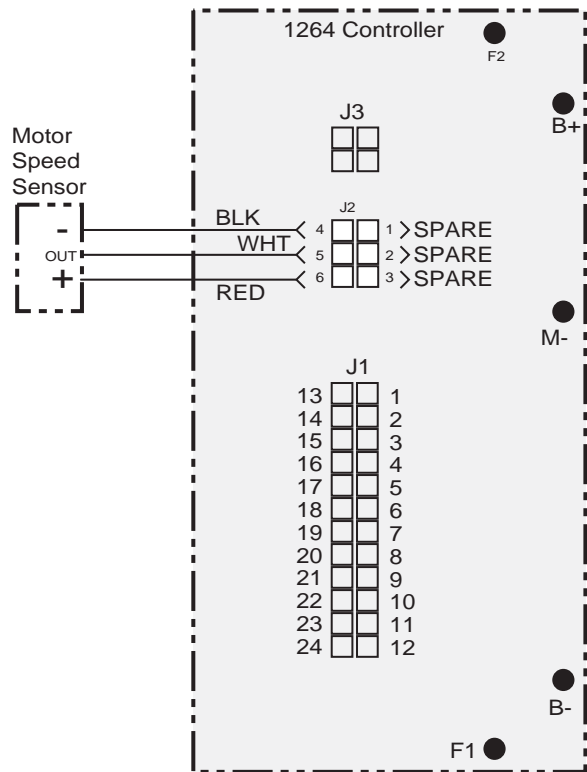
Make certain all pin connections are firmly seated.

Pin number	Voltage	If not/ Then
J1-1	BRV	Verify key switch, wiring connections, and pin 12 voltage.
J1-2	BRV	Verify reed switch, tow switch, and wiring connections
J1-3	BRV	Verify tow switch and aux power wiring
J1-4	BRV	Verify aux power voltage and wire condition.
J1-5	BRV	Verify wiring. Possible controller failure.
J1-6	BRV	Verify accelerator micro, wiring, and pin 8 voltage.
J1-7	BRV	Verify wire connections. Possible controller failure.
J1-8	BRV	Verify wiring. Possible faulty controller.
J1-9		Performance option plug wiring. No need to check.
J1-10	BRV	Verify direction selector and wiring.
J1-11	BRV	Verify direction selector and wiring.
J1-12	BRV	Verify wiring. Possible faulty controller.
J1-13	1-3.5 volts	ITS output. Verify wiring and ITS field. Measured with pedal up to wide open throttle.
J1-15	16 - 17 volts	ITS input voltage. If low voltage is observed, unplug from field. If voltage comes up, replace the ITS field. If voltage remains low, replace the controller
J1-17	BRV	BRV will be observed until solenoid engages. BRV will diminish to around 0 volts to engage solenoid. If not, verify wiring. Possible faulty controller or shorted solenoid.
J1-19	BRV	BRV will be observed until vehicle is placed in the reverse direction. BRV will diminish to 0 - 4 volts. Operates reverse alarm. If not, verify wiring. Possible faulty controller.
J1-20		Performance option plug wiring. No need to check.
J1-23		Performance option plug wiring. No need to check.
J1-24		Performance option plug wiring. No need to check.

**Fig. 11 J-1 Pin Connector Diagnostics (Continued)**

# ELECTRONIC SPEED CONTROL (48V)

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings



All tests are to be performed with the negative lead of the DVOM connected to the negative side of battery pack voltage.

The positive lead of the DVOM is used to probe the controller connections. Leave connections plugged in the controller

Armature will need to be rotated for this test. Jack vehicle up on the passenger side and rotate the rear wheel by hand

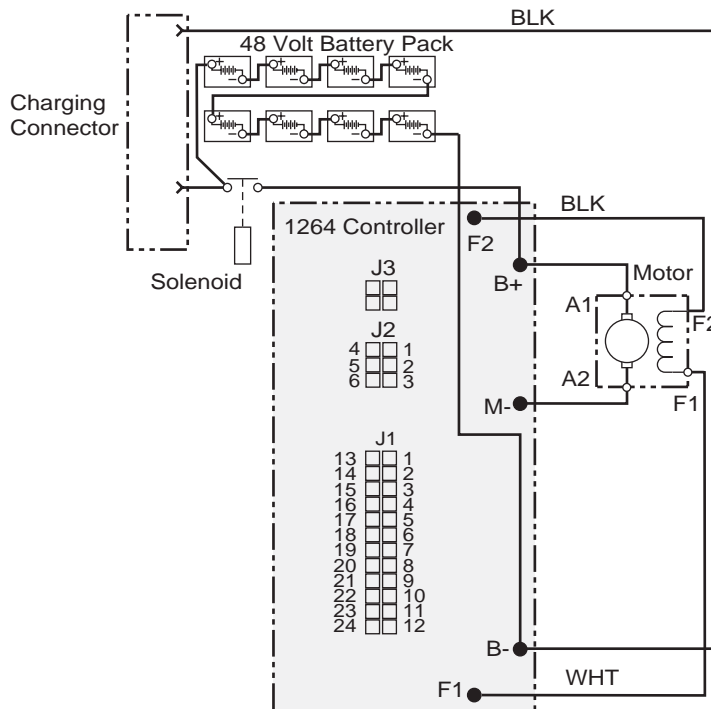
Pin number	Voltage	If not/ Then
J2-1		Spare
J2-2		Spare
J2-3		Spare
J2-4	0 volts	Verify sensor harness and connection. This connection serves as the sensor ground
J2-5	0 - 6.5 volts	Verify the speed sensor and harness . This connection provides the flash voltage from the sensor while the armature rotates.
J2-6	16 - 17 volts	Verify sensor harness. Possible faulty controller

Fig. 12 J-2 Pin Connector Diagnostics



# ELECTRONIC SPEED CONTROL (48V)

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings



This test will verify secondary circuit voltage. Please reference the chart for probe connections.

Probe Connection	Voltage	If not/ Then
Positive probe on BL+ and negative probe on BL-	BRF preferably 48 Volt	Perform battery discharge test. Verify the charger/process
Negative probe on BL- and positive probe on battery side of solenoid	BRF	Verify wire/connection quality
Negative probe on BL- and positive probe on solenoid B+	BRF with solenoid engaged	Verify primary voltage at Pin 5 & 17. If BRF is found on the primary terminals, replace solenoid.
Positive probe on B+ and negative probe on B-	BRF	Verify solenoid function. Check wiring.
Positive probe on B+ and negative probe on M-	1-48 Volt depending on performance plug	To verify: engage solenoid at high pedal. Voltage should start around 1-2 volt. As the pedal is slowly depressed to the floor, voltage should rise to around 48 volt. If extremely low voltage is observed, replace the controller. If immediate high voltage is observed, replace the motor.

Fig. 13 Secondary Wiring Diagnostics

# ELECTRONIC SPEED CONTROL (48V)

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

## INDUCTIVE THROTTLE SENSOR (ITS) TESTING AND REPLACEMENT

Tool List	Qty. Required
Phillips screwdriver.....	1
Wrench, 7/16".....	1
Nut driver, 7/16".....	1
Drill bit, 7/32".....	1
DVOM.....	1

Raise the rear wheels of the vehicle and support the vehicle on jack stands (Refer to Lifting Procedure in Section 'B'). Test the vehicle stability before proceeding.

Remove the driver side rocker panel insert and pull the floormat forward to expose the metal cover to the pedal box. Remove the cover and remove the four screws securing the plastic cover to the pedal box, remove the cover (Ref Fig. 14 on page F-32).

Carefully remove the two wires that attach to the ITS and carefully remove the nuts securing the ITS to the plastic pedal box studs.

Install a new ITS being careful to align the ITS and not to overtighten the retaining nuts. Attach the wiring.

With the accelerator pedal in the full up position, insert a 7/32" drill bit between the plunger and the face of the ITS. The drill bit should be used to verify and adjust the distance between the face of the ITS and the face of the plunger (Ref Fig. 15 on page F-33). **If the plunger needs adjustment**, loosen the lock nut at the accelerator yoke and rotate the plunger until the desired dimension is achieved. Firmly tighten the jam nut.

Replace the plastic cover and press it firmly into place before tightening the cover screws.

Replace the metal cover, floormat and rocker panel insert.

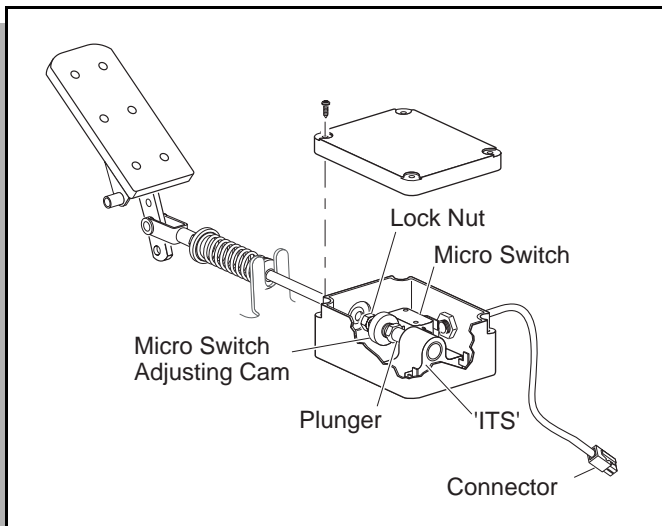


Fig. 14 ITS and Plunger

With the DVOM set to volts, probe the white wire at the ITS with the positive probe and attach the negative probe to the B- at battery. Place the direction selector in 'F' and turn the key switch to 'ON'. Depress the accelerator pedal. The meter should read  $1.0V \pm 0.3V$  when the solenoid clicks and  $2.7V \pm 0.5$  volts at full pedal (Ref Fig. 16 on page F-34). If the reading is out of specification, **the ITS sensor must be replaced.**

**CAUTION** The 'ITS' attaches to the plastic pedal box using two plastic studs and two speed nuts. Use care not to overtighten the nuts which could strip the plastic studs while tightening the nuts enough to prevent movement of the 'ITS'.

# ELECTRONIC SPEED CONTROL (48V)

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

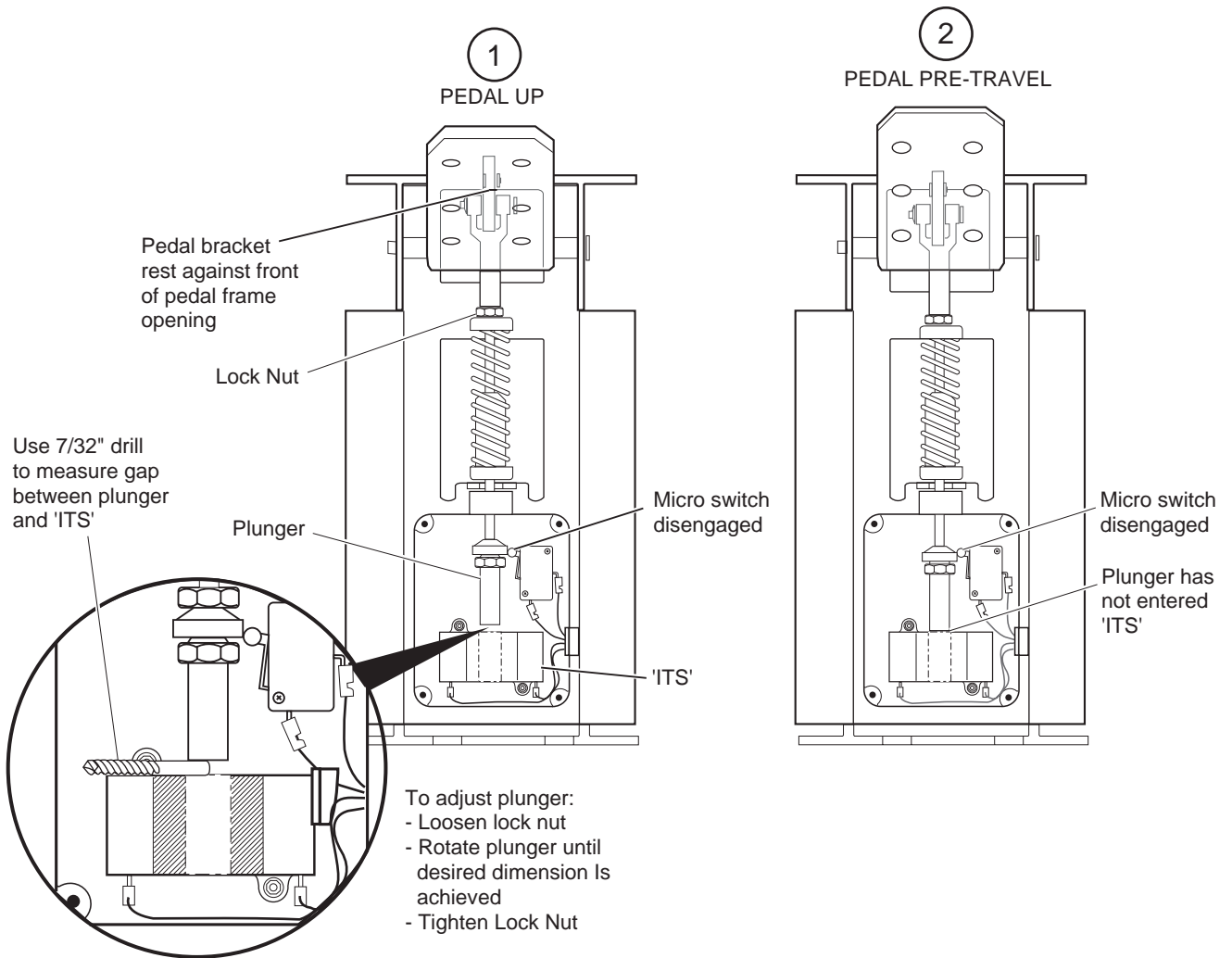


Fig. 15 ITS Adjustment (Sheet 1 of 2)

# ELECTRONIC SPEED CONTROL (48V)

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

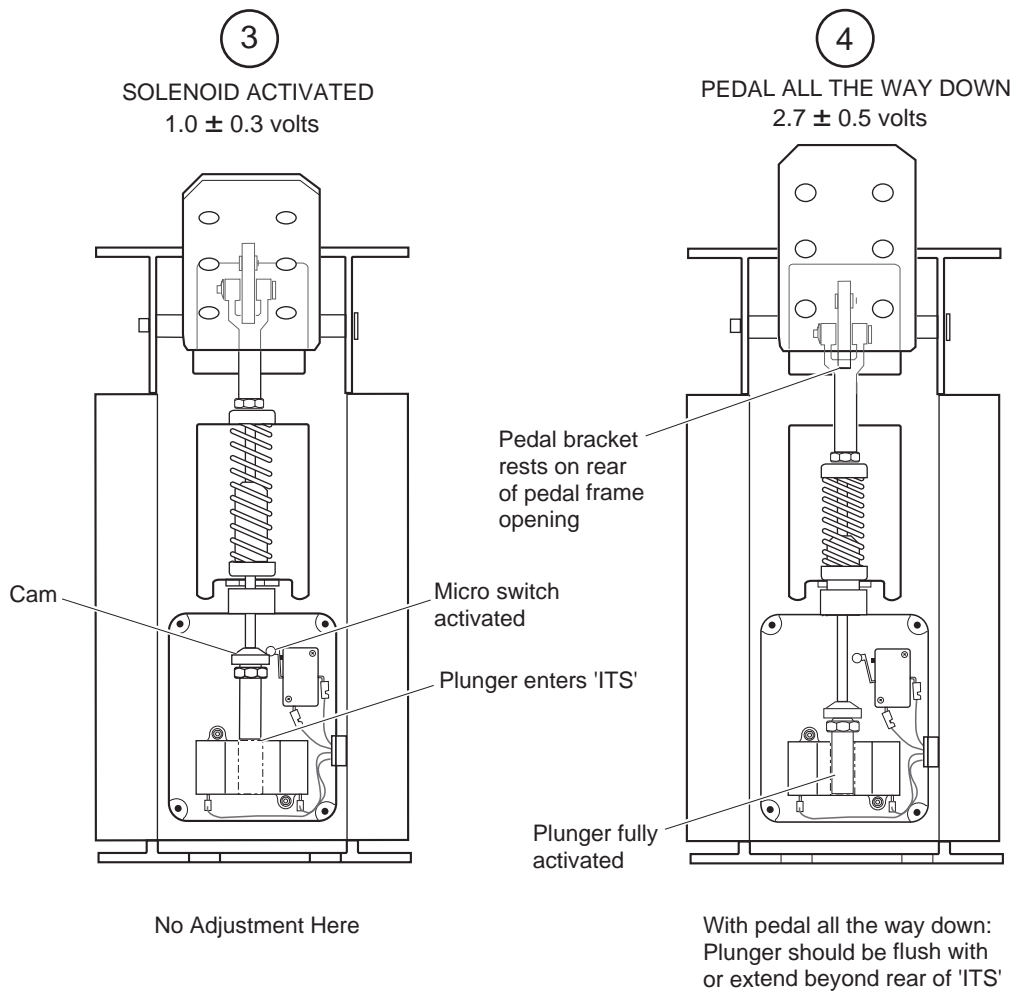


Fig. 16 ITS Adjustment (Sheet 2 of 2)

# ELECTRONIC SPEED CONTROL (48V)

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

## CONTROLLER REPLACEMENT

Tool List	Qty. Required
Socket, 10mm, 3/8" drive .....	1
Socket, 7/16", 3/8" drive .....	1
Socket, 13mm, 3/8" drive .....	1
Ratchet, 3/8" drive.....	1
Extension, 6", 3/8" drive .....	1
Insulated wrench, 9/16".....	1
Shop towel .....	1
Torque wrench, 3/8" drive, in. lbs. ....	1
Torque wrench, 3/8" drive, ft. lbs. ....	1

Remove the seat.

**CAUTION** Before any electrical service is performed on 48 volt model vehicles, the Run-Tow/Maintenance switch must be placed in the 'Tow/Maintenance' position.

If a power wire (battery, motor or controller) is disconnected for any reason on the 48 volt model vehicle, the Run-Tow/Maintenance switch must be left in the 'Tow/Maintenance' position for at least 30 seconds after the circuit is restored.

**WARNING** To prevent electrical shock, the BL- wire must be removed before discharging the controller by shorting the B+ and B- terminals of the controller with a large screwdriver. Be sure to hold screwdriver by the insulated portion.

Using an insulated wrench, remove the BL- wire from the battery.

**NOTE** Note the location of the wiring on the controller before removing wiring from controller. (Ref Fig. 17 on page F-36)

Remove the controller mounting nuts and remove the controller.

Mount new controller to mount and reconnect wiring. Tighten the controller mounting bolts to 108 - 132 in. lbs. (12 - 15 Nm) torque and the M6 (F1 and F2) bolts to 80 - 90 in. lbs. (9 - 10 Nm) torque and M8 (B+, M-, B-) bolts to 120 - 130 in. lbs. (14 - 15 Nm) torque.

Replace controller mount assembly in vehicle. Replace and tighten nuts to 6 - 8 ft. lbs. (8 - 11 Nm) torque.

Reconnect the BL- battery cable and replace the seat.

## SOLENOID REPLACEMENT

Tool List	Qty. Required
Socket, 3/8", 3/8" drive .....	1
Socket, 7/16", 3/8" drive .....	1
Socket, 1/2", 3/8" drive .....	1
Ratchet, 3/8" drive.....	1
Extension, 6", 3/8" drive .....	1
Insulated wrench, 9/16".....	1
Shop towel.....	1
Torque wrench, 3/8" drive, in. lbs. ....	1

Remove the seat.

**CAUTION** Before any electrical service is performed on 48 volt model vehicles, the Run-Tow/Maintenance switch must be placed in the 'Tow/Maintenance' position.

If a power wire (battery, motor or controller) is disconnected for any reason on the 48 volt model vehicle, the Run-Tow/Maintenance switch must be left in the 'Tow/Maintenance' position for at least 30 seconds after the circuit is restored.

**WARNING** To prevent electrical shock, the BL- wire must be removed before discharging the controller by shorting the B+ and B- terminals of the controller with a large screwdriver. Be sure to hold screwdriver by the insulated portion.

Using an insulated wrench, remove the BL- wire from the battery.

**NOTE** Note the location of the wiring on the solenoid before removing wiring from solenoid (Ref Fig. 17 on page F-36)

Remove the solenoid mounting bolts and remove the solenoid.

Mount new solenoid and reconnect wiring. Tighten the solenoid mounting nuts to 67 - 82 in. lbs. (8 - 9 Nm) torque, the #10 terminal nuts to 13 - 17 in. lbs. (1 - 2 Nm) and the 5/16" terminal nuts to 50 - 60 in. lbs (6 - 7 Nm) torque.

Reconnect the BL- battery cable and replace the seat.

# ELECTRONIC SPEED CONTROL (48V)

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

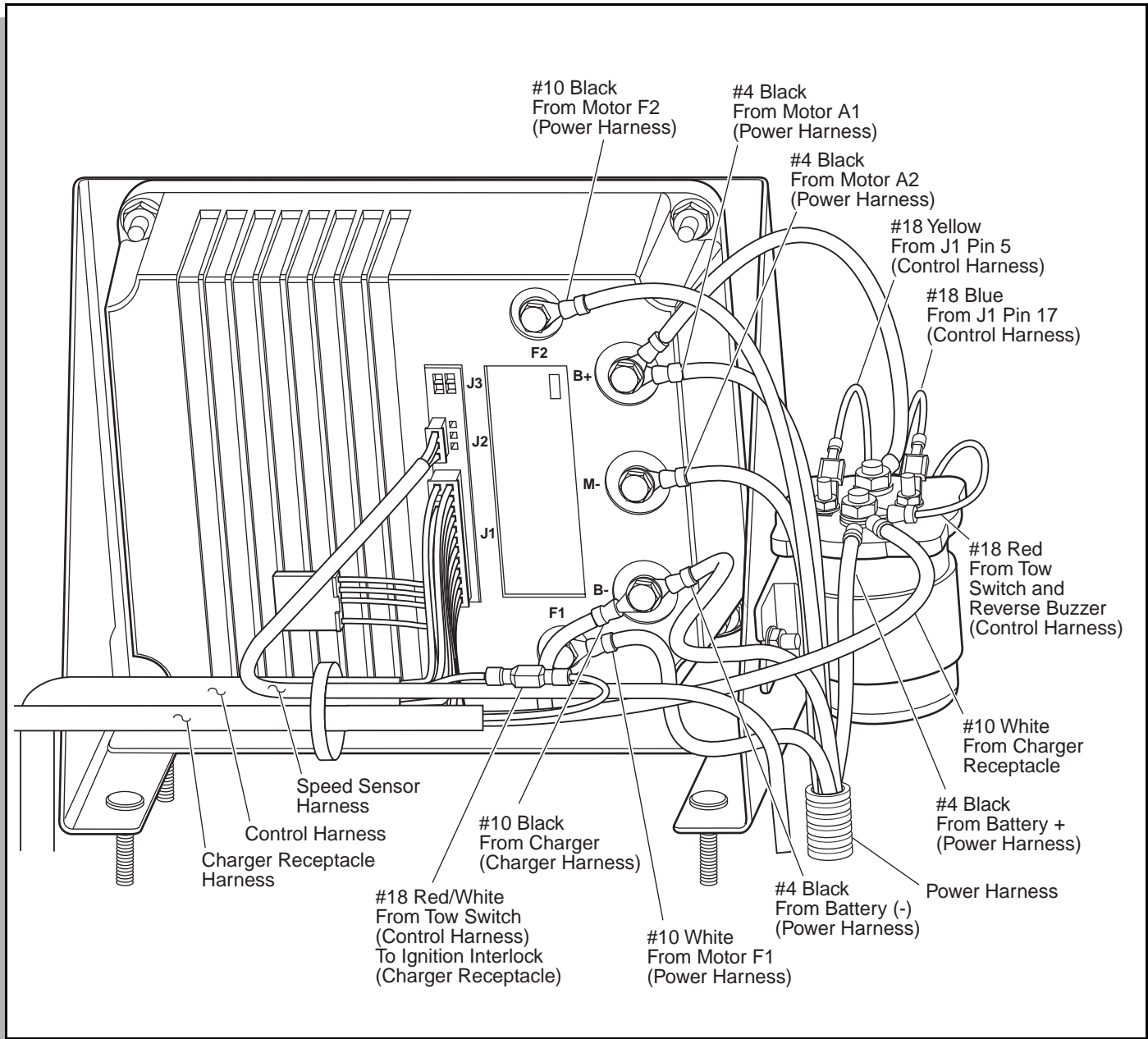


Fig. 17 Controller Wiring

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## MOTOR

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

### GENERAL

**CAUTION** Do not hold vehicle on hill by using accelerator and motor. Leaving the motor in a stalled condition for more than 3-4 seconds will raise the commutator bars resulting in unacceptable noise and accelerated brush wear and cause permanent damage to motor.

Disassembly of the motor is not recommended except to replace a worn or noisy bearing. If the motor is disassembled, it should be cleaned of any dirt buildup and the brush length checked. Replace brushes if required.

The motor housing is not available as a service item, therefore in the unlikely event of a failure in this component, the entire motor must be replaced.

### Motor Removal

**WARNING** Disconnect the negative (BL-) battery cable with an insulated wrench before attempting to remove wires from the motor (see safety procedures in SAFETY section of this manual). The shorting of motor wires could cause an explosion.

Tool List	Qty. Required
Insulated wrench, 9/16".....	1
Chalk or paint pen.....	1
Socket, 7/16", 3/8" drive.....	1
Ratchet, 3/8" drive.....	1
Internal snap ring pliers.....	1

Using an insulated wrench, disconnect the negative (-) battery cable from the battery (Ref Fig. 1 on page G-1). Remove all wires from motor.

Mark both the axle and motor housings to permit realignment during reassembly of motor to rear axle (Ref Fig. 2 on page G-1).

**CAUTION** Take care not to damage the splines when removing and reassembling the motor to the rear axle housing.

Remove the three bolts that secure the motor to the axle housing and carefully slide the motor straight out from the axle splines.

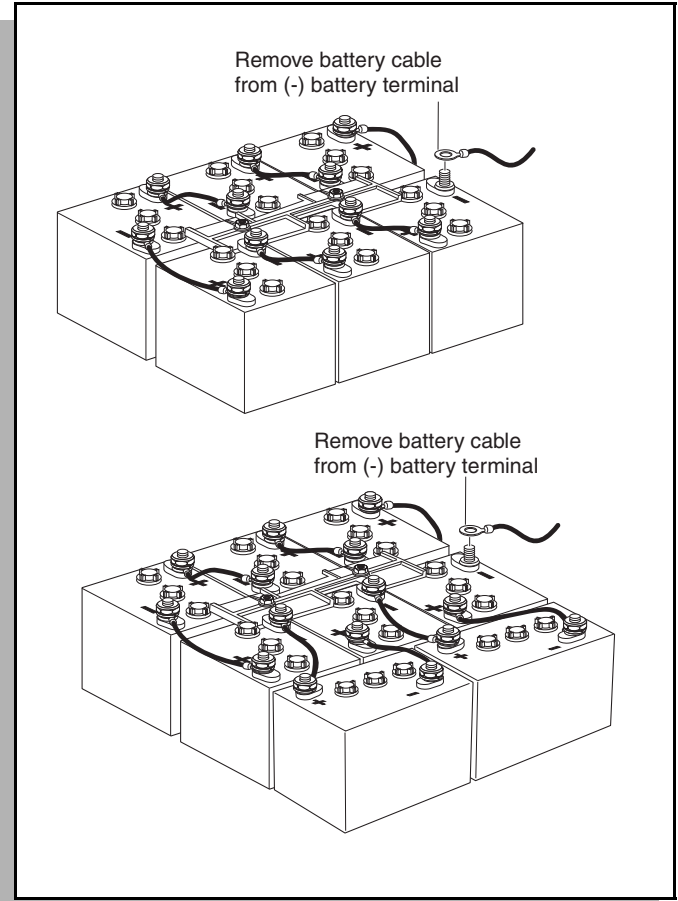


Fig. 1 Disconnect Battery Cable

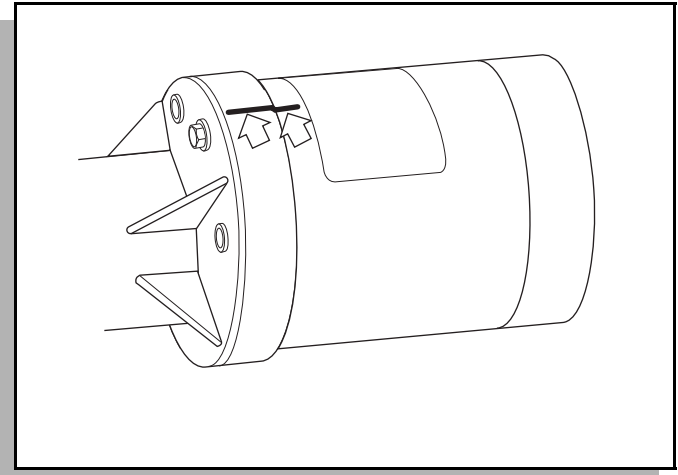


Fig. 2 Mark Axle and Motor

# MOTOR

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

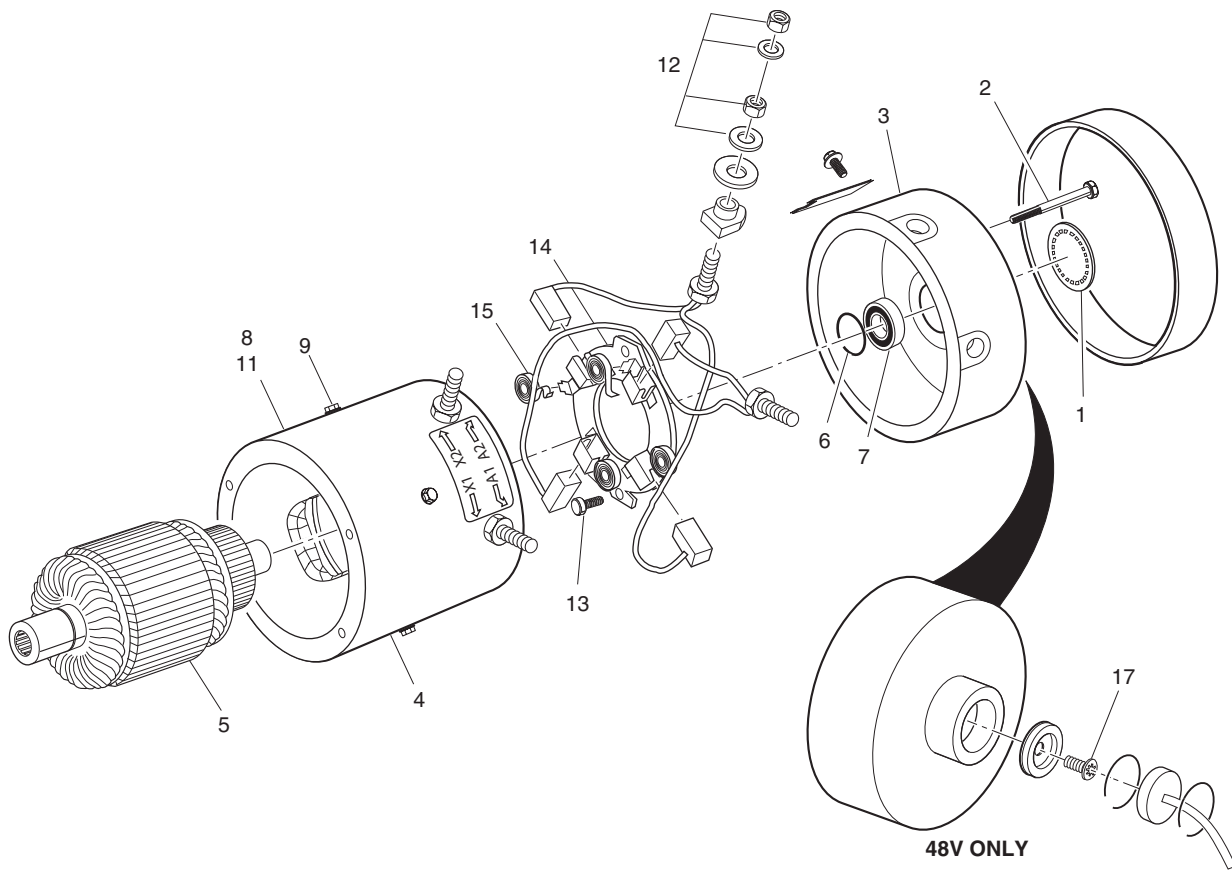


Fig. 3 Motor Components

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

## Motor Disassembly

Tool List	Qty. Required
Straight blade screwdriver.....	1
Ratchet, 3/8" drive.....	1
Socket, 3/8", 3/8" drive.....	1
Plastic faced hammer .....	1

Remove bearing cap (1) (Ref Fig. 3 on page G-2). Remove the magnet on the end of the armature by carefully removing the attaching screw.

Remove bolts (2) that hold the commutator end cover (3) to the motor housing (4).

Pull on commutator end cover to remove armature (5) and cover (as an assembly) from the housing. A light tap on the end cover may be necessary to loosen.

## Bearing Replacement

Tool List	Qty. Required
Heat gun or lamp .....	1
Arbor press .....	1
Bearing driver set.....	1
Snap ring pliers .....	1

**CAUTION** Do not use a torch to heat the commutator end cover. Only a moderate amount of heat should be applied. Excessive heat will damage the end cover and bearing.

Proper support must be given to the commutator end cover during press operations. Inadequate and/or uneven support will cause the end cover to fracture.

To aid disassembly, heat only the commutator end cover before attempting removal of the armature.

Once heated, place the commutator end cover/armature assembly in press, giving as much support to the end cover as possible, and press the armature out of the bearing.

Push back each brush until its spring (15) is resting against the side of the brush. This keeps the brushes out of the way during bearing replacement (Ref Fig. 5 on page G-4).

Remove internal snap ring (6) and heat the commutator end cover again. Press bearing (7) out from commutator end cover (3).

**CAUTION** When installing bearing into end cover, apply pressure against the bearing's outer race to avoid bearing damage.

Press the new bearing into the commutator end cover using heat again to aid installation.

Install the snap ring.

**NOTE** If brushes are to be replaced, proceed now to 'Brush Replacement' before installing the armature.

For proper location, the armature has a positive stop feature.

**CAUTION** When installing armature into the bearing/end cover assembly, support the bearing's inner race to avoid damage.

Press the armature into the new bearing using moderate heat to aid installation.

Release brushes against commutator. Ensure the springs are seated against the rear of the brushes and are able to move freely.

## Field Coil Replacement

Tool List	Qty. Required
Wrench, 1/2" .....	1
Ratchet, 3/8" drive.....	1
Socket, 1/2", 3/8" drive.....	1

To replace field coil (8), remove field coil terminal hardware (9) at S1 and S2 (Ref Fig. 3 on page G-2).

Remove bolts (10) that secure field coil retainers (11) to motor housing (4). Remove the field coils.

Replacement field coils are installed in reverse order of disassembly.

## Brush Replacement

Tool List	Qty. Required
Wrench, 1/2" .....	1
Ratchet, 1/4" drive.....	1
Socket, 5/16", 1/4" drive.....	1

Brushes should be measured as shown and replaced when the minimum dimension of .62" (16 mm) is reached (Ref Fig. 4 on page G-4).

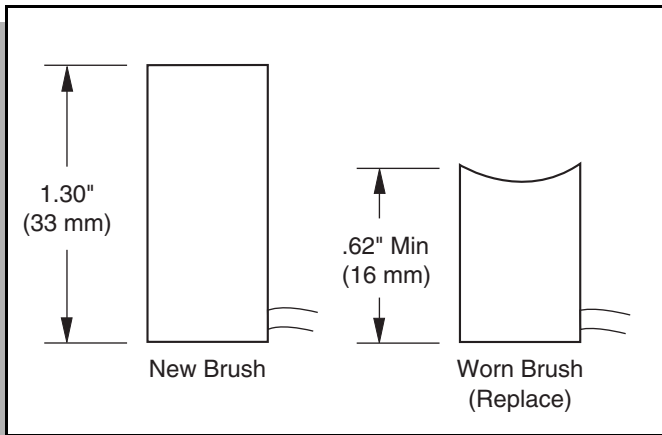
Remove brush terminal hardware (12) at A1 and A2 (Ref Fig. 3 on page G-2).

Remove screws (13) securing brush plate (14). Remove brushes, rigging and brush plate.

Pull back each brush until each of the springs (15) rest against the side of its brush (Ref Fig. 5 on page G-4).

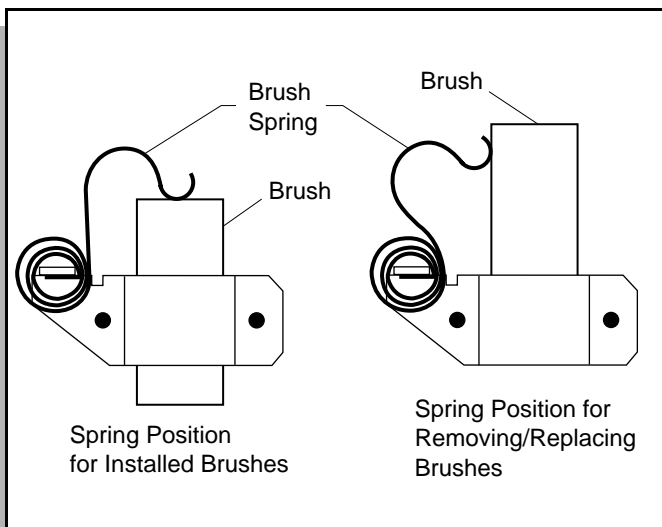
# MOTOR

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings



**Fig. 4 Brush Wear**

Remove brushes and replace with new brush replacement kit. Locate springs against the side of each brush.



**Fig. 5 Securing Brushes**

Install terminals and brush plate using reverse order of removal. Install armature (commutator end) through brush plate and press into new bearing using moderate heat to aid installation. Position brushes against commutator. Ensure the springs are seated against the rear of the brushes and are able to move freely.

## Motor Assembly

### Tool List

### Qty. Required

Socket, 3/8", 3/8" drive ..... 1  
Torque wrench, in. lbs., 3/8" drive ..... 1

Align the commutator end cover with the holes in the motor housing and assemble (Ref Fig. 3 on page G-2). Secure the commutator end cover to the motor housing with bolts (2) and tighten to 90 in. lbs. (10 Nm) torque. For non PDS motors, install bearing cap (1). For PDS vehicles, attach ring magnet to armature shaft with screw. Install inner snap ring in cover and insert speed sensor. Secure with second snap ring (Ref Fig. 3 on page G-2).

## Motor Tests

The motor housing is not available as an individual part. No testing is recommended to determine the specific area of failure. When a test of the power wiring system indicates that the system is operating correctly and the vehicle either does not run or runs poorly, the motor is the only remaining component and must be replaced.

## Motor Installation

### Tool List

### Qty. Required

Socket, 7/16", 3/8" drive ..... 1  
Torque wrench, in. lbs., 3/8" drive ..... 1

Be sure that a bumper spline is installed between the motor input pinion shaft and splines. Apply a small quantity of **molybdenum** grease to the **male** portion of the spline. Carefully mate the motor spline with the input shaft of the rear axle. Align the orientation marks and install the mounting hardware. Tighten to 168 in. lbs. (19 Nm) torque (Ref Fig. 2 on page G-1).

Attach the four motor wires to motor (Ref Fig. 6 on page G-5) (Ref Fig. 7 on page G-5). Tighten the nuts to 66 in. lbs. (7 Nm) torque.

On 48 volt model motors, tighten speed sensor magnet attachment screw (17) to 18 - 23 in. lbs. (2 Nm) torque (Ref Fig. 3 on page G-2).

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

**MOTOR WIRING 36V**

Motor Terminal	Wire Marker	From
S1	S1	Direction Selector "B"
S2	S2	Direction Selector "D"
A1	A1	Controller "B+"
A2	A2	Controller "A2"

**Fig. 6 Motor Wiring 36V****MOTOR WIRING - 48V**

Motor Terminal	Wire Marker	From
F1	F1	Controller "F1"
F2	F2	Controller F2"
A1	A1	Controller "B+"
A2	A2	Controller "M-"

**Fig. 7 Motor Wiring - 48V**

# **MOTOR**

*Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings*

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## BATTERIES AND CHARGING

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes,

### SAFETY

Always observe the following warnings when working on or near batteries:



**To prevent battery explosion that could result in severe personal injury or death, keep all smoking materials, open flame or sparks away from the batteries.**

**Hydrogen gas is formed when charging batteries. Do not charge batteries without adequate ventilation. A 4% concentration of hydrogen gas is explosive.**

**Be sure that the key switch is off and all electrical accessories are turned off before starting work on vehicle.**

**Never disconnect a circuit under load at a battery terminal.**



**Batteries are heavy. Use proper lifting techniques when moving them. Always lift the battery with a commercially available battery lifting device. Use care not to tip batteries when removing or installing them; spilled electrolyte can cause burns and damage.**

**The electrolyte in a storage battery is an acid solution which can cause severe burns to the skin and eyes. Treat all electrolyte spills to the body and eyes with extended flushing with clear water. Contact a physician immediately.**



**Always wear a safety shield or approved safety goggles when adding water or charging batteries.**

**Any electrolyte spills should be neutralized with a solution of 1/4 cup (60 ml) sodium bicarbonate (baking soda) dissolved in 1 1/2 gallons (6 liters) of water and flushed with water.**

**Overfilling batteries may result in electrolyte being expelled from the battery during the charge cycle. Expelled electrolyte may cause damage to the vehicle**

**and storage facility.**

**Aerosol containers of battery terminal protectant must be used with extreme care. Insulate metal container to prevent can from contacting battery terminals which could result in an explosion.**



**Wrap wrenches with vinyl tape to prevent the possibility of a dropped wrench from 'shorting out' a battery, which could result in an explosion and severe personal injury or death.**

### BATTERY

A battery is defined as two dissimilar metals immersed in an acid. If the acid is absent or if the metals are not dissimilar, a battery has not been created. The batteries most commonly used in these vehicles are lead acid.

A battery does not store electricity, but is able to produce electricity as the result of a chemical reaction which releases stored chemical energy in the form of electrical energy. The chemical reaction takes place faster in warm conditions and slower in cold conditions. Temperature is important when conducting tests on a battery and test results must be corrected to compensate for temperature differences.

As a battery ages, it still performs adequately except that its **capacity** is diminished. Capacity describes the time that a battery can continue to provide its design amperes from a full charge.

A battery has a maximum life, therefore good maintenance is designed to maximize the **available** life and reduce the factors that can reduce the life of the battery.

### BATTERY MAINTENANCE

Tool List	Qty. Required
Insulated wrench, 1/2" .....	1
Battery carrier .....	1
Hydrometer .....	1
Battery maintenance kit P/N 25587-G01 .....	1

#### At Each Charging Cycle



**To reduce the possibility of fire, never attach a battery**

# BATTERIES AND CHARGING

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

**charger to a vehicle that is to be unattended beyond the normal charging cycle. Over-charging could cause damage to the vehicle batteries and result in extreme overheating. The charger should be checked after 24 hours and unplugged after the charge cycle is complete.**

Before charging the batteries, inspect the plug of the battery charger and vehicle receptacle housing for dirt or debris.

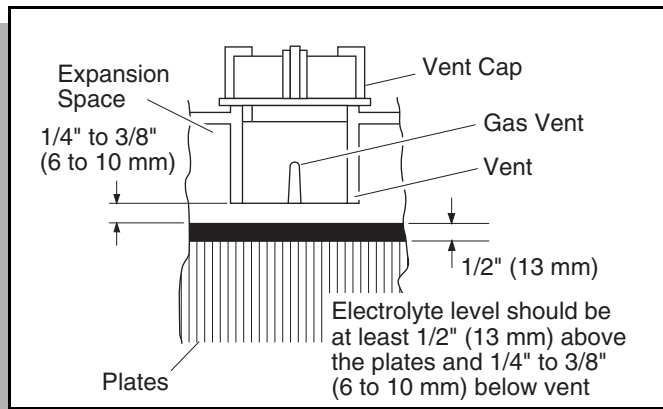
Charge the batteries after each days use.

## Monthly

- Inspect all wiring for fraying, loose terminations, corrosion or deterioration of insulation.
- Check that the electrolyte level is correct and add suitable water as required.
- Clean the batteries and wire terminations.

## Electrolyte Level and Water

The correct level of the electrolyte is 1/2" (13 mm) above the plates in each cell (Ref Fig. 1 on page H-2).



**Fig. 1 Correct Electrolyte Level**

This level will leave approximately 1/4" - 3/8" (6 - 10 mm) of space between the electrolyte and the vent tube. The electrolyte level is important since **any portion** of the plates exposed to air will be ruined beyond repair. Of equal importance is too much water which will result in electrolyte being forced out of the battery due to gassing and the increase in volume of the electrolyte that results from the charging cycle.

**CAUTION** Do not overfill batteries. The charging cycle will expel electrolyte and result in component damage.

A battery being charged will 'gas' with the majority of the gassing taking place at the end of the charging cycle. This gas is hydrogen which is lighter than air. Water and sulfuric acid droplets will be carried out of the battery vents by the hydrogen gas; however, this loss is minimal. If the battery electrolyte level is too high, the electrolyte will block the vent tube and the gas will **force** it out of the vent tube and battery cap. The water will evaporate but the sulfuric acid will remain where it can damage vehicle components and the storage facility floor. Sulfuric acid loss will weaken the concentration of acid within the electrolyte and reduce the life of the battery.

Over the life of the battery, a considerable amount of water is consumed. It is important that the water used be pure and free of contaminants that could reduce the life of the battery by reducing the chemical reaction. The water must be distilled or purified by an efficient filtration system. Water that is not distilled should be analyzed and if required, filtration installed to permit the water to meet the requirements of the water purity table (Ref Fig. 2 on page H-2).

Impurity	Parts Per Million
Color .....	Clear
Suspended .....	Trace
Total Solids .....	100
Calcium & Magnesium Oxides .....	40
Iron .....	5
Ammonia .....	8
Organic & Volatile Matter .....	50
Nitrites .....	5
Nitrates .....	10
Chloride .....	5

**Fig. 2 Water Purity Table**

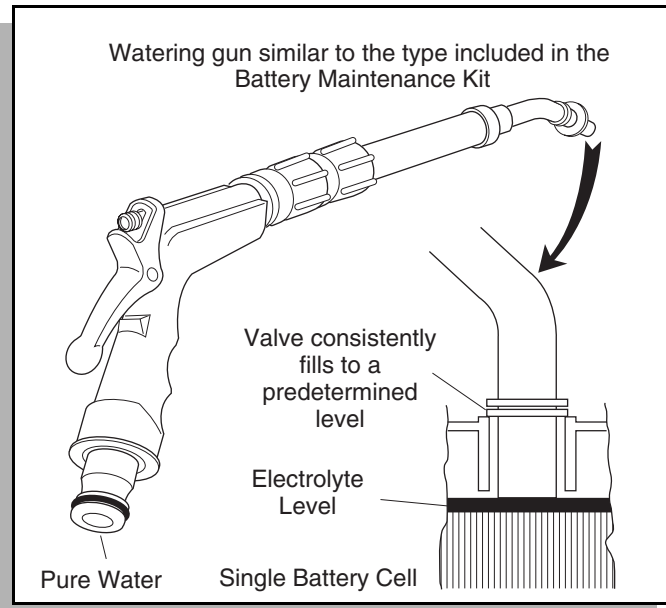
Even if the water is colorless, odorless, tasteless and fit for drinking, the water should be analyzed to see that it does not exceed the impurity levels specified in the table.

Automatic watering devices such as the one included in the Battery Maintenance Kit (P/N 25587-G01) can be used with an approved water source (Ref Fig. 3 on page H-3). These watering devices are **fast and accurate** to use and maintain the correct electrolyte level within the battery cells.

**NOTE** The watering device should only be used if the electrolyte level is less than 1/2" (13 mm)

## BATTERIES AND CHARGING

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings



**Fig. 3 Automatic Watering Gun**

above top of plates.

### Cleaning Batteries

**CAUTION** To reduce the possibility of damage to vehicle or floor, neutralize acid before rinsing batteries.

To reduce possible damage to electrical components while cleaning, do not use pressure washer to clean batteries.

Cleaning should take place per Periodic Service Schedule (Ref. GENERAL INFORMATION & ROUTINE MAINTENANCE).

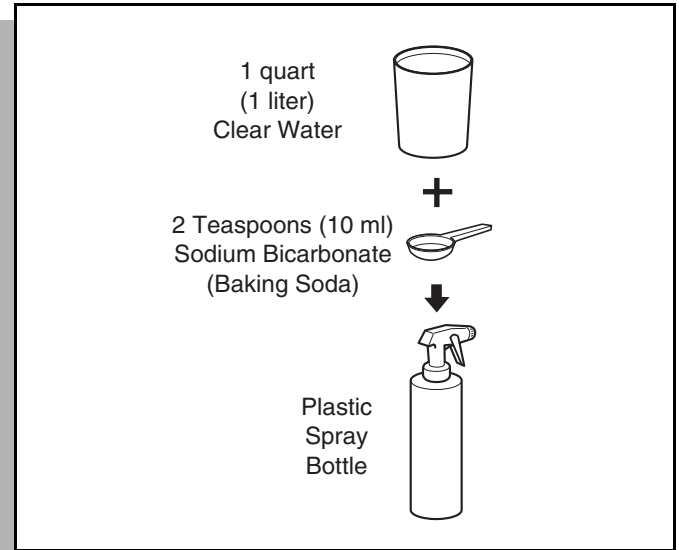
When cleaning the outside of the batteries and terminals, do not use a water hose without first spraying with a solution of sodium bicarbonate (baking soda) and water to neutralize any acid deposits.

Use of a water hose without first neutralizing any acid, will move acid from the top of the batteries to another area of the vehicle or storage facility where it will attack the metal structure or the concrete/asphalt floor. After hosing down the batteries, a residue will be left on the batteries which is conductive and will contribute to the discharge of the batteries.

**CAUTION** To prevent battery damage, be sure that all battery caps are tightly installed.

The correct cleaning technique is to spray the top and sides of the batteries with a solution of sodium bicarbon-

ate (baking soda) and water. This solution is best applied with a quart sized hand sprayer. The solution should consist of 2 teaspoons (10 ml) of sodium bicarbonate (baking soda) mixed with 1 quart (1 liter) of clear water (Ref Fig. 4 on page H-3). In addition to the batteries, special attention should be paid to metallic components adjacent to the batteries which should also be sprayed with the sodium bicarbonate (baking soda) solution.



**Fig. 4 Preparing Acid Neutralizing Solution**

Allow the solution to sit for at least three minutes; use a soft bristle brush or cloth to wipe the tops of the batteries in order to remove any residue that could cause the self discharge of the battery. Rinse the entire area with low pressure clear water. All of the items required for complete battery cleaning and watering are contained in the Battery Maintenance Kit (P/N 25587-G01).

### Battery Replacement

**CAUTION** Before any electrical service is performed on 48 volt model vehicles, the Run-Tow/Maintenance switch must be placed in the 'Tow/Maintenance' position.

If a power wire (battery, motor or controller) is disconnected for any reason on the 48 volt model vehicle, the Run-Tow/Maintenance switch must be left in the 'Tow/Maintenance' position for at least 30 seconds after the circuit is restored.

Remove battery hold downs and cables. Lift out batteries with a commercially available lifting device.

If the batteries have been cleaned and any acid in the battery rack area neutralized as recommended, no corro-

# BATTERIES AND CHARGING

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

sion to the battery racks or surrounding area should be present. Any corrosion found should be immediately removed with a putty knife and a wire brush. The area should be washed with a solution of sodium bicarbonate (baking soda) and water and thoroughly dried before priming and painting with a corrosion resistant paint.

The batteries should be placed into the battery racks and the battery hold downs tightened to 45 - 55 in. lbs. (5 - 6 Nm) torque, to prevent movement but not tight enough to cause distortion of the battery cases.

Inspect all wires and terminals. Clean any corrosion from the battery terminals or the wire terminals with a solution of sodium bicarbonate (baking soda) and brush clean if required.



**To prevent battery explosion that could result in severe personal injury or death, extreme care must be used with aerosol containers of battery terminal protectant. Insulate the metal container to prevent the metal can from contacting battery terminals which could result in an explosion.**

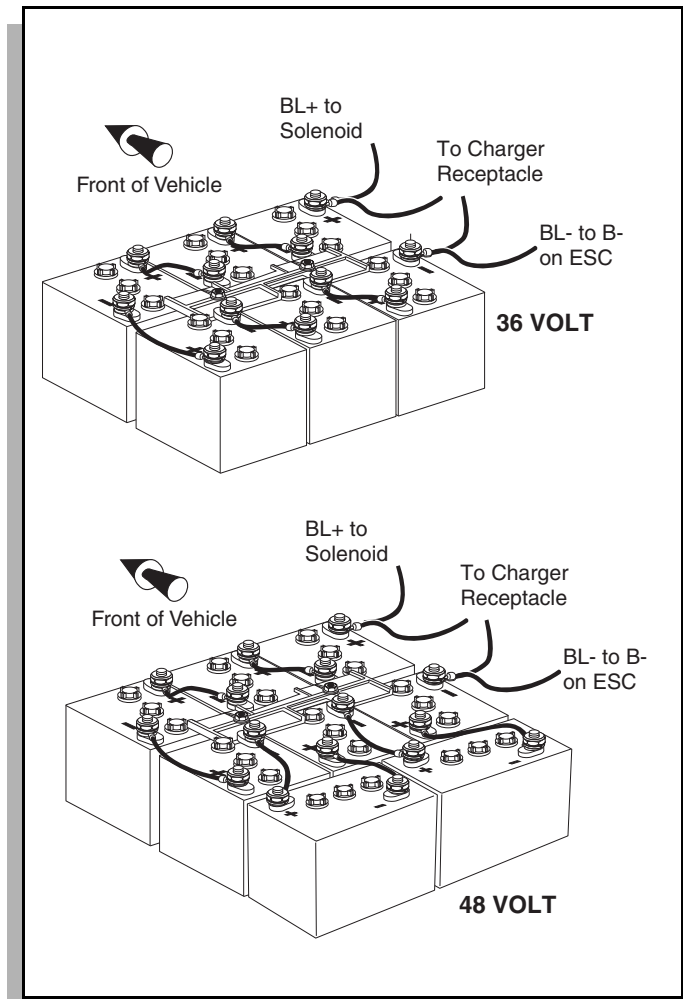
Use care to connect the battery wires as shown (Ref Fig. 5 on page H-4). Ensure that all battery terminals are installed crimp up. Tighten the battery post hardware to 50 - 70 in. lbs. (6 - 8 Nm) torque. Protect the battery terminals and battery wire terminals with a commercially available protective coating.

## Prolonged Storage

**CAUTION** Battery charger and controller and other electronic devices need to be disconnected since they will contribute to the premature discharge of batteries.

During periods of storage, the batteries will need attention to keep them maintained and prevent discharge.

In high temperatures the chemical reaction is faster, while low temperatures cause the chemical reaction to slow down. A vehicle that is stored at 90 F (32 C) will lose .002 of specific gravity each day. If a fully charged battery has a specific gravity of 1.275, and the battery is allowed to sit unused, it will become partially discharged. When it reaches 1.240, which it will do in less than twenty days, it should be recharged. If a battery is left in a discharged state, sulfating takes place on and within the plates. This condition is not reversible and will cause permanent damage to the battery. In order to prevent



**Fig. 5 Battery Connections**

damage, the battery should be recharged. A hydrometer (P/N 50900-G1) can be used to determine the specific gravity and therefore the state of charge of a battery.

In winter conditions, the battery must be fully charged to prevent the possibility of freezing (Ref Fig. 6 on page H-5). A fully charged battery will not freeze in temperatures above -75 F (-60 C). Although the chemical reaction is slowed in cold temperatures, the battery must be stored fully charged, and disconnected from any circuit that could discharge the battery. For portable chargers, disconnect the charging plug from the vehicle receptacle. For on-board chargers, disconnect the charging harness from the batteries. The batteries must be cleaned and all deposits neutralized and removed from the battery case to prevent self discharge. The batteries should be tested or recharged at thirty day minimum intervals.

# BATTERIES AND CHARGING

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

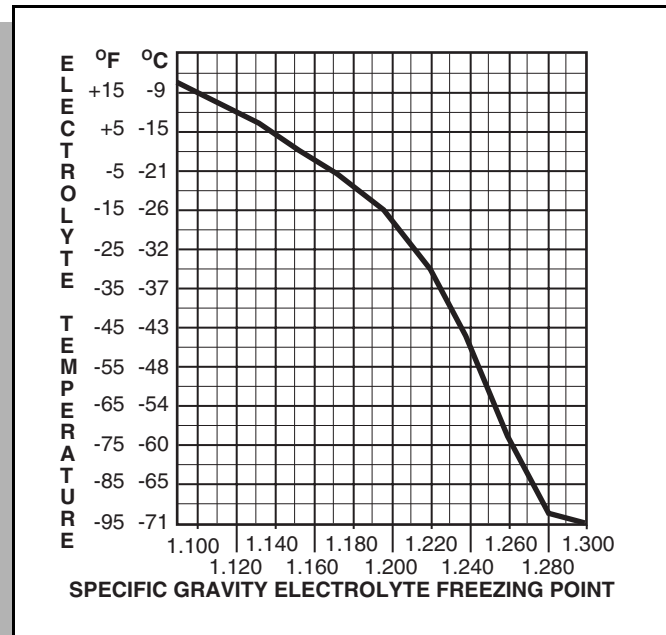


Fig. 6 Freezing Point of Electrolyte

## Battery Charging

The battery charger is designed to fully charge the battery set. If the batteries are severely deep cycled, some automatic battery chargers contain an electronic module that may not activate and the battery charger will not function. Automatic chargers will determine the correct duration of charge to the battery set and will shut off when the battery set is fully charged. Always refer to the instructions of the specific charger used.

Before charging, the following should be observed:

**CAUTION** Do not overfill batteries. The charging cycle will expel electrolyte and result in component damage.

- The electrolyte level in all cells must be at the recommended level and cover the plates.
- The charging must take place in an area that is well ventilated and capable of removing the hydrogen gas that is generated by the charging process. A **minimum** of five air exchanges per hour is recommended.
- The charging connector components are in good condition and free from dirt or debris.
- The charger connector is fully inserted into the vehicle receptacle.
- The charger connector/cord set is protected from damage and is located in an area to prevent injury

that may result from personnel running over or tripping over the cord set.

- The charger is automatically turned off during the connect/disconnect cycle and therefore no electrical arc is generated at the DC plug/receptacle contacts.

**NOTE** In some portable chargers, there will be a rattle present in the body of the charger DC plug. This rattle is caused by an internal magnet contained within the charger plug. The magnet is part of the interlock system that prevents the vehicle from being driven when the charger plug is inserted in the vehicle charging receptacle.

## AC Voltage

Battery charger output is directly related to the input voltage. If multiple vehicles are receiving an incomplete charge in a normally adequate time period, low AC voltage could be the cause and the power company should be consulted.

## TROUBLESHOOTING

In general, troubleshooting will be done for two distinct reasons. First, a battery that performs poorly and is outside of the manufacturer's specification should be identified in order to replace it under the terms of the manufacturer's warranty. Different manufacturers have different requirements. Consult the battery manufacturer or the manufacturer's representative for specific requirements.

The second reason is to determine why a particular vehicle does not perform adequately. Performance problems may result in a vehicle that runs slowly or in a vehicle that is unable to operate for the time required.

A new battery must **mature** before it will develop its maximum capacity. Maturing may take up to 100 charge/discharge cycles. After the maturing phase, the older a battery gets, the lower the capacity. The only way to determine the capacity of a battery is to perform a load test using a discharge machine following manufacturer's recommendations.

A cost effective way to identify a poorly performing battery is to use a hydrometer to identify a battery in a set with a lower than normal specific gravity. Once the particular cell or cells that are the problem are identified, the suspect battery can be removed and replaced. At this point there is nothing that can be done to salvage the battery; however, the individual battery should be replaced with a good battery of the same brand, type and approximate age.

# BATTERIES AND CHARGING

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

## Hydrometer

A hydrometer (P/N 50900-G1) is used to test the state of charge of a battery cell (Ref Fig. 7 on page H-6). This is performed by measuring the density of the electrolyte, which is accomplished by measuring the specific gravity of the electrolyte. The greater the concentration of sulfuric acid, the more dense the electrolyte becomes. The higher the density, the higher the state of charge.

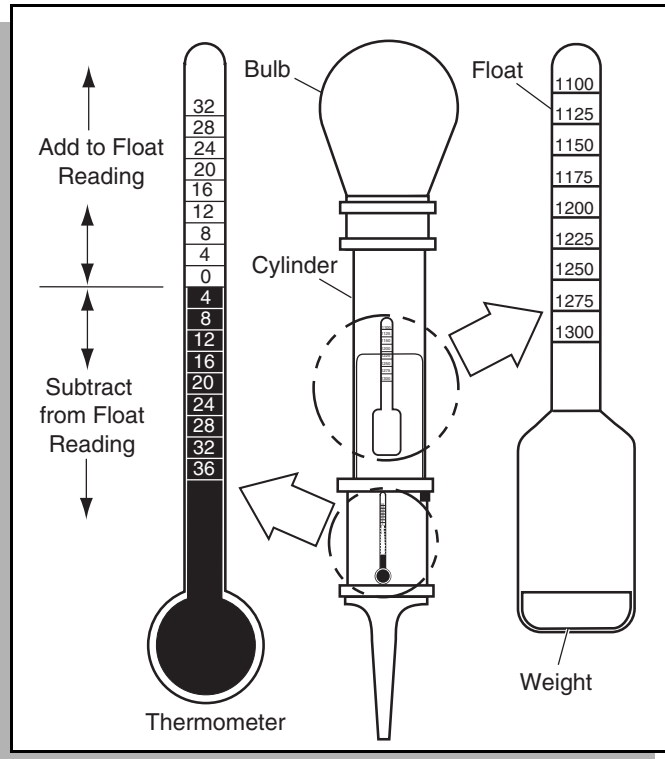


Fig. 7 Hydrometer

**⚠ WARNING ⚠** *To prevent a battery explosion that could result in severe personal injury or death, never insert a metal thermometer into a battery. Use a hydrometer with a built in thermometer that is designed for testing batteries.*

Specific gravity is the measurement of a liquid that is compared to a baseline. The baseline is water which is assigned a base number of 1.000. The concentration of sulfuric acid to water in a new golf car battery is 1.280 which means that the electrolyte weighs 1.280 times the weight of the same volume of water. A fully charged battery will test at 1.275 - 1.280 while a discharged battery will read in the 1.140 range.

**NOTE** *Do not perform a hydrometer test on a battery that has just been watered. The battery must go through at least one charge and discharge cycle in order to permit the water to adequately mix with the electrolyte.*

The temperature of the **electrolyte** is important since the hydrometer reading must be corrected to 80 F (27 C). High quality hydrometers are equipped with an internal thermometer that will measure the temperature of the electrolyte and will include a conversion scale to correct the float reading. It is important to recognize that the electrolyte temperature is significantly different from the ambient temperature if the vehicle has been operated.

## Using A Hydrometer

1. Draw electrolyte into the hydrometer several times to permit the thermometer to adjust to the electrolyte temperature and note the reading. Examine the color of the electrolyte. A brown or gray coloration indicates a problem with the battery and is a sign that the battery is nearing the end of its life.
2. Draw the minimum quantity of electrolyte into the hydrometer to permit the float to float freely without contacting the top or bottom of the cylinder.
3. Hold the hydrometer in a vertical position at eye level and note the reading where the electrolyte meets the scale on the float.
4. Add or subtract four points (.004) to the reading for every 10 F (6 C) the electrolyte temperature is above or below 80 F (27 C). Adjust the reading to conform with the electrolyte temperature, e.g., if the reading indicates a specific gravity of 1.250 and the electrolyte temperature is 90 F (32 C), **add** four points (.004) to the 1.250 which gives a corrected reading of 1.254. Similarly if the temperature was 70 F (21 C), **subtract** four points (.004) from the 1.250 to give a corrected reading of 1.246 (Ref Fig. 8 on page H-7).
5. Test each cell and note the readings (corrected to 80 F or 27 C). A variation of fifty points between any two cell readings (example 1.250 - 1.200) indicates a problem with the low reading cell(s).

As a battery ages the specific gravity of the electrolyte will decrease at full charge. This is not a reason to replace the battery, providing all cells are within fifty points of each other.

Since the hydrometer test is in response to a vehicle exhibiting a performance problem, the vehicle should be recharged and the test repeated. If the results indicate a weak cell, the battery or batteries should be removed

# BATTERIES AND CHARGING

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

and replaced with a good battery of the same brand, type and approximate age.

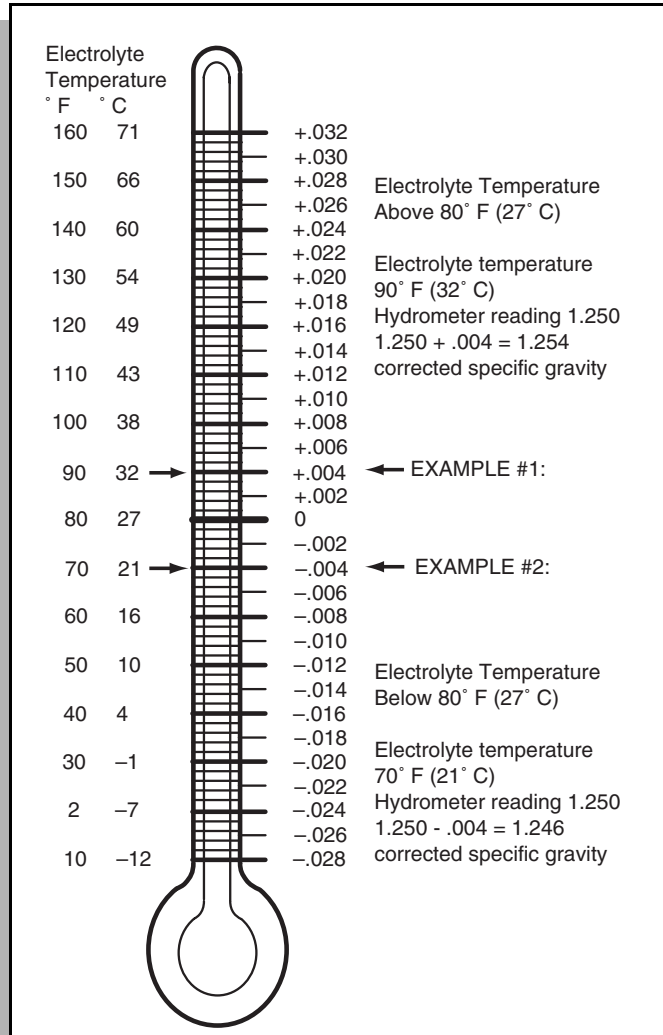


Fig. 8 Hydrometer Temperature Correction

## BATTERY CHARGER

### Description

The battery charger accompanying this vehicle is 120 volt AC, 60 Hz input with 48 volt or 36 volt DC output. Contact charger manufacturer for maintenance or service parts.

For service assistance, contact Service Parts Department, 1-800-227-7029.

### Portable Charger Installation

**! WARNING !** Portable chargers must be mounted on a platform above the ground or in such a manner as to permit the maximum air flow underneath and around the charger. Do not block or obstruct the airways as overheating may result which could cause serious damage to the charger and create the potential for fire.

If the charger is operated in an outdoor location, rain and sun protection must be provided.

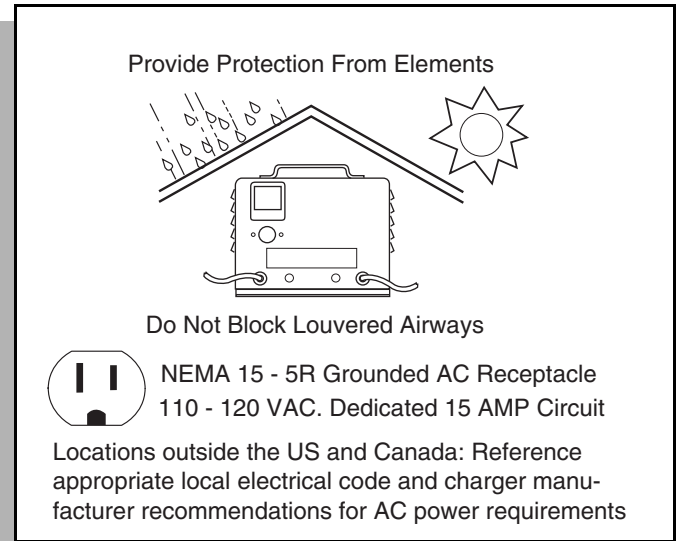


Fig. 9 Charger Installation

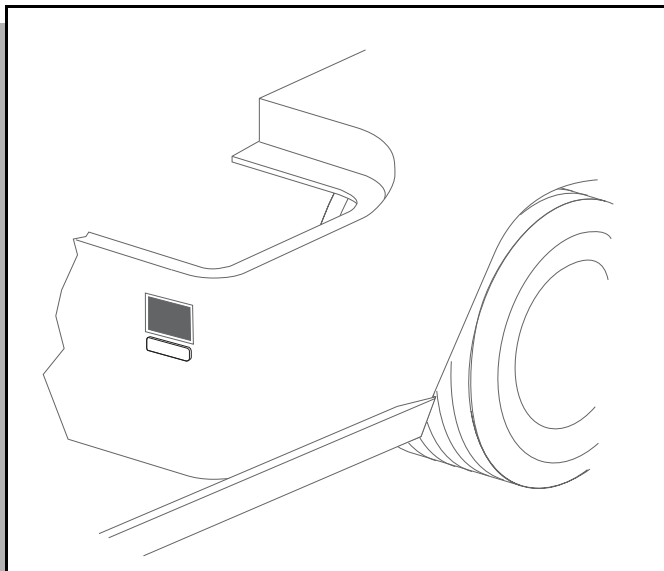
A dedicated circuit is required for the charger. Refer to the charger manual for appropriate circuit protection. The charger may remain plugged into the AC outlet. To charge the vehicle, refer to the instruction labels on the charger. Insert the DC plug completely into the vehicle receptacle located on the panel underneath the driver seat (Ref Fig. 10 on page H-8). After inserting the polarized DC plug, wait a few seconds and observe ammeter on charger to make sure it moves indicating that charger is charging.

The charger will automatically start a few seconds after plug insertion. The charger will automatically stop when batteries are fully charged and the DC plug can be removed to permit use of the vehicle.

The charger may remain plugged into the AC outlet. To charge the vehicle, refer to the instruction label on charger.

## BATTERIES AND CHARGING

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings



**Fig. 10 Polarized Receptacle**

### Charger Maintenance

The charging (DC) cord is equipped with a polarized connector which fits into a matching receptacle on the vehicle. The power (AC) cord is equipped with an appropriate plug. If the charger is equipped with a grounding plug, do not attempt to remove or bend the ground plug.



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# ELECTRICAL SYSTEM



Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

## DIGITAL VOLT OHM METER

A typical digital volt ohm meter (DVOM) is shown (Ref Fig. 1 on page H-1). A recommended DVOM is available through the Service Parts Department as P/N 27481-G01. For the purpose of this section, the red probe (+) and black probe (-) are used. Any DVOM may be used, however the controls, displays, accuracy and features may vary depending on the make and model. Always follow the meter manufacturer's recommendations and instructions for the use and care of the meter.

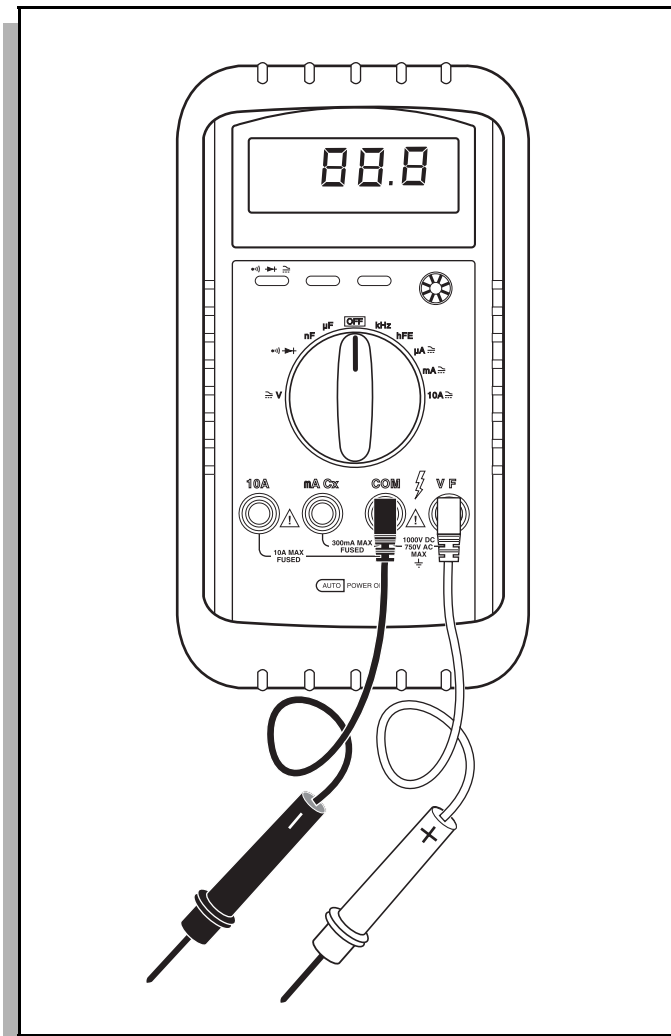


Fig. 1 DVOM

## TROUBLESHOOTING

In order to effectively troubleshoot the circuits that include the horn, lighting, brake/turn signals and gauges, the technician must be able to use the wiring diagram and a DVOM.

The wiring diagram shows the path followed by a voltage or signal from its origination point to its destination (Ref Fig. 2 on page H-2). Each wire is indicated by color.

The technician should use simple logic troubleshooting in order to reduce the number of steps required to isolate the problem.

**Example 1:** If the vehicle will not start and none of the lights function (or burn dimly) the battery should be tested before trying to troubleshoot the lighting circuit.

**Example 2:** If a problem occurs in the lighting circuit that results in only one of the headlights not working, there is no reason to check battery wiring or the fuse since it is obvious that voltage is present. Since bulbs will burn out over time, the obvious place to start is at the headlight that is not functioning. If power is present at the connector and the ground wiring is satisfactory, the only possibilities that exist are a burned out bulb or a poor contact between the connectors and the headlight.

If power is not present but the other headlight functions, a wiring problem is indicated between the two headlights.

In some cases where battery voltage is expected, the easiest way to test the circuit is to set the DVOM to DC volts and place the negative (-) probe of the DVOM on the negative battery terminal. Move the positive (+) probe to each wire termination starting at the battery and working out to the device that is not working. Be sure to check both sides of all switches and fuses.

When no battery voltage is found, the problem lies between the point where no voltage is detected and the last place that voltage was detected. In circuits where no voltage is expected, the same procedure may be used except that the DVOM is set to continuity. Place the negative (-) probe on a wire terminal at the beginning of the circuit and work towards the device that is not working with the positive (+) probe. When continuity is no longer indicated, a failed conductor or device is indicated.

# ELECTRICAL SYSTEM

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

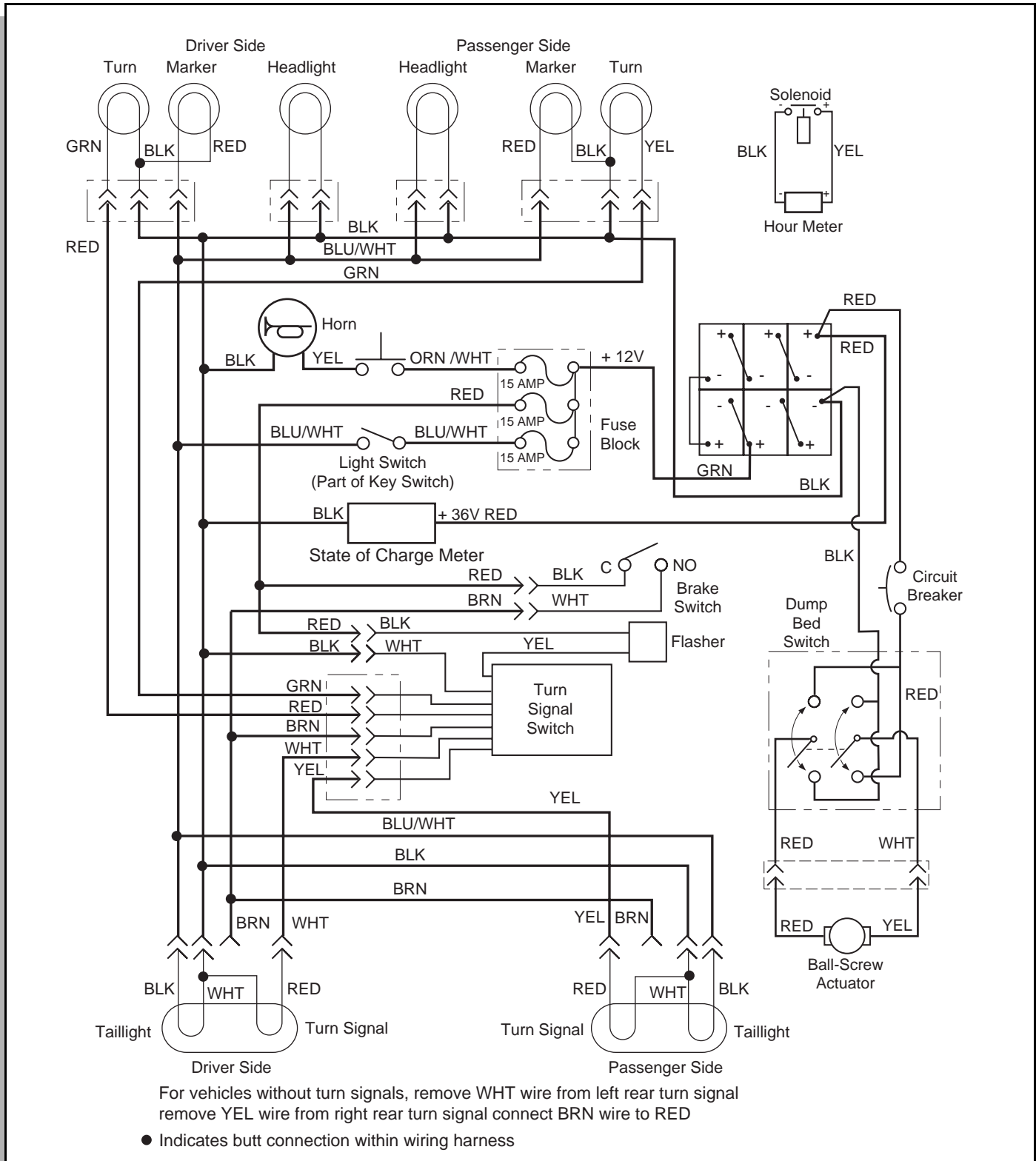


Fig. 2 36 Volt Wiring Diagram

# ELECTRICAL SYSTEM

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

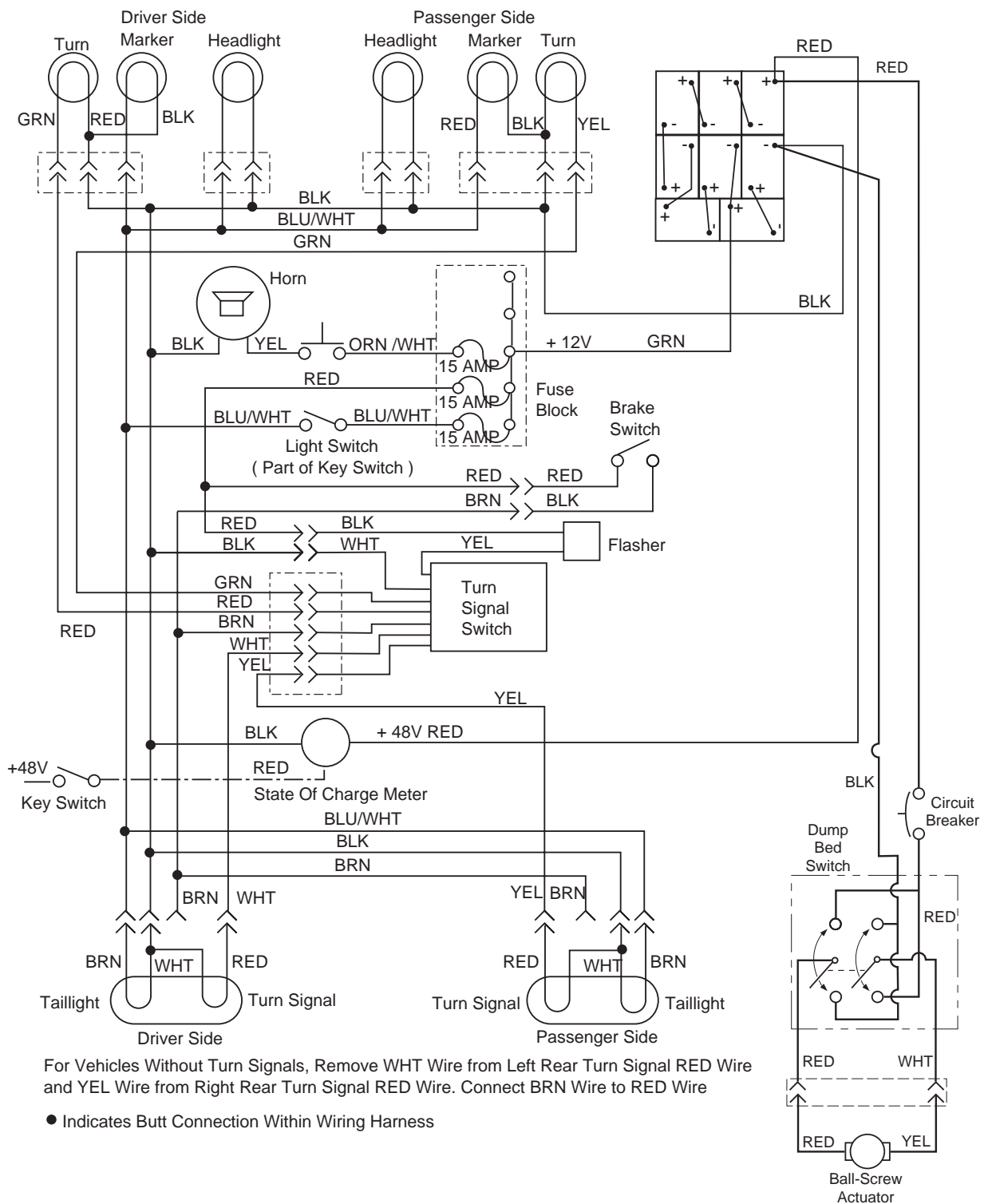


Fig. 3 48 Volt Wiring Diagram

# ELECTRICAL SYSTEM

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

## POWER SUPPLY

Tool List	Qty. Required
DVOM.....	1

### 1. CHECK FOR LOOSE OR BARE WIRES

Check for loose wires at each terminal connection and for worn insulation or bare wires touching the frame. **Bare wires may cause a short circuit.**

**NOTE** *If any DVOM readings indicate a faulty wire, it is recommended that the condition of the terminals and wire junction be examined. A faulty wire should be replaced with one of the same gauge and color and wired between the correct components and wire tied to the harness bundle. The faulty wire should be cut back close to the harness and the ends protected with vinyl electrical tape.*

### 2. CHECK BATTERY CONDITION

Check for adequate battery volts (nominal 12 VDC) by setting DVOM to 30 VDC range and place the red probe (+) to the middle negative (-) battery post with the green wire attached. Place the black probe (-) to the first negative (-) battery post on the driver side with the black wire attached. A reading of 11 VDC or greater indicates adequate battery condition. No reading indicates (a) a poor connection between the probes and the battery terminals; (b) a faulty DVOM. A voltage reading below 11 volts indicates poor battery condition and the vehicle should be recharged before proceeding with the test.

**NOTE** *Due to the resistance of the wires involved within the harness, voltage readings may be somewhat lower than battery voltage. A reading of 1 volt below battery voltage is acceptable.*

### 3. CHECK GREEN POWER WIRE

Firmly attach black probe (-) to the first negative(-) battery post on the driver side with the black wire attached and the red probe (+) to the terminal on the side of the fuse block where the green wire is connected. A reading of battery voltage indicates that the green wire is in good condition.

**NOTE** *The green wire supplies power to the entire fuse block.*

### 4. CHECK FUSE

Place the red probe (+) to each wire terminal on the fuse block. A reading of battery voltage indicates that the fuse is in good condition. No reading indicates a faulty fuse; replace with a good 15 amp fuse.

## ACCESSORY WIRING

After determining that there is power to the fuse panel, and the fuse is good, continue checking the circuit using the procedures previously used to check the power supply, i.e. loose or rusted connections, bare wires, continuity of the wiring from terminal to terminal, operating condition of switch, etc.

Use the wiring diagram (Ref Fig. 2 on page H-2), and illustrations (Ref Figs 3, 4 and 5 on pages H-4, 5 and 6) to check correct wiring and wire routing. If there is power at the fuse end of the wire, there must also be power at the other end of the wire at the switch or electrical accessory, and eventually at the ground connection. Electricity must flow from the fuse panel through the full length of the circuit to the ground connection. Any interruption of electricity flow must be corrected, whether by repairing or replacing the wire, the switch or accessory.

## LIGHT BULB REPLACEMENT

**CAUTION** **To prevent premature bulb failure, do not touch new bulbs with bare fingers. Use a clean, dry tissue or paper towel to handle the glass portion of the bulb.**

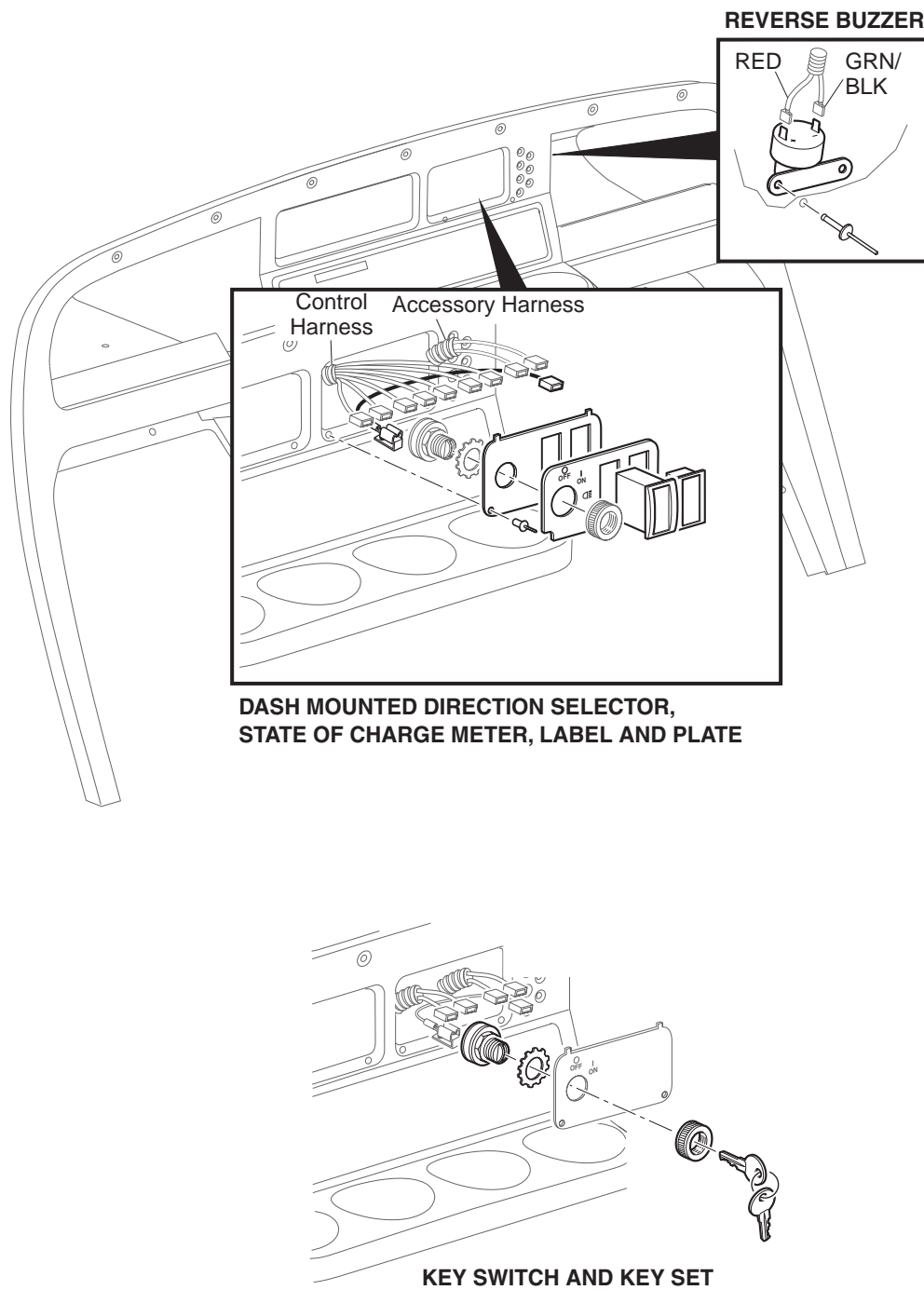
Always hold bulbs with a clean, dry tissue or paper towel. Natural oils from fingers will cause halogen bulbs to fail prematurely.

Determine which bulb needs to be replaced. Reach underneath light bar to access bulb from rear. Turn the bulb socket a quarter turn counterclockwise to unlock and pull out bulb. Insert new bulb and rotate quarter turn clockwise to secure.

To replace the taillight bulb, remove hardware securing lens and remove lens. Install replacement bulb and reinstall lens.

# ELECTRICAL SYSTEM

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings



**Fig. 4 Ignition Switch, Direction Selector, State of Charge Meter**

# ELECTRICAL SYSTEM

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

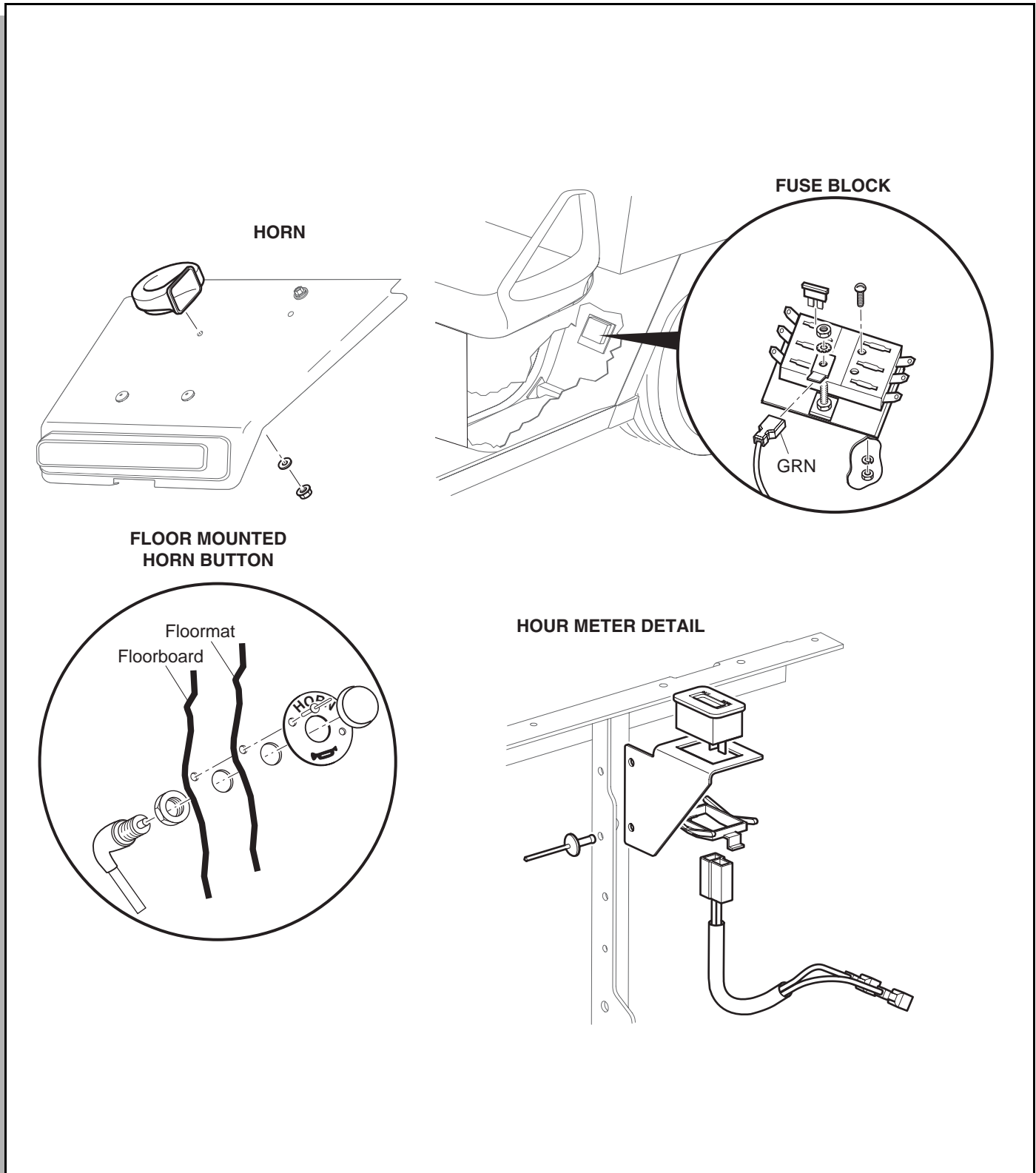


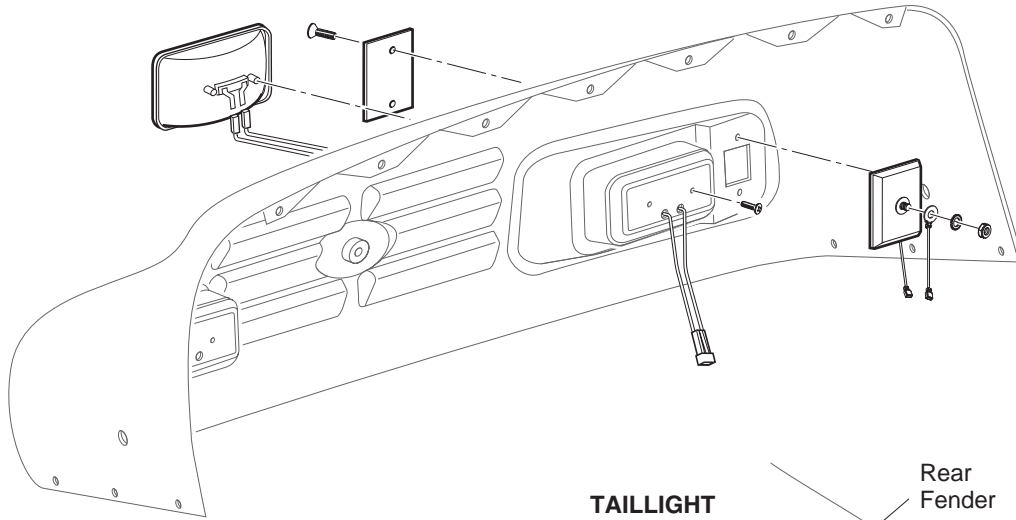
Fig. 5 Horn, Fuse Block, Hour Meter



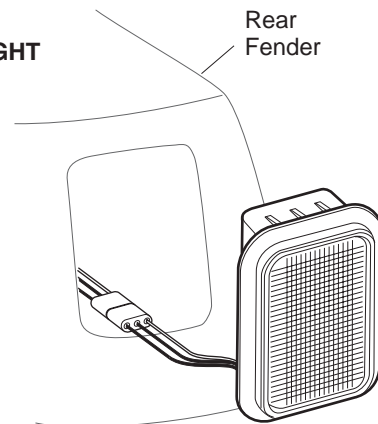
# ELECTRICAL SYSTEM

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

## HEADLIGHT



## TAILLIGHT



## TURN SIGNAL

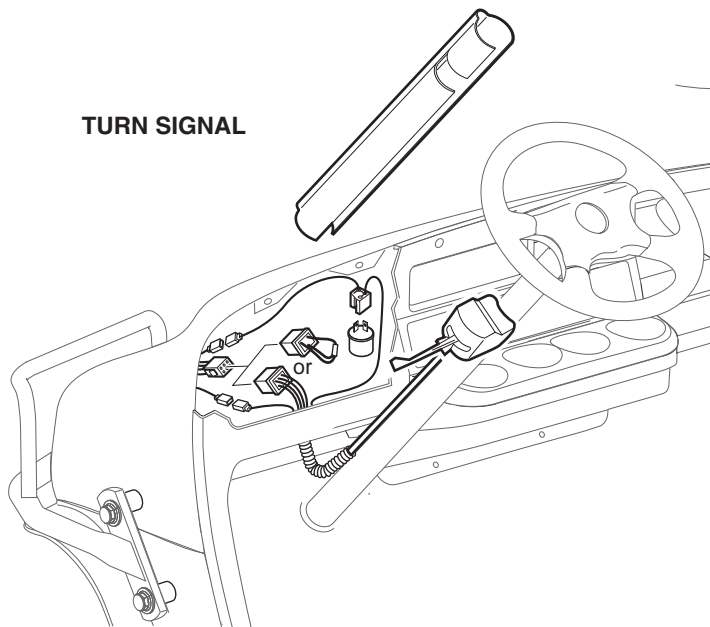


Fig. 6 Turn Signal, Headlight, Tail Light

# **ELECTRICAL SYSTEM**

*Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings*

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# BRAKES

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# BRAKES - REAR MECHANICAL

# K

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

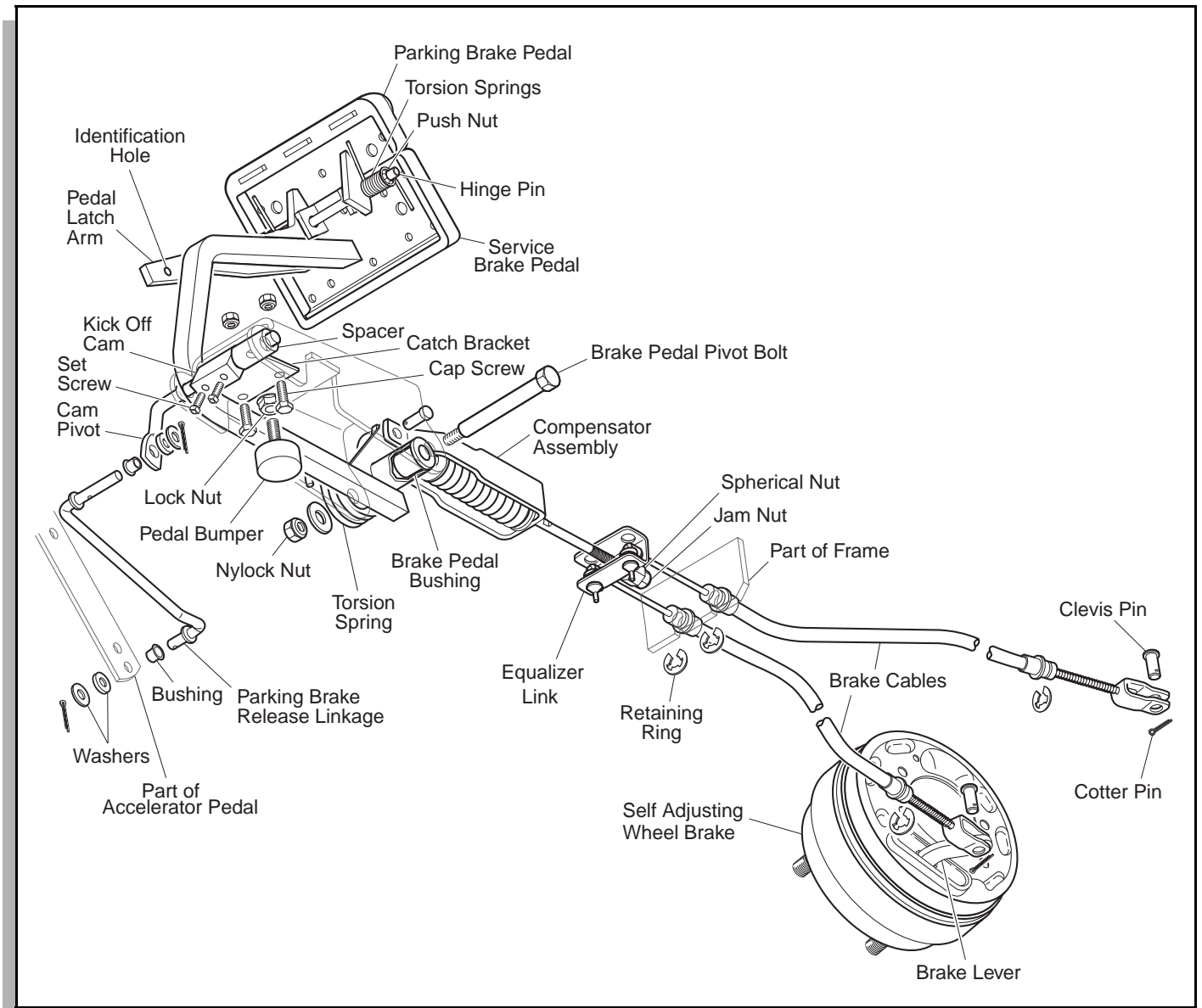


Fig. 1 Mechanical Brake System

## BRAKE SYSTEM OVERVIEW

### General Description

This vehicle is equipped with a mechanically activated rear drum brake system. The brake system consists of a service brake and parking brake pedal, parking brake release linkage, compensator assembly, equalizer link, brake cables and self adjusting wheel brake assemblies (Ref Fig. 1 on page K-1).

Although the brake system is similar to an automobile, it is **different in important ways**. The system operates in

a very severe environment. Fertilizer, dust, grass clippings, tree roots and other objects can cause corrosion and physical damage to the brake components. Unlike automotive hydraulic brakes, mechanical brakes depend on the travel of the brake cables to move the brake shoes against the brake drums. The travel of the brake cables is governed by the brake pedal. If the cables cannot travel far enough to absorb the slack (free travel) in the system and still apply the shoes to the drums, the braking effort at the wheel brake will not be adequate. The self adjusting mechanism in the wheel brakes

# BRAKES - REAR MECHANICAL

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

requires enough cable travel at the wheel brake to work reliably. When the brake is released, there must be slack in the system so the brakes will release fully and the adjusters will function. Free pedal travel, pedal force, shoe to drum clearance and braking capability are closely related. It is very important to maintain the proper relationships to assure braking performance and the best wheel brake adjustment.

## How the Service Brake Works

Depressing the service brake pedal pulls the compensator assembly and equalizer link, which are connected to the brake cables (Ref Fig. 1 on page K-1). The first part of the pedal travel removes slack from the system. Continued motion of the brake pedal pulls both the left and right brake cables. Each brake cable pulls a brake lever which pushes the rear brake shoe against the brake drum. When the rear shoe contacts the brake drum, it can no longer move rearward. Additional pedal (and cable) travel causes the actuator bracket (moving anchor) to move and applies force to the front shoe, pushing it against the brake drum. The force applied to the front and rear shoes is approximately equal. As the shoes contact the moving brake drum, the shoes try to move in the direction of drum rotation. This movement results in the typical brake shoe wear patterns.

## Equalizer Link

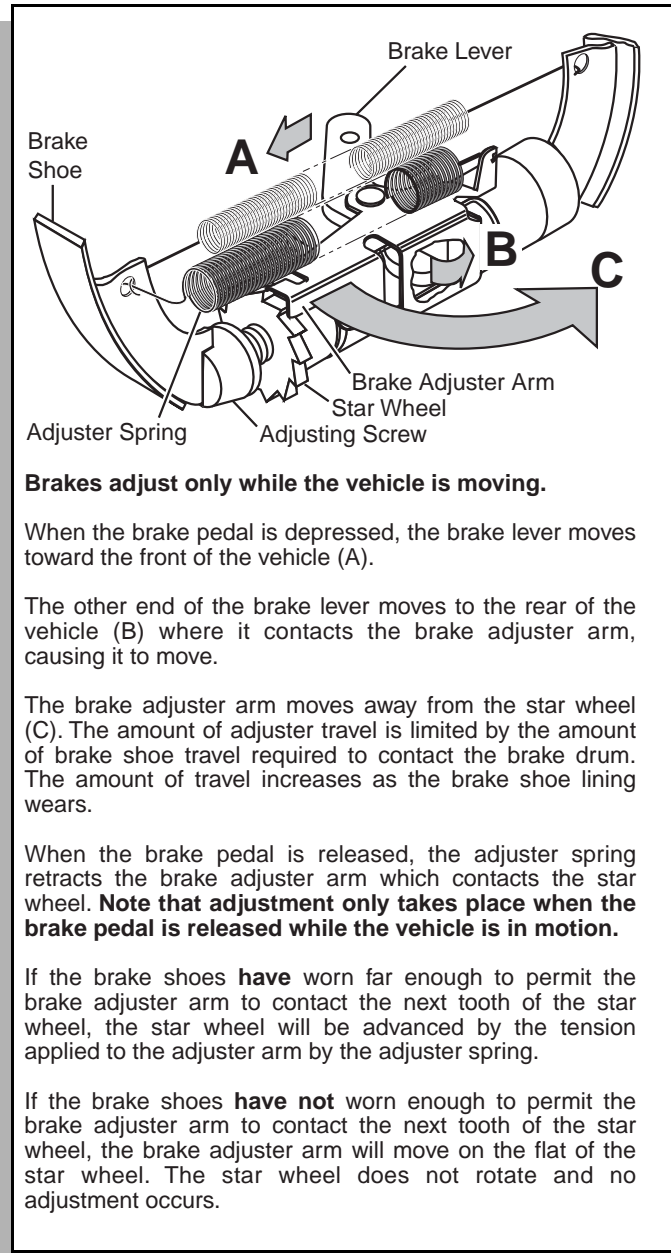
The equalizer link balances braking between the driver and passenger sides of the vehicle. Variations in wheel brake adjustment, cable friction and manufacturing tolerances may cause the equalizer to be slightly misaligned. This misalignment is normal.

## Automatic Adjuster Mechanism

**CAUTION** Never manually adjust the brakes at the star wheel. Doing so will cause permanent damage to the adjuster assembly and result in a gradual loss of brakes.

The wheel brakes are equipped with an automatic adjuster mechanism that is designed to compensate for brake shoe wear and eliminate the need for manual brake shoe adjustment. Do not manually adjust the brakes by prying back the adjuster arm and turning the star wheel. Permanent damage to adjuster will result.

Adjustment takes place only when the brake is fully applied and released **while the vehicle is moving** (Ref Fig. 2 on page K-2). It is very important that the brake cables permit the brake levers to release fully when the brake pedal is in the released position.



### Brakes adjust only while the vehicle is moving.

When the brake pedal is depressed, the brake lever moves toward the front of the vehicle (A).

The other end of the brake lever moves to the rear of the vehicle (B) where it contacts the brake adjuster arm, causing it to move.

The brake adjuster arm moves away from the star wheel (C). The amount of adjuster travel is limited by the amount of brake shoe travel required to contact the brake drum. The amount of travel increases as the brake shoe lining wears.

When the brake pedal is released, the adjuster spring retracts the brake adjuster arm which contacts the star wheel. **Note that adjustment only takes place when the brake pedal is released while the vehicle is in motion.**

If the brake shoes **have** worn far enough to permit the brake adjuster arm to contact the next tooth of the star wheel, the star wheel will be advanced by the tension applied to the adjuster arm by the adjuster spring.

If the brake shoes **have not** worn enough to permit the brake adjuster arm to contact the next tooth of the star wheel, the brake adjuster arm will move on the flat of the star wheel. The star wheel does not rotate and no adjustment occurs.

Fig. 2 Wheel Brake Adjustment

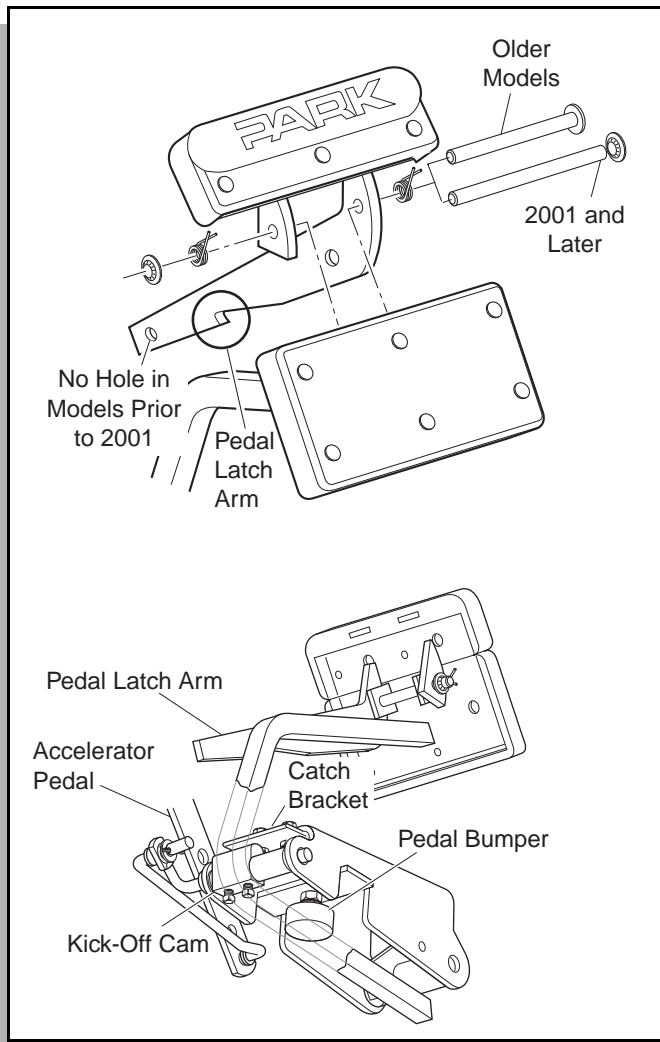
## How the Parking Brake Works

The parking brake is operated by a smaller pedal which extends across the top of the service brake pedal. It is attached to the service brake pedal with a hinge pin and is spring loaded (Ref Fig. 3 on page K-3).

Depressing the parking brake pedal moves the latch arm against the catch bracket attached to the chassis. As the parking brake is depressed, the service brake is applied until the notch in the latch arm engages with the catch

# BRAKES - REAR MECHANICAL

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings



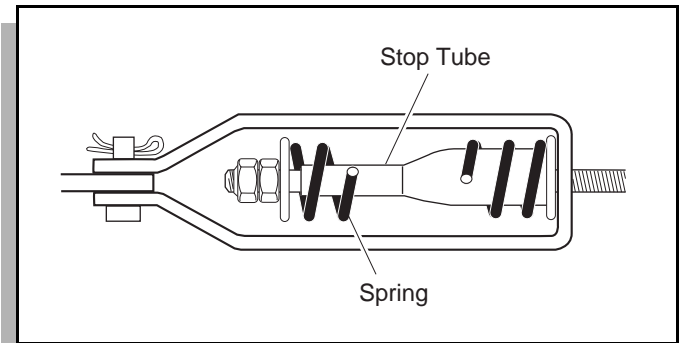
**Fig. 3 Parking Brake and Kick-Off Mechanism**

bracket. The service brake pedal is held in the applied (down) position by the catch bracket. The latch arm is held in position by the tension in the brake linkage. The Parking Brake can be released by two methods:

1. Depressing the service brake, which permits the spring loaded Parking Brake pedal to return to its original position, disengaging the latch arm from the catch bracket. This is the preferred method which minimizes wear on components.
2. Pressing the accelerator pedal rotates the kick-off cam which forces the pedal latch arm to move away from the catch bracket. The spring loaded Parking Brake pedal returns to its original position, releasing the brake.

## Compensator Assembly

The compensator assembly contains a spring, which is compressed until the stop tube within the spring is engaged and the linkage becomes solid (Ref Fig. 4 on page K-3). The brake compensator assembly applies a spring load to the parking brake system and insures that the parking brake remains under tension whenever it is engaged.



**Fig. 4 Compensator Assembly**

## Kick-Off Actuating Linkage

The kick-off actuating linkage may require periodic adjustment to compensate for the normal wear. Replacement of any linkage components will also require an adjustment.

# BRAKES - REAR MECHANICAL

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

## TROUBLESHOOTING FLOWCHART

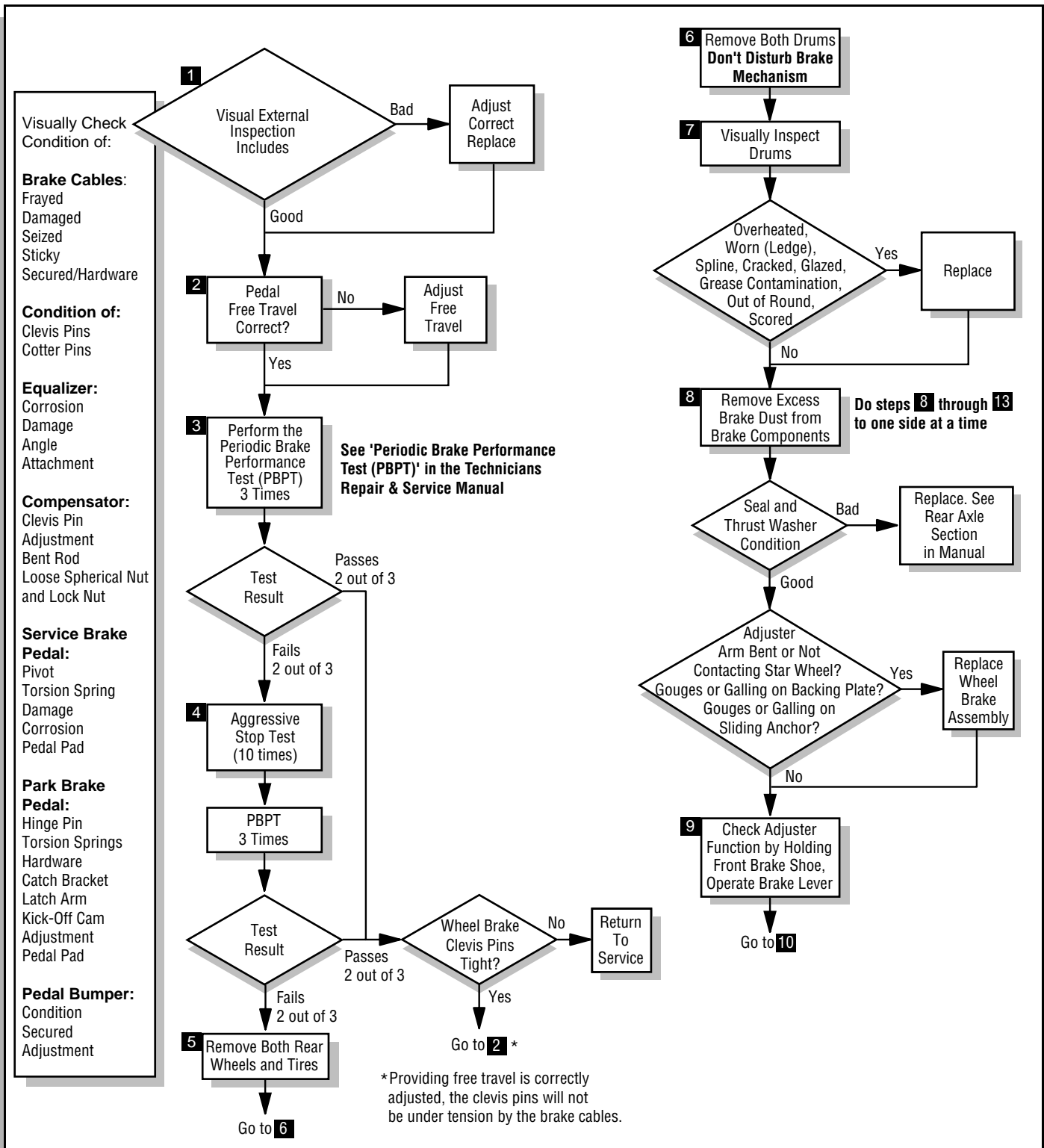


Fig. 5 Troubleshooting Flowchart



# BRAKES - REAR MECHANICAL

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

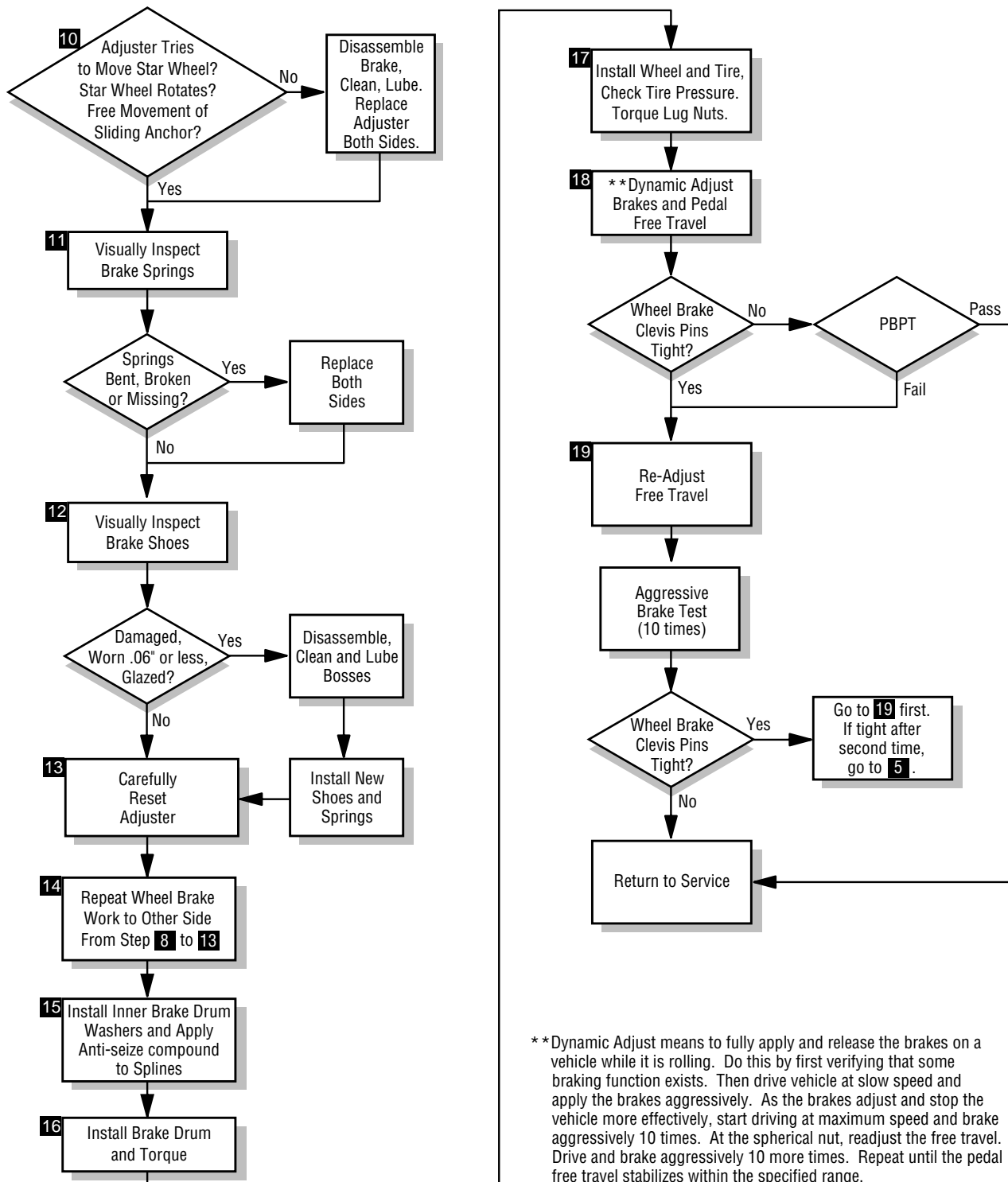


Fig. 5 Troubleshooting Flowchart

# BRAKES - REAR MECHANICAL

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

## TROUBLESHOOTING TABLE

Test (PBPT), and Aggressive Stop Test is performed (Ref Fig. 6 on page K-6).

Refer to the following troubleshooting table only after the thorough visual inspection, Periodic Brake Performance

Condition	Possible Cause	Correction
<b>Fails Brake Performance Test by stopping in a longer distance than normal</b>	Wheel brake failure due to severely worn or damaged components	Replace all severely worn or damaged components
	Brake pedal not returning Brake not adjusting	Check for binding of brake pedal Check brake pedal free travel Check brake cables Check brake adjusters Check pedal pivot
	Brake shoes wet	Check again when shoes are dry
	Brake cables damaged or sticky	Check brake cable and replace if sticky or damaged
	Brake shoes severely worn	Replace
	Brake shoes glazed	Sand shoes with emery cloth provided that shoes have .06" (1.5 mm) min. material
	System not adjusted properly	Check and adjust per manual
	End of brake cable loose from anchor brackets	Check and repair
	Cracked brake drum	Replace
<b>Starting 2001 Model Year - In excess of 1 1/8" (2.9 cm) free pedal travel (Soft Pedal)</b> <b>Prior to 2001 Model Year - In excess of 2 1/4" (5.7 cm) free pedal travel (Soft Pedal)</b>	Low pedal force at parking brake latch	Adjust per manual
	Brake cables damaged	Replace
	Brake return bumper out of adjustment	Adjust per manual
	End of brake cable loose from anchor brackets	Check and repair
	Wheel brake failure due to severely worn or damaged components	Replace all severely worn or damaged components
	System not adjusted properly	Adjust per Manual
<b>Starting 2001 Model Year - Less than 7/8" (2.2 cm) free pedal travel (Hard Pedal)</b> <b>Prior to 2001 Model Year - Less than 2" (5 cm) free pedal travel (Hard Pedal)</b>	High pedal force at parking brake latch	Adjust per Manual
	Brake cables damaged or sticky	Check brake cable and replace if sticky or damaged
	System not adjusted properly	Check and adjust per manual
	Wheel brake failure due to severely worn or damaged components	Replace all severely worn or damaged components

Fig. 6 Troubleshooting Table

## BRAKES - REAR MECHANICAL

*Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings*

Condition	Possible Cause	Correction
<b>Neither wheel locks when park brake is latched. (Note: At full speed the wheels may not lock, but should brake aggressively).</b>	Incorrect compensator spring adjustment	Return to factory specification
	Excessive brake pedal free travel	Adjust per manual
<b>Unequal braking (one wheel locks while other rotates)</b>	Wheel not locking is not adjusting	Check brake operation of wheel that is <b>not</b> locking
	Sticky/dragging cable	Check for brake lever return Check that brake levers return at equal rate - (Indication of dragging cable)
	Cracked brake drum	Replace
	Brake shoes wet or glazed	Check again when shoes are dry
	Rusted or sticky brake pivot hardware	Replace
<b>Neither wheel locks</b>	Brake system requires complete adjustment	Adjust entire system
	Brake pedal not returning	Check for binding of brake pedal Check brake pedal free travel
<b>Grabbing brakes (oversensitive)</b>	Moisture has caused surface rust on drums	Apply moderate force to pedal while at maximum level ground speed to remove rust until condition is relieved.
	Brake Pivot binding	Check and replace poor components
<b>Parking brake hard to latch</b>	Inadequate free play	Adjust pedal free travel at spherical nut and check that wheel brake actuators are returning fully
	Sticky/dragging cable	Check for brake lever return Check that brake levers return at equal rate - (Indication of dragging cable)
	Dragging shoes	Check wheel brakes
<b>Parking brake will not stay latched</b>	Excessive wear	Check for worn latch mechanism

**Fig. 6 Troubleshooting Table**

# BRAKES - REAR MECHANICAL

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

## TROUBLESHOOTING AND INSPECTION

### New Vehicles

A new vehicle will undergo an initial break-in of components including brake cables and brake shoes. In this break-in period, it is not uncommon for the brake pedal free travel (and the effort required to latch the parking brake) to change. The timing of this change varies with terrain and the driving habits of the operator(s). When this occurs, the brake linkage should be adjusted. See 'Adjusting Brake Pedal Free Travel' on page K-14. After this initial period, no further adjustments should be required until routine maintenance is scheduled.

### Troubleshooting and Inspection Procedures

To troubleshoot the mechanical brake system, inspect the brake pedal and linkage to find worn or damaged parts per the Troubleshooting Flowchart (Ref Fig. 5 on page K-4). Then, perform the Periodic Brake Performance Test to evaluate system performance. Based on the results of the inspection and tests, refer to the Troubleshooting Table (Ref Fig. 6 on page K-6) to evaluate symptoms and repairs. If required, disassemble the wheel brake to locate and correct internal faults.

Instructions for removal or replacement of parts and adjustments referred to in this section of the manual are described in detail under 'MAINTENANCE AND REPAIRS' on page K-14.

**CAUTION** Satisfactory brake performance does not eliminate the need for routine brake testing and inspection as shown on the Periodic Service Schedule in Section A. Continued proper brake operation depends on periodic maintenance.

### Brake Pedal and Linkage Inspection

#### 1. Inspect brake pedal return bumper.

Be sure that the brake pedal is contacting the pedal return bumper when released, that the bumper is in good condition and that a 1/4 - 3/8" (6 - 9.5 mm) gap exists between the brake pedal arm and the setscrew heads of the kick-off cam (Ref Fig. 7 on page K-8). Replace or adjust the pedal bumper if required. See 'Pedal Bumper Adjustment' on page K-20.

#### 2. Check brake pedal return.

Apply the brake pedal and release. Check that the brake pedal arm rests against the pedal bumper when released. Check that the torsion spring is hooked around both the pedal and the frame and is in good condition. If the pedal does not return fully or is sluggish, the brake pedal bushings and pivot bolt

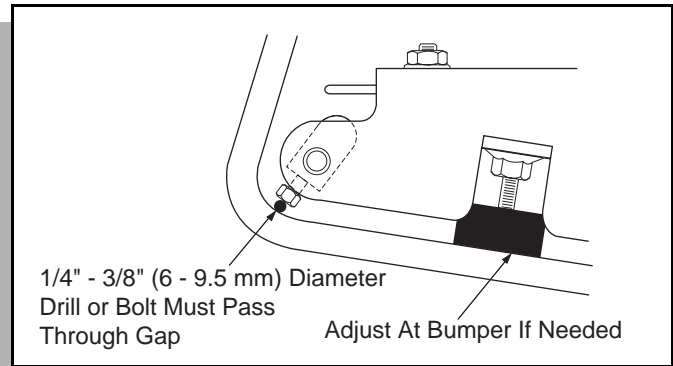


Fig. 7 Brake Pedal Bumper Inspection

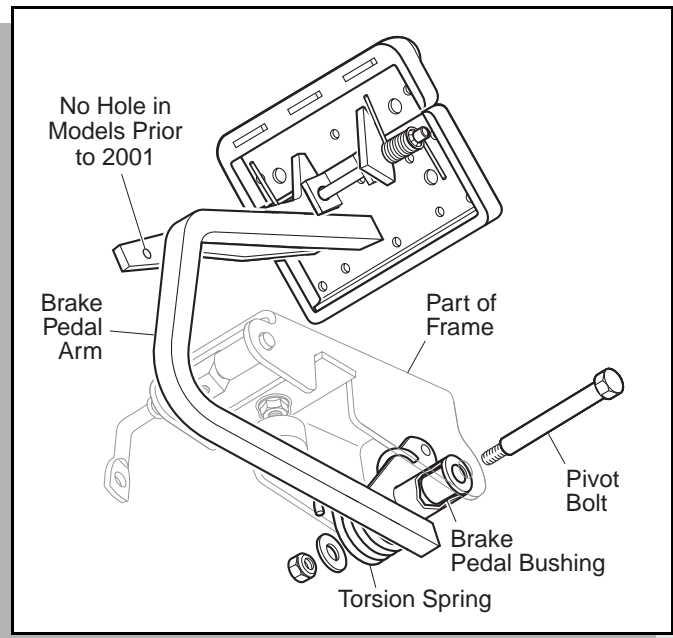


Fig. 8 Brake Pedal Inspection

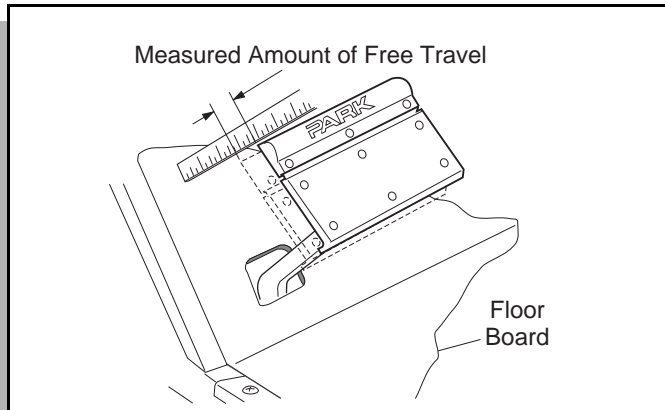
should be inspected (Ref Fig. 8 on page K-8). Replace pedal, spring, bushings and bolt as required. See 'Brake Pedal Removal and Installation' on page K-18.

#### 3. Check the brake pedal free travel.

Brake pedal free travel is the distance the pedal moves from rest to the point at which the brake shoes first contact the brake drums. This should not be confused with the light resistance that is felt as the brake pedal is depressed enough to remove slack from the compensator and cables. Too much pedal free travel may indicate wheel brakes not adjusting, wear in the cables and linkages or initial break-in of components. Not enough pedal free travel may indicate improper adjustment of the wheel brake or the brake linkage. Either condition can prevent the brakes from adjusting properly.

# BRAKES - REAR MECHANICAL

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings



**Fig. 9 Checking for Excessive Free Travel**

**NOTE** Adjustment of free travel depends on manufacturing date.

The correct brake pedal free travel setting varies depending on the date of manufacture. Older models (latch arm without a 1/4" (6 mm) diameter hole in the lower portion (Ref Fig. 8 on page K-8)) should be set to 2" - 2 1/4" (5 - 6.5 cm) free travel. Starting model year 2001 (with a 1/4" (6 mm) diameter hole in the lower end of the latch arm), free travel should be set to 7/8" - 1 1/8" (2.2 - 2.9 cm) (Ref Fig. 9 on page K-9).

The parking brake latching force may be checked as a verification after setting brake pedal free travel. The preferred method of checking parking brake latching force is to place a 'bathroom' scale on the service and parking brake pedals. Using both feet, press the scale down evenly against the parking brake pedal until it latches. The parking brake should latch between 65 and 75 lbs. (29 - 34 kg) indicated on the scale (Ref Fig. 20 on page K-15).

Adjust brake pedal free travel as described in 'MAINTENANCE AND REPAIRS' on page K-14 if required.

#### 4. Inspect the brake cables.

Inspect for damage to the outer cable, fraying of the inner cable or lack of free motion when the pedal is applied and released. Inspect the brake cable supports to be sure the cables are properly secured. If any of these conditions are found, replace both cables and equalizer as a set.

#### 5. Check the clevis pins.

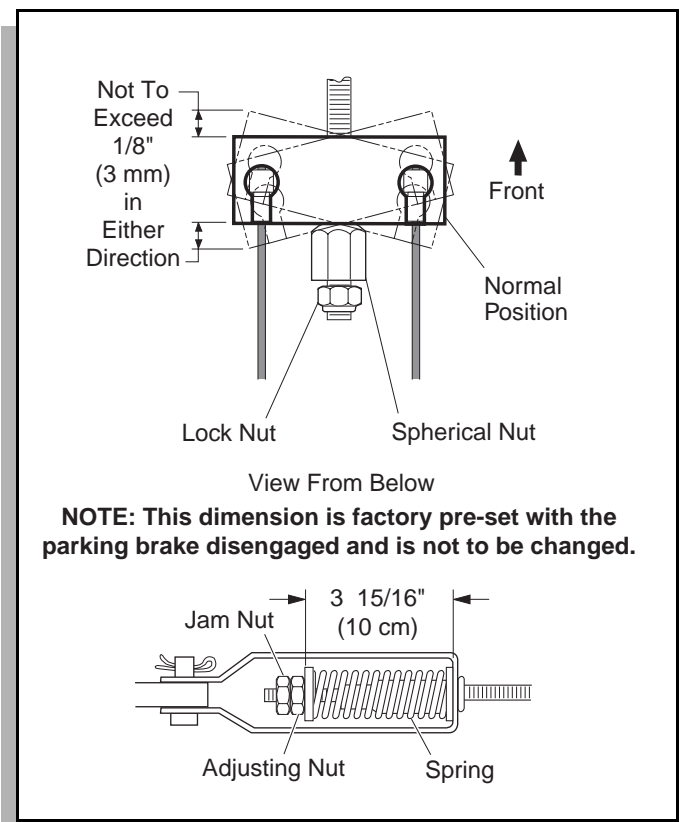
Check clevis pins attaching the brake cables to the brake lever. They must be loose when the brake pedal has been released (Ref Fig. 19 on page K-15). If the clevis pins are not loose, but brake pedal free travel is correctly adjusted and the brake cables move freely, the problem is likely in the wheel brake.

#### 6. Inspect the brake cable equalizer linkage.

Inspect for signs of corrosion, damage, wear or excessive misalignment (Ref Fig. 10 on page K-9). Replace if corrosion, damage, or wear is found.

#### 7. Inspect the compensator assembly.

Inspect for damage, corrosion or wear. Replace the complete assembly if problems are found. In general, no adjustment will be needed, as the spring assembly is factory calibrated. With the parking brake disengaged check that the compensator spring length is 3 15/16" (10 cm) (Ref Fig. 10 on page K-9). If an adjustment is required, it should be made at the nuts at the spring facing the front of the vehicle. Tighten the jam nut firmly after adjusting.



**Fig. 10 Equalizer and Compensator**

#### 8. Inspect parking brake pedal hinge.

Check for broken or rusted springs and correct retention of the hinge pin. Operate parking brake pedal to confirm smooth operation of the hinge mechanism (Ref Fig. 11 on page K-10).

#### 9. Check the condition and operation of the parking brake latching mechanism.

The parking brake should latch firmly and release as soon as the accelerator pedal is depressed.

# BRAKES - REAR MECHANICAL

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

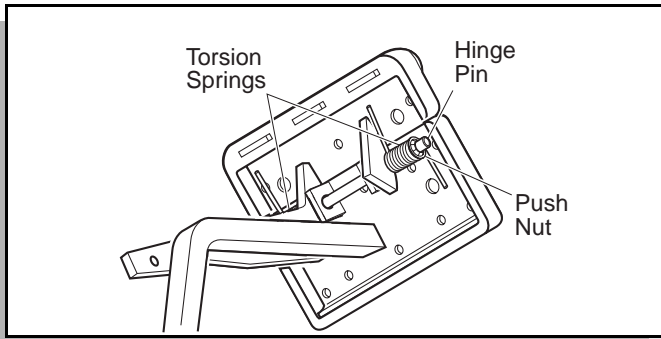


Fig. 11 Parking Brake Pedal Hinge Inspection



**To prevent serious injury or death from the use of worn parking brake components, do not attempt to re-new worn components. The parking brake latch arm, kick-off cam and catch bracket are hardened parts. Do not grind or file them as doing so will cause the parts to lose their hardness characteristics. New parts must be used.**

## 10. Inspect catch bracket and latch arm.

Replace if showing signs of wear or damage (Ref Fig. 12 on page K-10).

## 11. Inspect the parking brake kick-off cam.

Look for wear and for correct adjustment. With the parking brake engaged and fully latched, there must be no gap between the top of the cam and the latch arm. Adjust the kick-off cam (3) if required (Ref Fig. 12 on page K-10). It is very important that the correct setscrews are used to hold the kick-off cam to the pivot rod. Use of longer screws prevents correct adjustment of pedal bumper (pedal travel) and may prevent the brakes from adjusting properly.

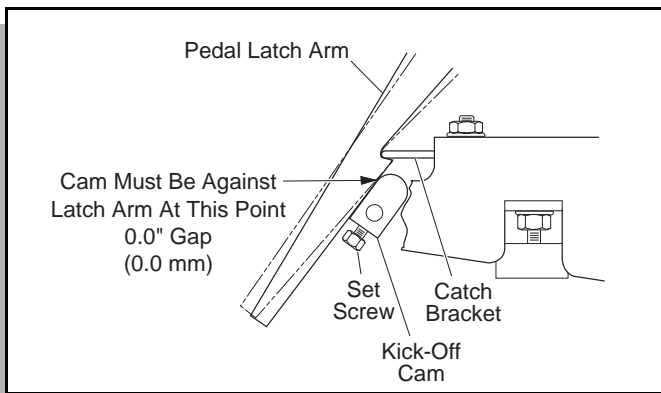


Fig. 12 Kick-Off Cam Inspection

## 12. Inspect kick-off cam linkage and bushings.

Check for wear and damage. The kick-off cam pivot

and bushings should move freely and be free of corrosion. The kick-off cam should rotate when the accelerator pedal is depressed.

## Periodic Brake Performance Test (PBPT)



**To prevent severe injury or death resulting from operating a vehicle with improperly operating brake system, the braking system must be properly maintained. All driving brake tests must be done in a safe location with regard for the safety of all personnel.**

The Periodic Brake Performance Test (PBPT) should be performed regularly (see Periodic Service Schedule in the GENERAL INFORMATION AND ROUTINE MAINTENANCE section of this manual) as an evaluation of braking system performance. It is useful as a method of identifying subtle loss of performance over time and as part of troubleshooting a problem vehicle.

Before performing this test, inspect the brake pedal and linkage and correct any problems found including adjusting the brake pedal free travel if required.

The purpose of this test is to compare the braking performance of the vehicle to the braking performance of new or "known to be good" vehicles or to an established acceptable stopping distance (see below). Actual stopping distances will be influenced by weather conditions, terrain, road surface condition, actual vehicle weight (accessories installed) and vehicle speed. No specific braking distance can be reliably specified. The test is conducted by latching the parking brake to eliminate different pedal pressures and to include the affects of linkage mis-adjustment. Significant changes or differences in braking performance will be evident due to mis-adjustment.

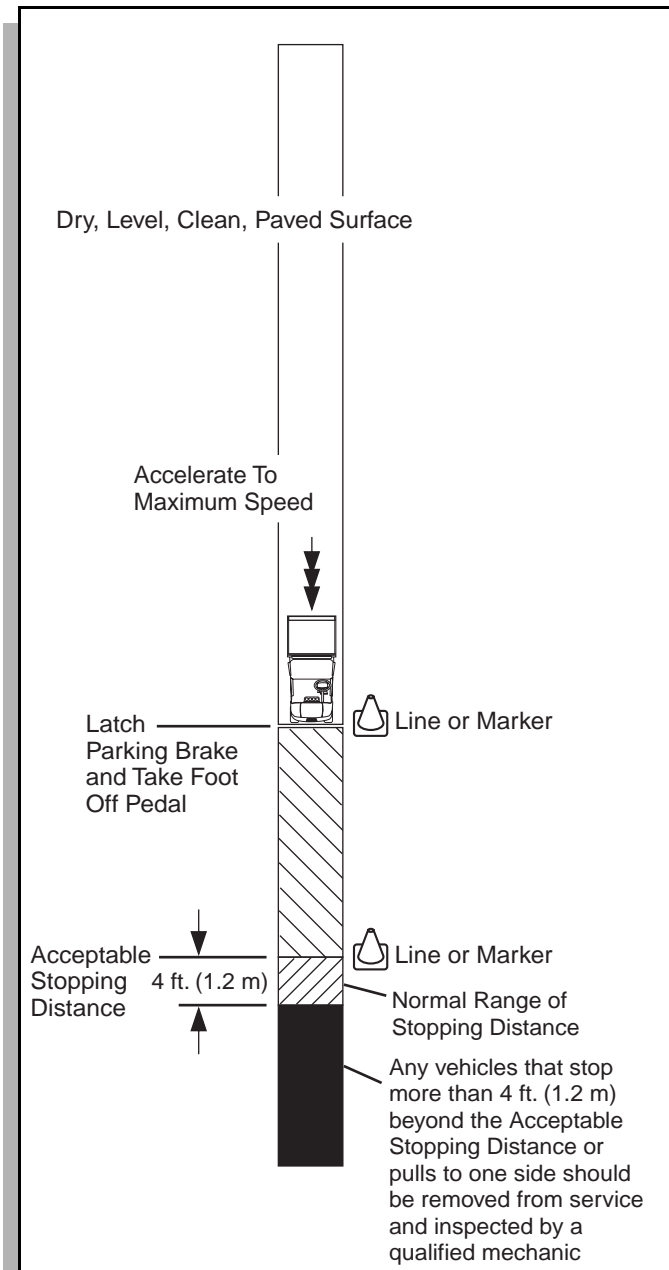
Establish the acceptable stopping distance by testing a new or "known to be good" vehicle and recording the stopping location or stopping distance. For fleets of vehicles, several vehicles should be tested when new and the range of stopping locations or distances recorded.

**NOTE** Over time, a subtle loss of performance may take place; therefore, it is important to establish the standard with a new vehicle.

Drive the vehicle at maximum speed on a flat, dry, clean, paved surface (Ref Fig. 13 on page K-11). Quickly depress the brake pedal to latch the parking brake at the line or marker in the test area and remove foot from pedal. The vehicle should stop aggressively. The wheel brakes may or may not lock. Observe the vehicle stop-

# BRAKES - REAR MECHANICAL

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings



**Fig. 13 Periodic Brake Performance Test**

ping location or measure the vehicle stopping distance from the point at which the brakes were latched. The vehicle should stop within the "normal" range of stopping distances. If the vehicle stops more than 4 ft. (1.2 m) beyond the acceptable stopping distance or pulls to one side, the vehicle has failed the test.

Repeat test two more times.

If the vehicle fails to pass two of three Periodic Brake Performance Tests, perform the Aggressive Stop Test 10

times as described below, then repeat the Periodic Brake Performance Test three more times (second set of three).

If the vehicle passes two of three Periodic Brake Performance Tests, check that the clevis pins at the brake levers are loose. If they are loose, return vehicle to service. If they are tight, adjust free travel. See 'Adjusting Brake Pedal Free Travel' on page K-14. Then repeat the Periodic Brake Performance Tests. If vehicle fails, remove from service and refer to 'Wheel Brake Inspection', on page K-12, to evaluate the reason for failure.

## Aggressive Stop Test



**WARNING** To prevent serious injury or death, all brake tests must be done in a safe location with regard for the safety of all personnel.

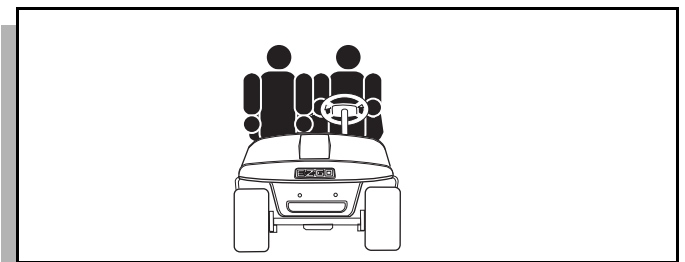
Always conduct a visual inspection and evaluate pedal travel before operating a vehicle to verify some braking function is present.

The purpose of this test is to attempt to fully expand and release the brake adjusters on a vehicle which has failed the first set of Periodic Brake Performance Tests. It is important that the technician/mechanic exercise care and perform the test in a non-congested area with regard for the safety of all personnel.

To perform an Aggressive Stop Test, equally load both sides of the vehicle (Ref Fig. 14 on page K-11) and apply maximum force and travel to the service brake pedal while moving. Do not latch the parking brake. Do this a total of 10 times with the first few at slow speed. If brake function is adequate or improves, increase speed for the remaining tests. Before the end of the tests, both wheels should lock at approximately the same time and slide straight.



**NOTE** The brake adjuster mechanism must expand and release fully to function. Under light usage this may not occur, even though the vehicle stops acceptably. The adjuster functions most consistently with aggressive braking.



**Fig. 14 Equally Load Vehicle**

# BRAKES - REAR MECHANICAL

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

## Wheel Brake Inspection



**WARNING** *Wear a dust mask and eye protection whenever working on wheel brakes. Do not use pressurized air to blow dust from brake assemblies. Replace both brake shoes on both wheels if one or more shoes are worn below .06" (1.5mm) thickness at any point.*



**CAUTION** Do NOT touch any of the wheel brake mechanism except as instructed.

Do NOT use a commercial brake cleaner unless the entire brake has been disassembled.

1. Remove the brake drums.  
Do not disturb adjuster mechanisms. Remove excess dust and dirt from the drum with a brush.



**WARNING** *The drum must not be turned to "true" a worn friction surface. Turning will make the drum too thin causing drum failure and a loss of brakes which could cause severe injury or death.*

2. Inspect the brake drum.  
Look for a blue coloration or blistered paint that would indicate that it has overheated. Check for evidence of scoring. Check for excessive wear indicated by the friction surface being significantly worn and leaving a ledge of unworn drum. Inspect the splines for galling, wear and corrosion. If any of these problems are found, the drum must be replaced.
3. Remove any accumulated brake dust from the wheel brake assembly with a brush.
4. Visually inspect the axle seal for oil leakage and the condition of the thrust washer. If oil is present, see REAR AXLE section.
5. Verify the inner brake drum washer is present and check its condition. Replace if damaged or missing.



**WARNING** *If one wheel brake assembly requires replacement, the second must also be replaced.*



**CAUTION** Use care when handling the adjuster arm. Too much force will damage the adjuster and require that both wheel brake assemblies be replaced.

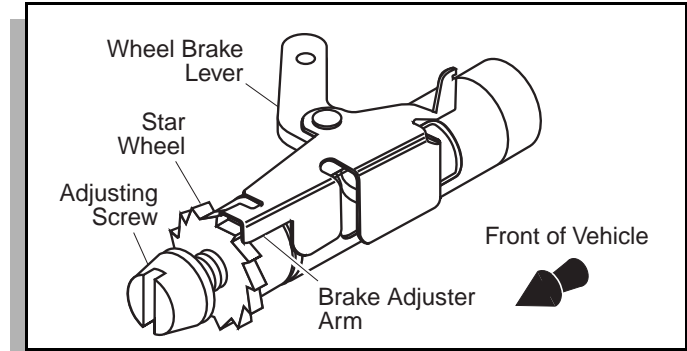
6. Visually check the condition and operation of the adjuster mechanism.

Inspect the brake lever for damage or wear. Test the adjuster function as follows:

Push the front brake shoe in the direction of the rear of the vehicle and hold in position.

Operate the brake lever.

Observe the brake adjuster arm and note if the arm engages the star wheel and attempts to rotate it (Ref Fig. 15 on page K-12).



**Fig. 15 Adjuster Mechanism**

If the adjuster arm **engages and turns** the star wheel, proceed. If the arm **fails to engage** the star wheel, it has been damaged and both wheel brake assemblies must be replaced.

If the adjuster arm engages the star wheel but **fails to rotate it**, the adjuster assemblies must be replaced with new color-coded adjusters. Note the location of the two Teflon coated washers (Ref Fig. 22 on page K-16).

7. Check the condition and operation of the moving anchor assembly (Ref Fig. 22 on page K-16).  
Operate the brake lever to check for free motion. The adjuster assembly and brake lever should move smoothly from front to back on the backing plate. If the moving anchor assembly is damaged or binds against the backing plate, replace both of the wheel brake assemblies.



**WARNING** *A backing plate assembly that shows any indication of galling or gouging is not repairable and must be replaced with a new wheel brake assembly. Always replace wheel brake assemblies in pairs.*

8. Inspect the backing plate.  
Inspect for gouges, galling or other damage, particularly where the backing plate is contacted by the brake shoes and by the moving anchor assembly. Replace both backing plates if any gouges or galling is found.



## BRAKES - REAR MECHANICAL

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

### 9. Measure the brake shoe thickness.

Measure at the most worn area. Brake shoe thickness must never be less than .06" (1.5 mm) at any point on the shoe. It is normal for the shoes to show more wear at the leading and trailing edges (Ref Fig. 16 on page K-13). If the brake shoe thickness is approaching .06" (1.5 mm), it is recommended that the shoes be replaced. It is recommended that the brake shoe springs and brake adjusters be replaced when installing new brake shoes.

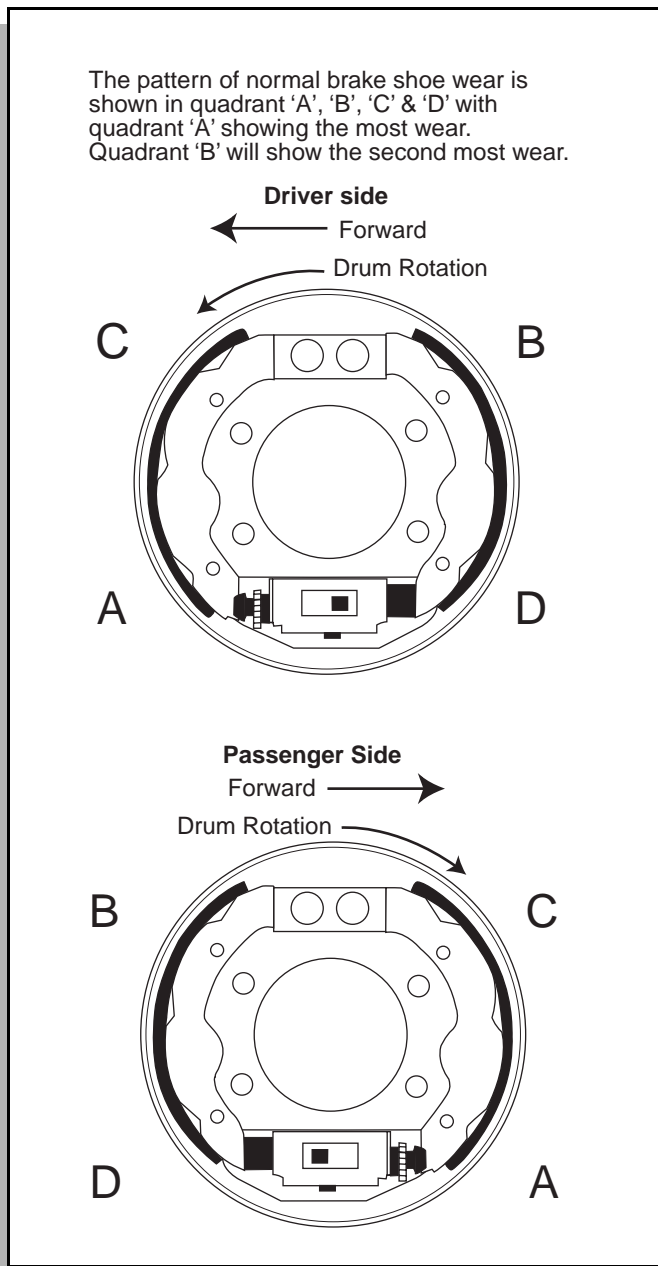


Fig. 16 Brake Shoe Wear

### 10. Inspect the brake shoe springs.

Be sure that they are not broken or damaged and are correctly installed. The hooked end of the adjuster spring is inserted through the front of the front shoe and the opposite end hooked to the adjuster with the hook end facing out. The brake shoe springs must be installed with the light spring closest to the adjuster mechanism with the hook installed down through the rear brake shoe and up through the front brake shoe. The heavy top spring is installed with both spring hooks installed down through the brake shoes (Ref Fig. 17 on page K-13).

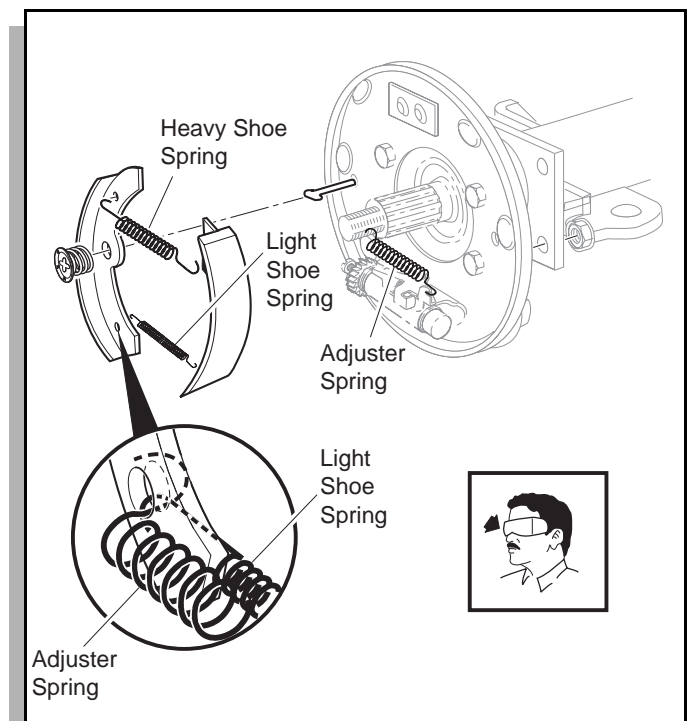


Fig. 17 Orientation of Brake Shoe Springs

### 11. Repeat procedure at the opposite wheel brake.

### 12. Check/adjust brake pedal free travel.

Whenever the brake system is serviced or requires a parts replacement, the brake pedal free travel must be checked and adjusted. See 'Adjusting Brake Pedal Free Travel' on page K-14. This includes all linkage and wheel brake components.

# BRAKES - REAR MECHANICAL

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

## MAINTENANCE AND REPAIRS

Tool List	Qty. Required
Hydraulic floor jack .....	1
Scale .....	1
Jack stands .....	4
Wheel chocks .....	4
Socket, 1/2", 1/2" drive .....	1
Socket, 3/4", 1/2" drive .....	1
Socket, 11/16", 1/2" drive .....	1
Socket, 15/16", 1/2" drive .....	1
Socket, 1 1/8", 1/2" drive .....	1
Socket, 1/4", 3/8" drive .....	1
Torque wrench, 1/2" drive, ft. lbs. ....	1
Torque wrench, 3/8" drive, in. lbs. ....	1
Extension, 6", 1/2" drive .....	1
Ratchet, 1/2" drive .....	1
Open end wrench, 1/4" .....	1
Open end wrench, 1/2" .....	1
Open end wrench, 5/8" .....	1
Straight blade screwdriver .....	1
Straight blade screwdriver, narrow .....	1
Pliers .....	1
Vernier/Dial calipers .....	1
Plastic tipped hammer .....	1
Puller (P/N 15947-G1) .....	1
Pry bar .....	1
Dust mask .....	1
Emery cloth .....	1

## Parts Replacement vs. Repair

Some maintenance or repair tasks can take considerable labor to do correctly. Assessment of the condition of worn components is critical to the operation of the brake system. In some cases, component replacement may be more cost effective than the removal, cleaning, inspection and reassembly of the component(s).

## Adjusting Brake Pedal Free Travel

**CAUTION** Brake pedal free travel MUST be checked and adjusted any time that the brake system is serviced or when parts are replaced.

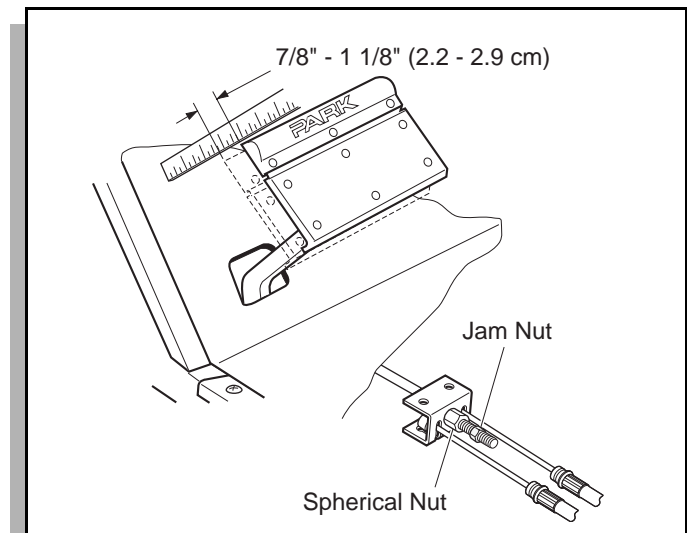
Brake pedal free travel is the distance the pedal travels from rest to the point at which the brake cables start to move the brake levers. This should not be confused with the light resistance that is felt as the brake pedal is

depressed enough to remove slack from the compensator and cables. Correct adjustment of free travel is essential to proper brake function. Too much pedal free travel will limit braking capability. Too little pedal free travel may cause the brakes to drag (not fully released). Either condition can prevent the brakes from adjusting properly.



**WARNING** This procedure is intended to adjust the brakes and seat brake system components. The brake system may not be effective for the first few applications of the brake pedal.

Pre-adjust service brake pedal free travel to the correct setting by loosening the jam nut and adjusting the spherical nut (Ref Fig. 18 on page K-14). Tighten the jam nut to 10 - 11 ft. lbs. (14 - 15 Nm).



**Fig. 18 Free Travel Adjustment**

The correct brake pedal free travel should be set to 7/8" - 1 1/8" (2.2 - 2.9 cm).

Press the brake pedal aggressively 4 - 6 times to establish known free travel.



**WARNING** All brake tests must be done in a safe location with regard to the safety of all personnel.

In a safe location free from people and vehicles, drive the vehicle at reduced speed and apply the brakes aggressively. As the brakes adjust and stop the vehicle effectively, start driving at maximum speed and brake aggressively 10 times.

# BRAKES - REAR MECHANICAL

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

At the spherical nut, adjust the free travel as noted above.

Drive again and brake aggressively 10 times.

Repeat the previous step(s) until the pedal free travel does not change during the aggressive braking.

Check to see that the clevis pins attaching the brake cables to the brake levers are loose (Ref Fig. 19 on page K-15). If they are not loose, inspect system again and correct as required. If the clevis pins are loose, tighten jam nut to 10 - 11 ft. lbs. (14 - 15 Nm) at the spherical nut.

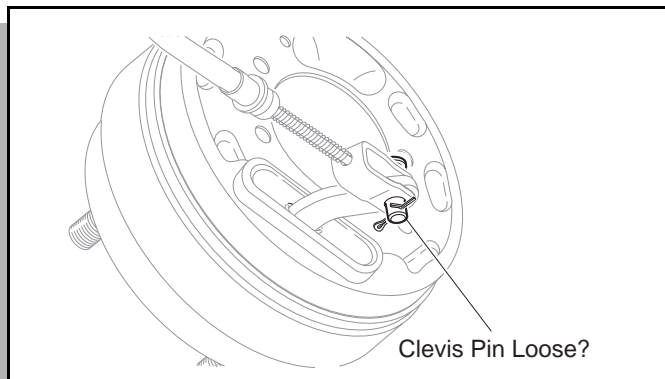


Fig. 19 Check Clevis Pins

The parking brake latching force can be checked as verification after setting brake pedal free travel. To check parking brake latching force, place a 'bathroom' scale on the service and parking brake pedals. Using both feet press the scale down against the parking brake pedal until it latches. The parking brake should latch between 65 and 75 lbs. (29 - 34 kg) indicated on the scale (Ref Fig. 20 on page K-15).

Perform the Periodic Brake Performance Test as described on page K-10 and return the vehicle to service if brake performance is satisfactory.

## Brake Drum Removal and Installation

Remove the dust cap (1) to gain access to the castellated nut (2) and the cotter pin (3) (Ref Fig. 21 on page K-15).

Remove the cotter pin and castellated nut as shown.

**NOTE** Do not apply the brake when removing the nut as the shoes may not fully retract preventing removal of the brake drum.

Remove washer (4).

Slide the brake drum (5) from the axle shaft. If required, tap the drum with a plastic faced hammer to loosen it from the axle shaft or use drum puller (P/N 15947-G1).

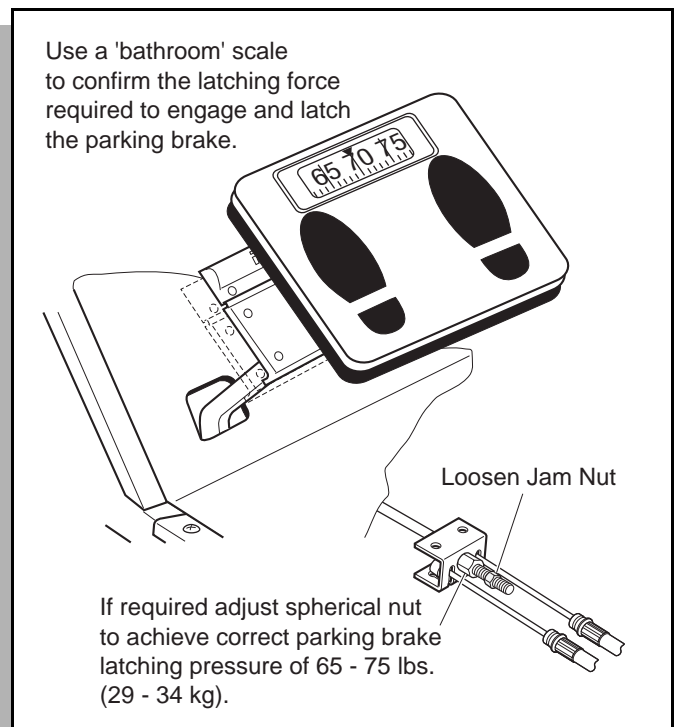


Fig. 20 Checking Parking Brake Latching Pressure

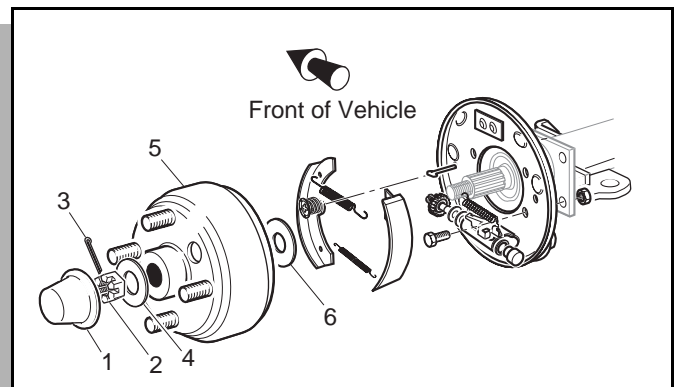


Fig. 21 Brake Assembly

**CAUTION** Use care when raising the adjuster arm. Too much force will damage the adjuster and require that both wheel brake assemblies be replaced.

If the drum does not slide from the brake assembly, the brake shoes must be retracted. Rotate the hub so that the hole in the drum is in the six o'clock position which is directly over the brake mechanism. Use a small straight blade screwdriver to raise the adjuster arm **just above** the star wheel.

Loosen the star wheel to retract the brake shoes and remove the brake drum.

# BRAKES - REAR MECHANICAL

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

**NOTE** Pay particular attention to the location of the inner brake drum washer (6) inside the brake drum, which may be on the axle shaft or attached to the rear of the drum hub. This washer must be reinstalled when the brake is reassembled.

To install the brake drum, clean the axle shaft and the splines on the brake drum to remove dirt, grease and foreign matter. Apply a small amount of anti-seize compound to the axle spline. Install the inner brake drum washer (6) and slide the brake drum (5) into place. Check to ensure the nose of drum hub is beyond the end of the axle splines. If not, remove drum and install one additional inner brake drum washer (total of 2) to obtain required spacing.

**CAUTION** Do not back off nut to install cotter pin.

Install the remaining hardware and tighten the nut to 80-90 ft. lbs. (108 - 122 Nm) torque. Continue to tighten until a new cotter pin can be installed through the castellated nut and the hole in the axle. Maximum torque is 140 ft. lbs. (190 Nm).

## Wheel Brake Service

Wheel brake service consists of disassembly, cleaning, inspection, lubrication and re-assembly of the wheel brake. Worn or damaged components must be replaced. Wheel brake service is required periodically as a preventive maintenance measure (see Periodic Service Schedule in Section A). The wear rate of brake shoes and required service intervals will vary based on usage, terrain and other conditions. It is recommended that wheel brake service be performed periodically on a sample of vehicles within the service fleet to establish the most efficient and effective service interval.

Remove the brake drum as described in 'Brake Drum Removal and Installation'.

**WARNING** Wear eye protection and a mask when cleaning brake components. Do not use compressed air to remove brake dust from brake assembly.

**CAUTION** Do NOT use a commercial brake cleaner unless the entire brake has been disassembled.

Remove any accumulated brake dust with a brush.

Remove the brake shoes. See 'Brake Shoe and Adjuster Replacement' on page K-17.

Clean backing plate with a commercial brake cleaner. Allow to dry completely.

**CAUTION** It is important that the friction areas between the backing plate and the brake shoes be lubricated. Be careful not to allow lubricant to contact the braking portion of the brake shoes or the friction surface of the brake drum. Use only recommended lubricants.

Lubricate the backing plate friction points of the shoes and moving anchor with Multi Purpose Grease (MPG) lubricant (Ref Fig. 22 on page K-16).

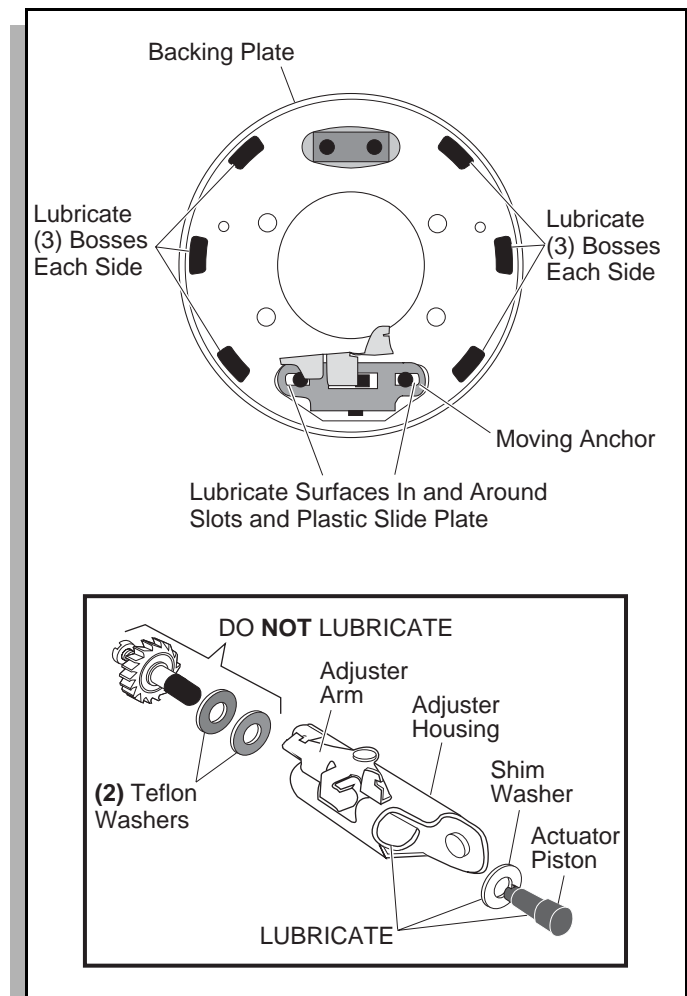


Fig. 22 Wheel Brake Lubrication Points

Install the actuator components, adjuster components and brake shoes. See 'Brake Shoe and Adjuster Replacement' on page K-17. If the brake shoes and drum are not to be replaced, sand the friction surfaces lightly with emery cloth to remove any foreign material.

# BRAKES - REAR MECHANICAL

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

**CAUTION** Be sure that the adjusting screw is screwed into the star wheel nut until only 1 - 2 threads are exposed (Ref Fig. 25 on page K-18). If the brake shoes are replaced, replace the three brake springs and the adjuster components.

Replace the springs one side at a time, using the other side as a guide.

Install brake drum as described in 'Brake Drum Removal and Installation'.

Repeat on other side of vehicle.

Adjust the brake pedal free travel. See 'Adjusting Brake Pedal Free Travel' on page K-14.

## Backing Plate/Entire Wheel Brake Assembly Removal and Installation

Remove the four bolts (1) and lock nuts (2) securing the wheel brake backing plate to the flange on the axle tube (Ref Fig. 23 on page K-17).

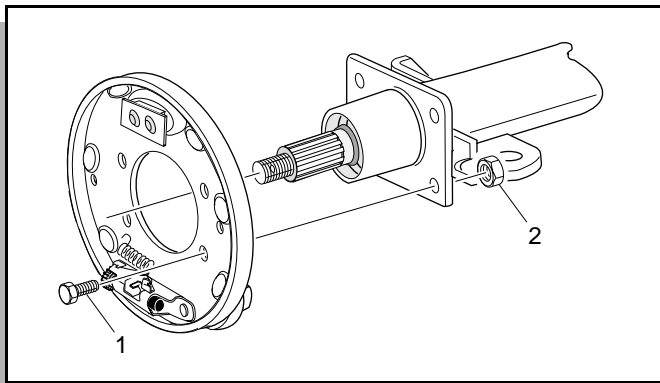


Fig. 23 Backing Plate Removal and Installation

Remove the clevis pin securing the brake cable to the brake lever.

Installation is the reverse of removal. Connect the brake cable to the wheel brake with the clevis pin installed from the top down and a new cotter pin. Install the brake assembly or backing plate to the axle tube flange. Install new hardware (locknut should only be used once) and tighten to 23 - 28 ft. lbs (31 - 38 Nm) torque.

## Brake Shoe and Adjuster Replacement

**NOTE** It is recommended that when brake shoes are replaced, the adjusters and springs also be replaced. It is good practice to do one side at a time, using the other side for reference.

Remove the three brake shoe springs and discard (1, 2, 3). Note the location of the heavy spring and the adjuster spring (Ref Fig. 24 on page K-17). Hold the shoe clamp

pin (4) and compress and rotate the shoe clamp (5) 90° to release it from the shoe clamp pin. Remove the brake shoes, adjusters and remaining components.

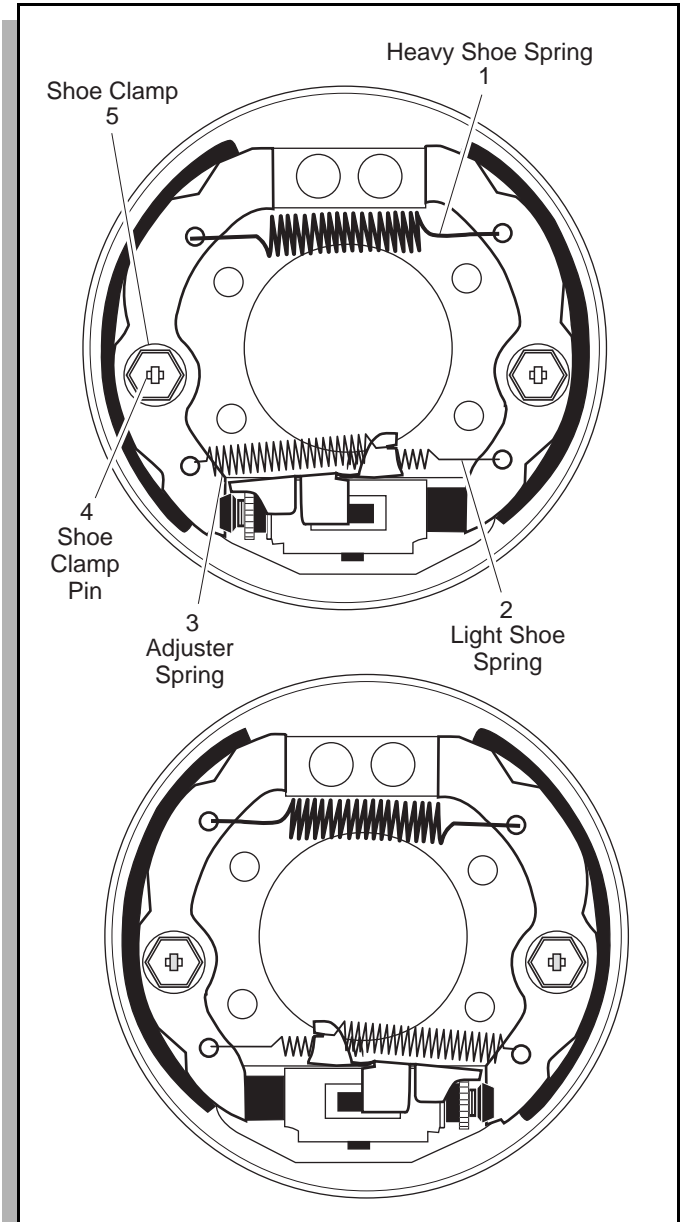


Fig. 24 Brake Shoes and Springs

Clean the backing plate with a commercial brake cleaner. Allow to dry completely. Lubricate the friction points of the shoes and moving anchor with Multi Purpose Grease (MPG) lubricant (Ref Fig. 22 on page K-16).

**CAUTION** Be sure that the adjusting screw is screwed into the star wheel nut until only 1 - 2 threads are exposed

# BRAKES - REAR MECHANICAL

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

Install adjuster mechanism (driver side silver, passenger side gold). Be sure that the two teflon coated washers are installed as shown (Ref Fig. 22 on page K-16). The adjusting screw must be screwed into the star wheel nut until only 1 - 2 threads are exposed (Ref Fig. 25 on page K-18).

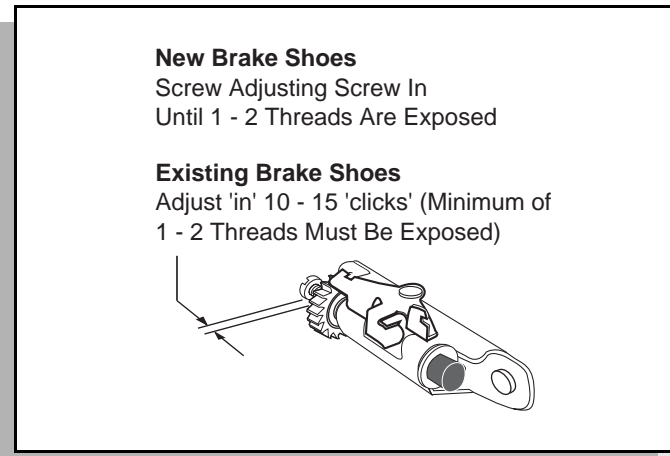


Fig. 25 Setting Adjuster Screw

Install the actuator piston. Be sure the hardened shim washer is installed as shown (Ref Fig. 22 on page K-16).

Always replace both brake shoes on both wheels as a set. Install the shoes as indicated and install the shoe clamp (5) over the shoe clamp pin (4) and rotate 90° to lock them in place (Ref Fig. 24 on page K-17).

Install new brake shoe and adjuster springs. The hooked end of the adjuster spring is inserted through the front of the front shoe as shown (Ref Fig. 24 on page K-17). The opposite end of the adjuster spring is hooked to the adjuster with the hook end facing out. The brake shoe springs must be installed with the light spring closest to the adjuster mechanism with the hook installed down through the rear brake shoe and up through the front brake shoe. The heavy top spring is installed with both spring hooks installed down through the brake shoes. Check to see that the brake is functioning properly.

Install the brake drum. See 'Brake Drum Removal and Installation' on page K-15.

Repeat on other side of vehicle.

Adjust the brake pedal free travel. See 'Adjusting Brake Pedal Free Travel' on page K-14.

## Brake Cable and Equalizer Assembly Removal and Installation

**NOTE** The brake cables and equalizer are only serviceable as a complete assembly.

Remove the cotter pins and clevis pins connecting the brake cables to the brake levers. Remove the retaining rings connecting the brake cables to their brackets at the axle (rear of cable) and at the frame (front of cable). Loosen and remove the jam nut and the spherical nut on the equalizer link (Ref Fig. 26 on page K-18). Inspect the hardware and replace if needed. Remove the brake cable and equalizer assembly and discard.

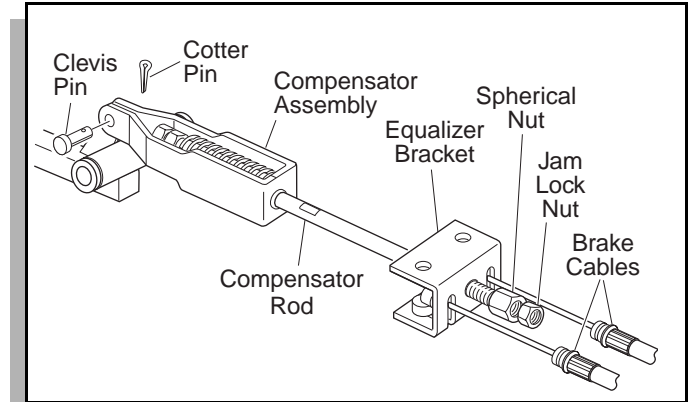


Fig. 26 Brake Cable, Equalizer and Compensator

Slide the equalizer link of the new assembly over the compensator rod. Loosely install the spherical nut and new locking jam nut. Insert the cables into the frame and axle brackets. Install new retaining rings. Connect the cables to the brake levers using new clevis pins and new cotter pins.

Adjust the brake pedal free travel. See 'Adjusting Brake Pedal Free Travel' on page K-14.

## Compensator Assembly, Removal and Installation

Disconnect the compensator assembly from the brake pedal by removing the cotter pin and clevis pin (Ref Fig. 26 on page K-18).

Loosen and remove the jam nut and the spherical nut connecting the compensator rod to the equalizer link. Remove the compensator assembly.

Installation is the reverse of removal. Use new cotter pins in the clevis pin.

Adjust the brake pedal free travel. See 'Adjusting Brake Pedal Free Travel' on page K-14.

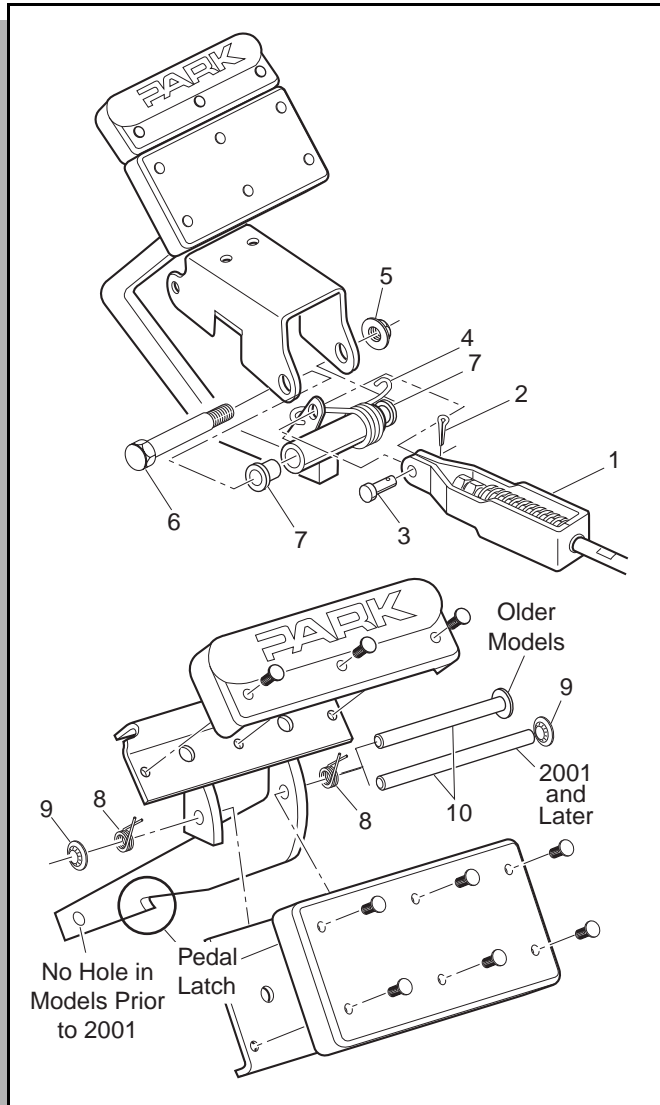
## Brake Pedal Removal and Installation

Disconnect the compensator assembly (1) from the brake pedal by removing the cotter pin (2) and the clevis pin (3). Unplug the wiring harness on models equipped with brake lights. Unhook the torsion spring (4) by insert-

## BRAKES - REAR MECHANICAL

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

ing a thin blade screwdriver between the small hook and the bracket. Move the hook back and to the side to release the torsion spring (Ref Fig. 27 on page K-19).



**Fig. 27 Brake Pedal Removal and Installation**

Remove the lock nut (5), the shoulder bolt (6) and remove the brake pedal.

Inspect the shoulder bolt for corrosion that could cause binding. This bolt and both bushings (7) must be replaced with new ones if corrosion or wear is found.

Brake pedal installation is in the reverse order of disassembly. Tighten the nut (5) to 25 - 29 ft. lbs. (34 - 39 Nm) torque and use a new cotter pin when installing the compensator assembly. Connect brake light wiring harness, if equipped.

Adjust the brake pedal free travel. See 'Adjusting Brake Pedal Free Travel' on page K-14.

Check for proper brake light operation if equipped.

### Parking Brake Catch Bracket Removal and Installation

Remove the driver side front wheel to gain access to the brake pedal release mechanism.

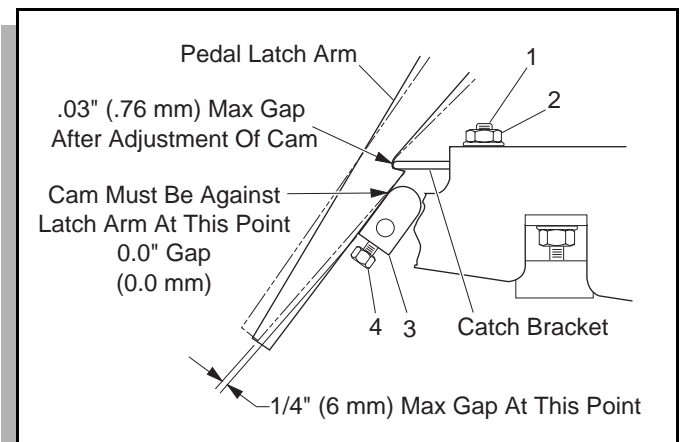


**WARNING** To prevent serious injury death resulting from the use of worn parking brake components, to not attempt to re-new worn components. The catch bracket is a hardened part. Do not grind or file it as doing so will cause the part to lose its hardness characteristics. A new part must be used.

Remove the two bolts (1) and nuts (2) which secure the catch bracket. Replace the catch bracket with a new one, replace and tighten the hardware to 85 - 95 in. lbs. (10 - 11 Nm) torque (Ref Fig. 28 on page K-19).

If required, adjust the kick-off cam (3). See 'Parking Brake Kick-Off Cam Removal, Replacement and Installation' on page K-20.

Install wheel. See WHEELS AND TIRES section.



**Fig. 28 Catch Bracket and Latch Arm**

### Parking Brake Pedal Removal and Installation

Note the location and orientation of the two torsion springs (8). Remove the push nut (9) and pin (10) (Ref Fig. 27 on page K-19) and remove the parking brake pedal. Some models may use two push nuts on the pin.

# BRAKES - REAR MECHANICAL

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

## ⚠ WARNING ⚠

To prevent serious injury or death resulting from the use of worn parking brake components, to not attempt to re-new worn components. The parking brake arm latch is a hardened part. Do not grind or file it as doing so will cause the part to lose its hardness characteristics. A new part must be used.

Installation is in the reverse order of disassembly. Use a new push nut (or push nuts).

If required, adjust the kick-off cam (3). See 'Parking Brake Kick-Off Cam Removal, Replacement and Installation' on page K-20.

### Pedal Bumper Adjustment

Loosen the bumper lock nut and adjust the bumper by rotating it (Ref Fig. 29 on page K-20). The brake pedal must contact the pedal bumper when pedal is released and the dimension from the top of the pedal arm to the setscrew heads in the kick-off cam should be approximately 1/4" - 3/8" (6 - 9.5 mm).

Tighten the lock nut to 12 - 14 ft. lbs. (16 - 19 Nm).

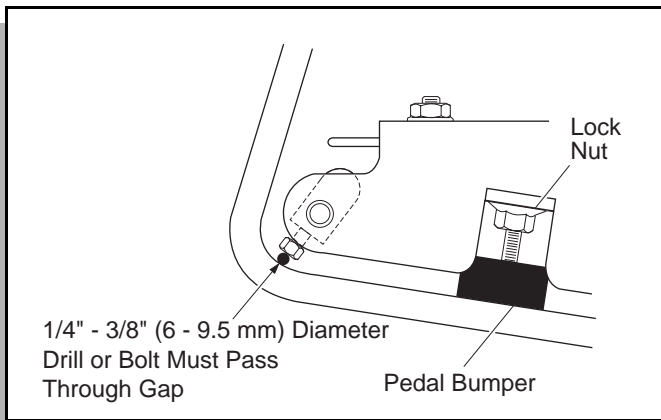


Fig. 29 Pedal Bumper Adjustment

### Parking Brake Release Linkage Removal and Replacement

Remove the cotter pin (2), washers (3) and bushings (4) from linkage rod (1). Remove the linkage rod (Ref Fig. 30 on page K-20).

Inspect the bushings (4). If they are worn replace them with new ones.

Installation is in the reverse order of disassembly.

If required, adjust the kick-off cam (6). See 'Parking Brake Kick-Off Cam Removal, Replacement and Installation' on page K-20.

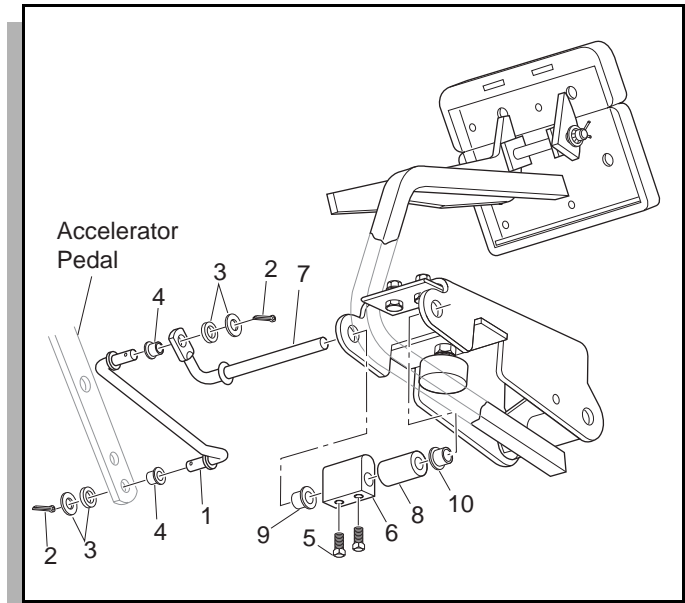


Fig. 30 Parking Brake Release Linkage and Kick-Off Cam Removal and Installation

### Parking Brake Kick-Off Cam Removal, Replacement and Installation

Disconnect the parking brake release linkage as described above. Loosen the two setscrews (5) from the cam (6) and remove the cam pivot (7), cam and spacer (8) (Ref Fig. 30 on page K-20).

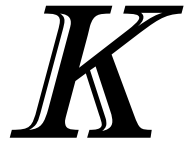
Inspect the bushings (9,10) and spacer. If they are worn, replace them with new ones.

Installation is in the reverse order of disassembly.

With the parking brake engaged and fully latched, there must be no gap between the top of the cam and the latch arm. To adjust the kick-off cam (6), engage the parking brake and loosen the two cam setscrews (5) and rotate the cam until it contacts the latch arm. Tighten the setscrews to 45 - 55 in. lbs. (5 - 6 Nm) torque. Always use new epoxy patch setscrews when replacing the kick-off cam.



# BRAKES - FRONT DISC



Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

## SYSTEM DESCRIPTION

**NOTE** To assure correct braking performance, all periodic maintenance, inspections and procedures must be performed as indicated in the Periodic Service Schedule in Section 'A' of this manual. The brake system must be bled whenever **any part of the brake system** has been replaced.

A hydraulic system is used to actuate the front brakes. The system transmits the power required to activate the friction surfaces (pads) of the braking system from the pedal to the individual disc brake hubs at each wheel.

The front hydraulic brake system is designed to operate only after significant rear brake pressure has been applied. This is accomplished by activating the master cylinder after the brake pedal has reached the parking brake latch position. The lower actuator pivot is connected to the brake pedal by a linkage rod which rotates to contact the upper actuator pivot. The upper actuator pivot is connected to a clevis of the master cylinder plunger. Movement of the plunger hydraulically activates the caliper pistons forcing the brake pads against the rotors. With the brake pedal released, the upper actuator pivot and the plunger returns to the 'at rest' position. With the master cylinder no longer applying hydraulic pressure to the brake pistons, the piston seals retract the pistons permitting the brake pads to float freely against their guide pins while removing all pressure against the rotors.

## MASTER CYLINDER REPLACEMENT

**CAUTION** During this process, it is likely that brake fluid will leak from the master cylinder. Avoid allowing brake fluid to contact the painted body components of the vehicle. Wipe off immediately.

Removing the front shield may improve access (See BODY)

To remove the master cylinder:

Remove the bolts securing the brake actuator assembly housing cover and remove cover. The clevis pin joining the brake cylinder clevis and the upper actuator pivot must be removed by removing the cotter pin and discarding. Remove clevis pin (Ref Fig. 1 on page K-21).

Remove the braided brake line from the master cylinder and allow brake fluid to drain into a container. **Do not reuse old brake fluid.** Remove the two nuts, bolts and washers securing the master cylinder to the brake actuator assembly housing. Install new master cylinder, and tighten nuts to 12 - 14 ft. lbs (16 - 19 Nm) torque. Install

brake line to new master cylinder and tighten to 15 in. lbs. (1.7 Nm) torque.

Latch the brake pedal. Rotate and hold the upper actuator pivot against the lower actuator pivot. (Rotate and hold the upper actuator pivot such that the rectangular stop tab contacts the lower actuator pivot stop tab.) Adjust master cylinder clevis until the clevis pin passes through the upper actuator pivot and the master cylinder clevis. Tighten jam nut against master cylinder clevis. Install a new cotter pin. Bleed hydraulic system.

Add clean fresh DOT 3 brake fluid into reservoir and bleed system per 'BLEEDING BRAKES'.

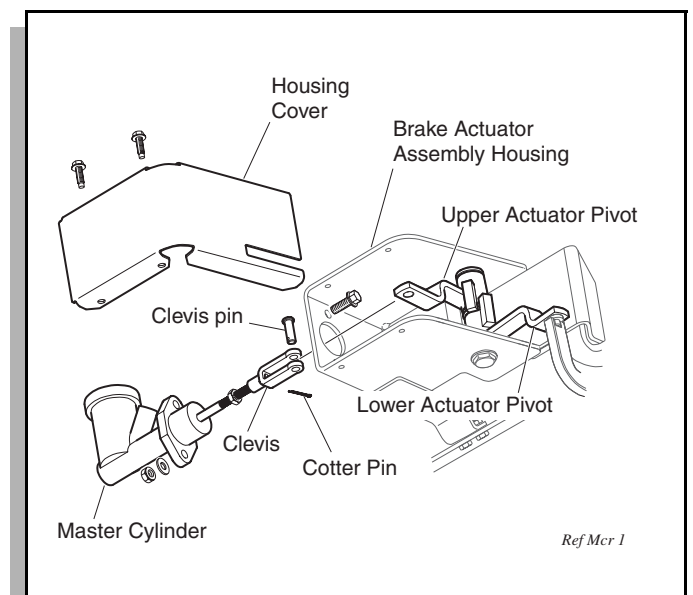


Fig. 1 Master Cylinder Replacement

## BRAKE MASTER CYLINDER FLUID

**NOTE** Hydraulic brake systems must be totally flushed if the fluid becomes contaminated with water, dirt or other corrosive chemicals. To flush, bleed the entire system until all brake fluid has been replaced with fresh DOT 3 standard automotive brake fluid.

### Check Brake Fluid

The brake fluid should be checked at regular intervals (as specified in the Periodic Service Schedule) or immediately if fluid leaks are found. The easiest way to check fluid level is to clean the cap with a shop rag and remove the cap. Check fluid level using a mechanics mirror and a flashlight. Add fluid if the level has fallen below 1/4" (6.5 mm) from the top of the reservoir and inspect for visible fluid leaks.

# BRAKES - FRONT DISC

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

## ROUTINE MAINTENANCE

Tool List	Qty. Required
Shop rag.....	A/R
Mechanics Mirror.....	1
Flashlight.....	1
Transmission fluid funnel.....	1
Torque wrench ft. lbs.....	1
Torque wrench in. lbs.....	1
Crows foot 9/16", 3/8" drive.....	1
Open end wrenches 3/8", 1/2", 5/8", 9/16".....	1
Needle nose pliers.....	1
Ratchet.....	1
Sockets 3/8", 1/2", 5/8", 9/16".....	1
Micrometer/vernier caliper.....	1
2" C clamp.....	1
Floor jack.....	1
Jack stands.....	1
Ball Joint seperator.....	1
Lug wrench, 3/4".....	1
Jack.....	1
Jack stands.....	4
Brake adjusting tool.....	1
Plastic faced hammer.....	1



**WARNING** *Never work on a vehicle supported by a jack alone. To prevent possible personal injury, the vehicle must be supported on jack stands during this procedure.*

## REPLACEMENT OF WEAR ITEMS

### Brake Pad Replacement

Brake pads should always be replaced as a full set of four pads. To remove the brake pads, raise the vehicle per 'Lifting the Vehicle' in the SAFETY section. Loosen both of the bolts securing the caliper to the spindle but only remove one. Swing the caliper free from the rotor. Push out the two guide/retainer pins from the caliper and remove the pads, being careful to note the orientation of the brake pads. Install a new set of pads. If the pads have been correctly oriented, the guide pins will easily engage. Re-insert the guide/retainer pins, being sure that they are correctly seated in the grooves machined in the caliper casting. Gently push the pads away from each other to provide adequate clearance with the rotor and then swing the entire caliper and pad assembly back

over the rotor. Secure the caliper to the spindle and tighten both bolts to 25 - 30 ft. lbs (33 - 40 Nm) torque. NOTE: Unless fluid is lost or a brake line is disconnected, there is no need to bleed the system.

### Rotor Replacement

**NOTE** *The rotor (disc brake hub) is not designed to be trued ("turned").*

If the rotor has deep grooves or gouges, it must be replaced. If the pad contact area has worn the rotor to .120" (3 mm) or less, the rotor must be replaced.

If the rotor must be replaced (or serviced), the caliper and pads must be swung out of the way to gain access to the rotor (See Brake Pad Replacement).

The disc hub (rotor) can be serviced in the same manner as the hub on non-front disc brake equipped vehicles.

For Hub Replacement, Wheel Bearing and Race Replacement, Wheel Bearing Packing and Wheel Bearing Adjustment procedures, see FRONT SUSPENSION AND STEERING.

### Spindle Replacement

See FRONT SUSPENSION AND STEERING.

### Actuator Linkage Bushings

Removing the front shield may improve access (See BODY)

The actuator linkage is connected to the lower actuator pivot with a flat washer and cotter pin. Remove and discard the cotter pin and remove the washer. A new nylon bushing may be installed (flange down) to the lower actuator pivot and the actuator linkage reinstalled using a new cotter pin. The actuator linkage is connected to the brake pedal arm with a flat washer and cotter pin. Remove and discard the cotter pin and remove the washer. A new nylon bushing may be installed (with the flange between the actuator linkage and the brake pedal arm) to the lower actuator pivot and the actuator linkage reinstalled using a new cotter pin.

### Actuator Pivot Bushings

Removing the front shield may improve access (See BODY)

Both the upper and lower actuator pivots contain an acetal flanged bushing at either end of the actuator and are unlikely to require replacement. The upper actuator pivot also is fitted with a nylon bushing between it and the brake cylinder clevis. To replace any of these bushings, the actuator linkage must be removed from the lower

# BRAKES - FRONT DISC

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

actuator pivot and the linkage rod (See Actuator linkage bushings).

The clevis pin joining the brake cylinder clevis and the upper actuator pivot must be removed by removing the cotter pin and discarding. Remove clevis pin.

Remove Locknut from shoulder bolt and remove shoulder bolt. Pivot components may now be removed and bushing removed and replaced with new ones. Be sure to replace the nylon bushing with the flange oriented up.

Reassemble using new cotter pins. and tighten lock nut to 5 - 10 (7 - 13 Nm) ft. lbs torque.

## BLEEDING BRAKES

Tool List	Qty. Required
Hose.....	A/R
Clean container .....	1
Brake fluid, DOT 3 .....	A/R
Wrench, 1/4" box end.....	1

The hydraulic brake system must be free of air to operate properly. Air can enter the system when hydraulic parts are disconnected for servicing or replacement, or when the fluid level in the master cylinder reservoir is very low. Air in the system will give the brake pedal a spongy feeling upon application.

**NOTE** An assistant will be necessary to perform this procedure.

Use a clean cloth to wipe off the master cylinder reservoir and wheel cylinder bleeder valves (Ref Fig. 2 on page K-23). Clean each fitting before opening to prevent contaminating the system. Open the master cylinder reservoir and top off with standard automotive DOT 3 brake fluid.

**⚠ WARNING ⚠** *Never reuse any excess fluid or return to the original container. Dispose of brake fluid properly.*

Brake fluid should never be returned to the original container and reused due to the possibility of contamination by dirt, grease, moisture or used brake fluid which could cause failure of the braking system. Dispose of in accordance with Federal, state and local codes.

Attach a short length of clear hose to the caliper bleed valve and insert the other end into a suitable clean container containing fresh, clean brake fluid (Ref Fig. 2 on page K-23). Check the fluid level in the master cylinder frequently during this operation to prevent air from entering the lines.

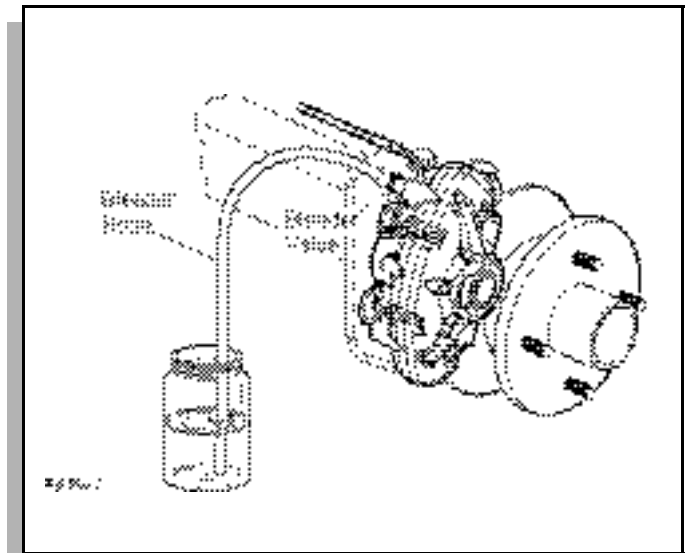


Fig. 2 Bleeding Brakes

Starting with the passenger side rear brake and going to the driver side rear brake, bleed the brakes using the following procedure:

**NOTE** The bleeder valve at the caliper must be closed at the end of each stroke and before the brake pedal is released to insure that air cannot enter the system. It is also important that the brake pedal be returned to full 'up' position.

Open the bleeder valve and have an assistant depress brake pedal **gently** until fluid flows into container. Close the bleeder valve and have the assistant slowly release the brake pedal. Repeat the process until no bubbles can be seen leaving the bleeder valve. Close the valve and repeat at other side. After bleeding, check fluid level using a mechanics mirror and a flashlight. Add fluid if the level has fallen below 1/4" (6.5 mm) from the top of the reservoir and inspect for visible fluid leaks.

# **BRAKES - FRONT DISC**

*Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings*

**Notes:** \_\_\_\_\_  
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## BATTERY CHARGER

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

### 48 VOLT BATTERY CHARGER

#### Description

The battery charger accompanying this vehicle is 120 volt AC, 60 Hz input with 48 volt DC output. Contact charger manufacturer for maintenance or service parts.

For service assistance, contact Service Parts Department, 1-800-227-7029.

### 36 VOLT BATTERY CHARGER

#### DESCRIPTION

The PowerWise™ battery charger is automatic and is designed specifically for charging electric vehicle batteries.

The charger type is known as ferroresonant. The term is applied to a charger that starts the charge at a relatively high rate of charge and continuously reduces the rate as the batteries become nearer to the full charge condition.

The battery charger can be connected to a vehicle that has been driven any distance and will charge the batteries fully before shutting itself off. The charger has a 3 second delay before turn on after plugging receptacle into vehicle.

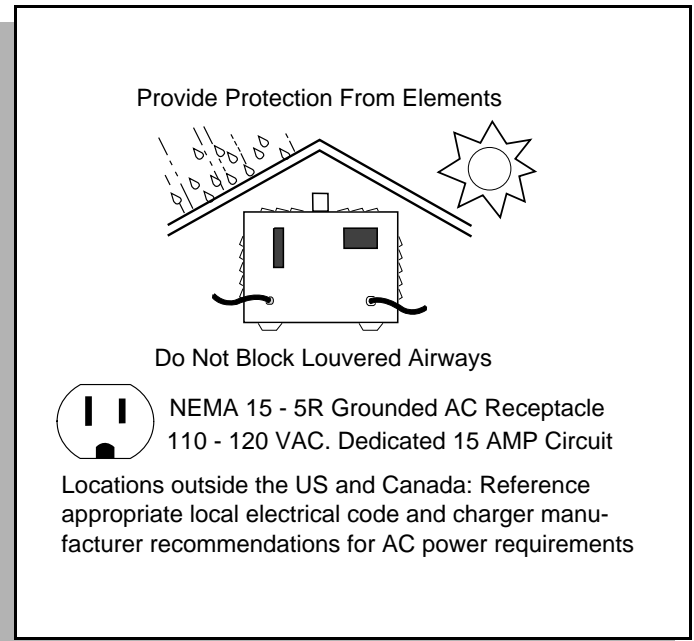
The electronic module within the charger samples the battery voltage during the charging period. If the module senses that the battery voltage has risen, it continues the charge. If the module senses no change, it determines that the batteries are fully charged and shuts the charger off.

### PORTABLE CHARGER INSTALLATION

**⚠ WARNING ⚠** *Portable chargers should be mounted on a platform above the ground or in such a manner as to permit the maximum air flow underneath and around the charger. Do not block or obstruct the louvers as overheating may result which could cause serious damage to the charger and create the potential for fire.*

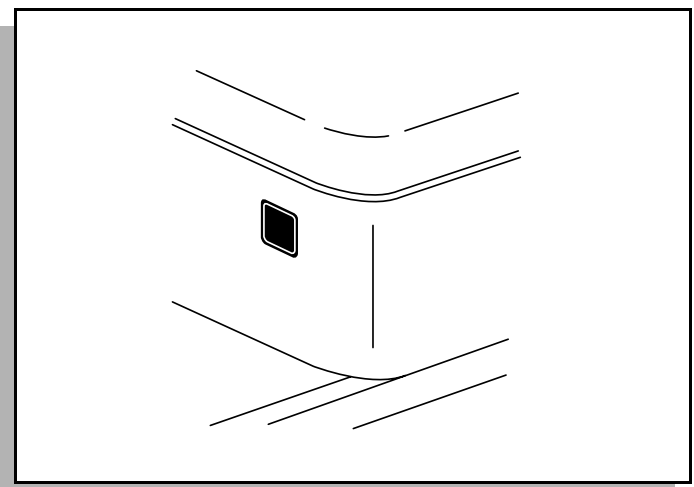
Portable chargers are shipped with the vehicle. Prior to vehicle or charger operation, chargers **must** be removed and mounted on a platform or wall above the ground to permit maximum air flow around and underneath the charger. If the charger is operated in an outdoor location, rain and sun protection must be provided (Ref Fig. 1 on page L-1). A dedicated circuit is required for the charger.

Refer to the charger manual for appropriate circuit protection.



**Fig. 1 Charger Installation**

The charger may remain plugged into the AC outlet. To charge the vehicle, refer to the instruction labels on the charger. Insert the polarized DC plug completely into the vehicle receptacle (Ref Fig. 2 on page L-1).



**Fig. 2 Polarized Receptacle**

The charger will automatically start a few seconds after plug insertion. The charger will automatically stop when batteries are fully charged and the DC plug can be removed to permit use of the vehicle.

# BATTERY CHARGER

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

**NOTE** Looping the DC cord through the steering wheel when charging serves as a good reminder to store the cord out of the way when finished with charging. The DC plug can be damaged by driving over or catching the cord on the vehicle when driving away. A charging interlock feature on the PowerWise™ charger prevents vehicle operation while the DC plug is inserted in vehicle receptacle.

**WARNING** An ungrounded electrical device may become a physical hazard that could result in an electrical shock or electrocution.

The charging (DC) cord is equipped with a polarized connector which fits into a matching receptacle on the vehicle.

The power (AC) cord is equipped with a grounded plug. Do not attempt to pull out, cut or bend the ground post.

**NOTE** If vehicle is to be charged with a non E-Z-GO charger, refer to the instructions supplied with the charger.

## ON-BOARD CHARGER

The on-board charger is located under the seat on the driver side. It is wired directly to the batteries, only requiring it be plugged into a dedicated 15 amp AC outlet to be operational (Ref Fig. 3 on page L-2). When charge cycle is complete, replace cord onto the cord storage handle.

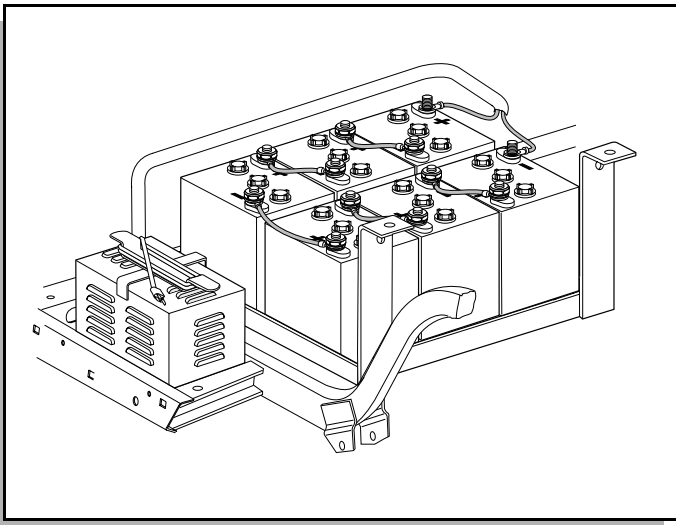


Fig. 3 On-board Charger

## UNDERSTANDING THE CHARGER

The battery charger reacts to unusual situations in various ways.

- If the charger is disconnected from the vehicle during the charge cycle, it will shut off immediately.
- If the AC power is interrupted, the charge cycle will continue normally for the remainder of the cycle when the power is restored.
- If the batteries become fully charged in a short period of time (under 2 hours), the charger will shut off. If the open circuit battery voltage drops to the point that charge is required the charger will turn itself on until the batteries are fully charged.
- The charger features an internal timer that will permit no more than 16 hours of continuous charge.

**WARNING** To prevent electrical shock or arc, which could cause serious body injury or damage to the facility or charger, unplug the charger from both the AC and DC power sources before starting any repair or maintenance procedure.

## OPENING THE CHARGER

**WARNING** Lethal voltages are present when charger is plugged in and the cover is removed.

If you have any doubts regarding your ability to safely perform the following test, have the charger repaired by a trained electrician/technician.

Use extreme care not to permit the uninsulated portion of test leads to contact any other component or the chassis of the charger.

Remove the screws (1 and 2) securing the front and rear of the handle (3) (Ref Fig. 4 on page L-3). This handle acts as a “key” and must be removed to permit the charger cover (4) to be removed.

Remove remaining screws (5) from sides and cover.

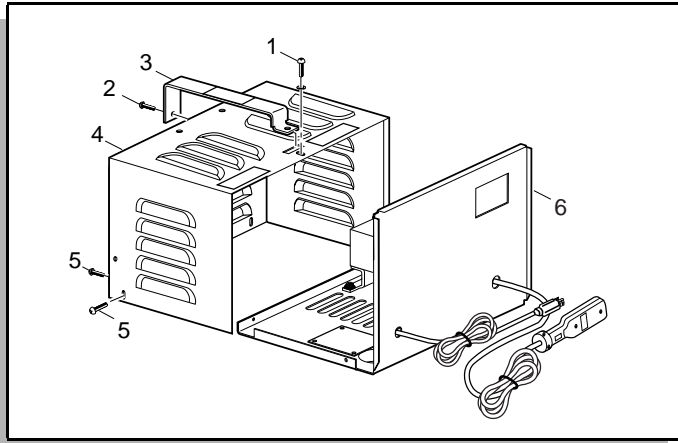
Tilt rear of the cover up and forward to release it from the front face (6) of the charger.

Assembly is in the reverse order of disassembly.



# BATTERY CHARGER

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings



**Fig. 4 Opening the Charger**

## TROUBLESHOOTING

Tool List	Qty. Required
DVOM .....	1
Phillips screwdriver .....	1

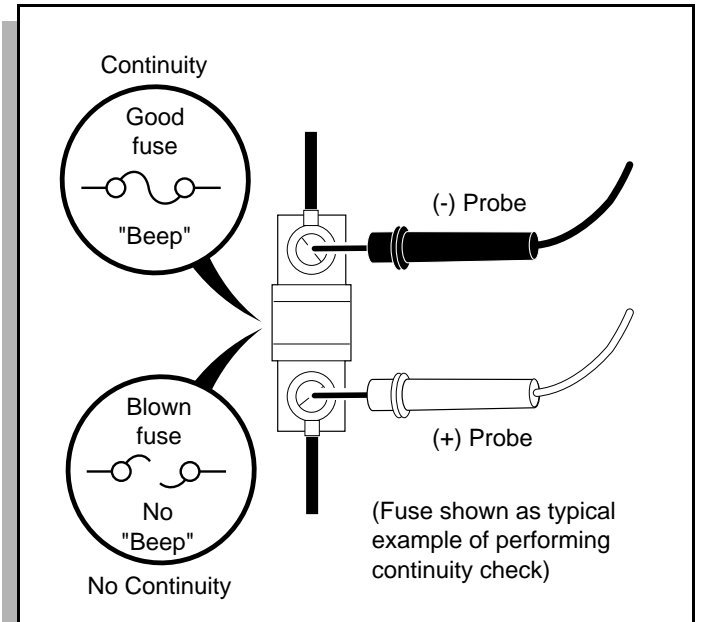
A simple but effective method of troubleshooting a battery charger that does not operate is to follow the sequenced troubleshooting procedures (Ref Fig. 6 on page L-4).

### Continuity Checks



**Before attempting to perform a continuity check, disconnect the battery charger from both AC and DC power sources.**

To check for continuity, set the DVOM (digital volt ohm meter) to K ohms setting and select 'Continuity'. The meter will give an audible signal when it detects continuity. If the meter does not have a continuity setting, set the meter then to K ohms, the meter will indicate "0" when continuity is detected (Ref Fig. 5 on page L-3).



**Fig. 5 Continuity Check**

### Diode Test Procedure

Tool List	Qty. Required
DVOM.....	1

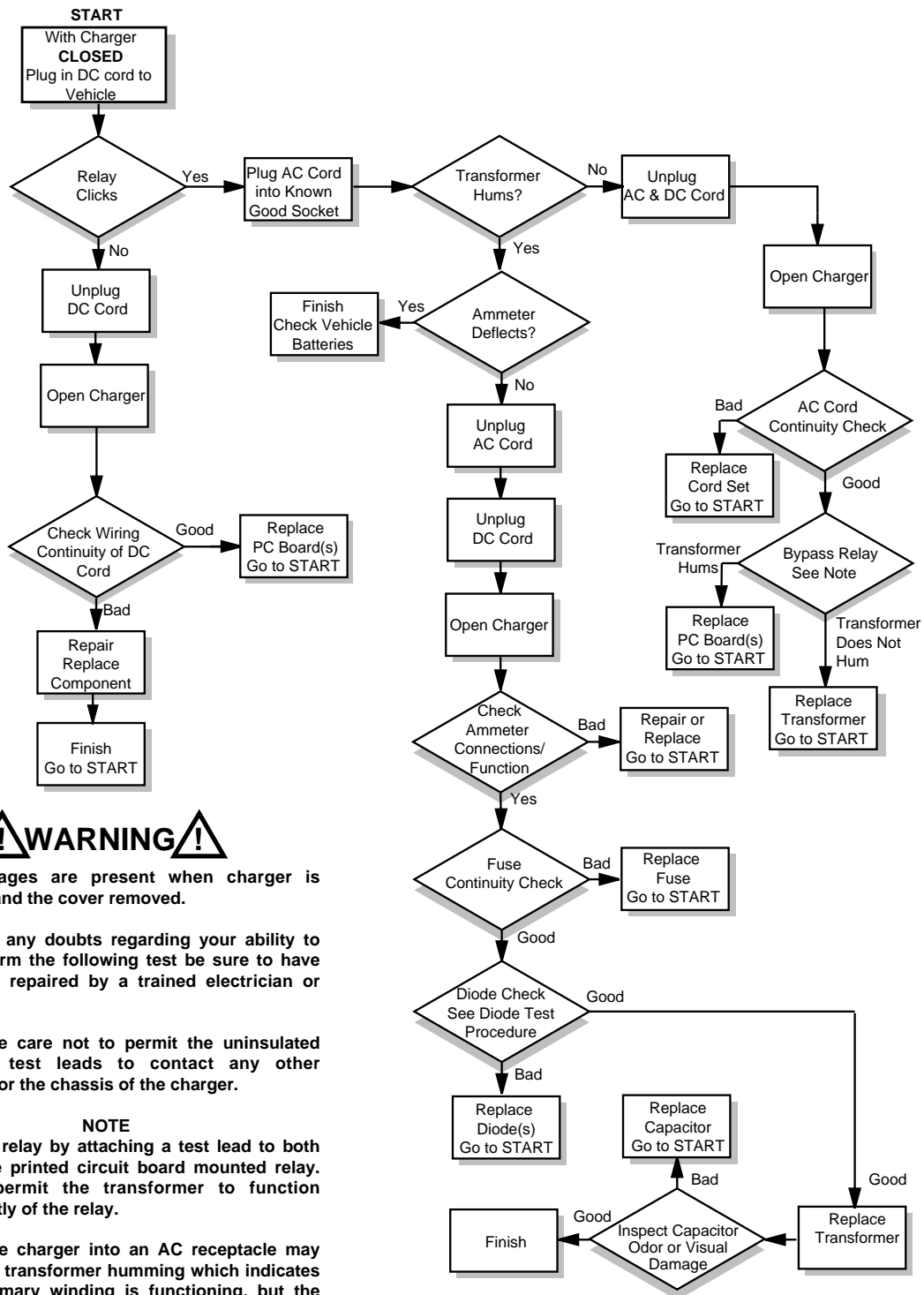
To test the diode, disconnect the battery charger AC power cord. With the DVOM set at highest ohms range available, place probes on diode as shown (Ref Fig. 7 on page L-5). A reading other than that shown indicates the diode is bad. Replace as necessary.

### COMPONENT REPLACEMENT

When replacing components, reinstall in reverse order of disassembly. Pay particular attention to any wiring that may have been disconnected, being sure to replace in original position.

# BATTERY CHARGER

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings



## ⚠ WARNING ⚠

Lethal voltages are present when charger is plugged in and the cover removed.

If you have any doubts regarding your ability to safely perform the following test be sure to have the charger repaired by a trained electrician or technician.

Use extreme care not to permit the uninsulated portion of test leads to contact any other component or the chassis of the charger.

### NOTE

Bypass the relay by attaching a test lead to both wires at the printed circuit board mounted relay. This will permit the transformer to function independently of the relay.

Plugging the charger into an AC receptacle may result in the transformer humming which indicates that the primary winding is functioning, but the printed circuit board has failed. If the transformer does not hum the transformer has failed.

Fig. 6 Troubleshooting Sequence

# BATTERY CHARGER

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

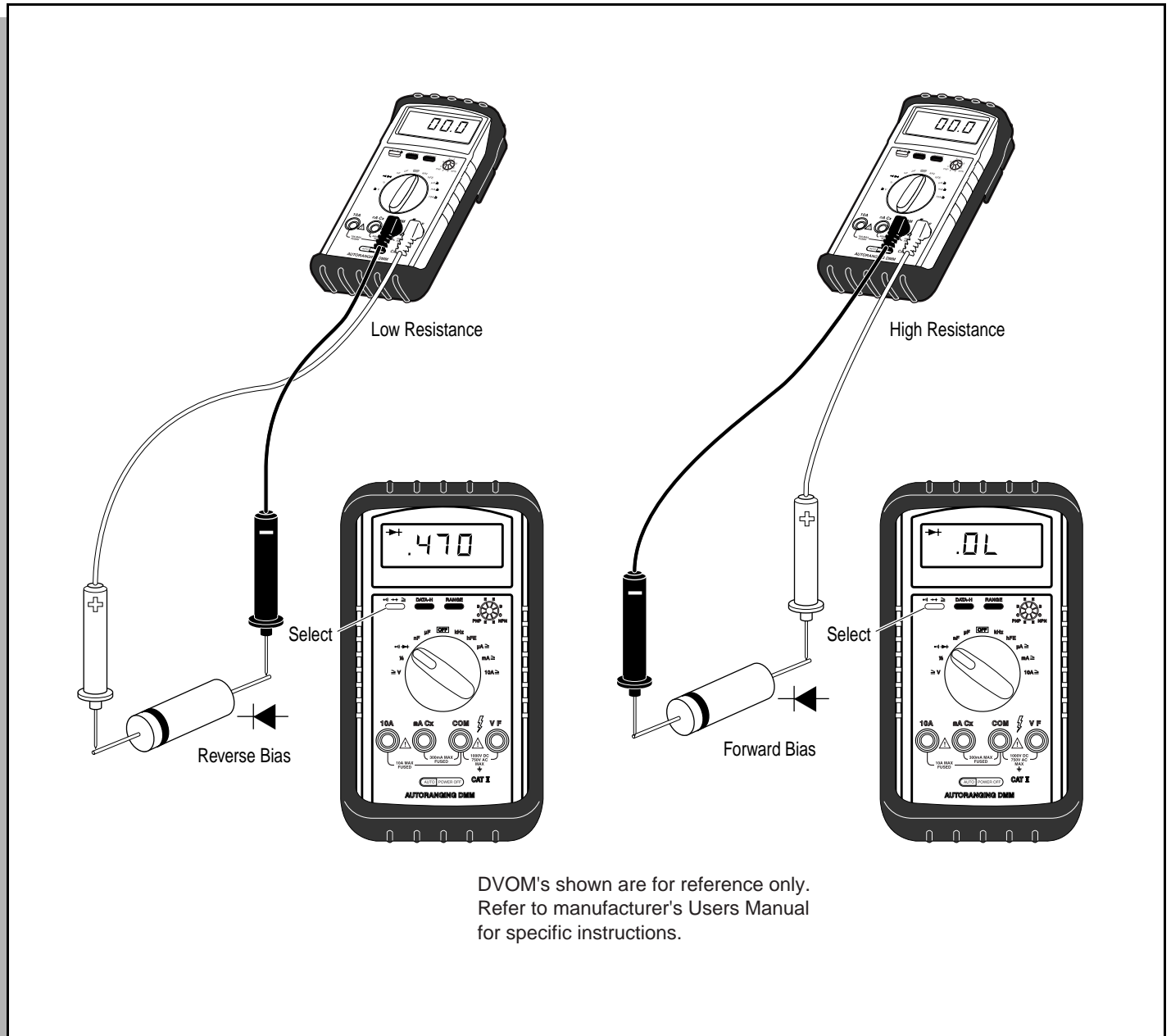


Fig. 7 Diode Test Procedure

# BATTERY CHARGER

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

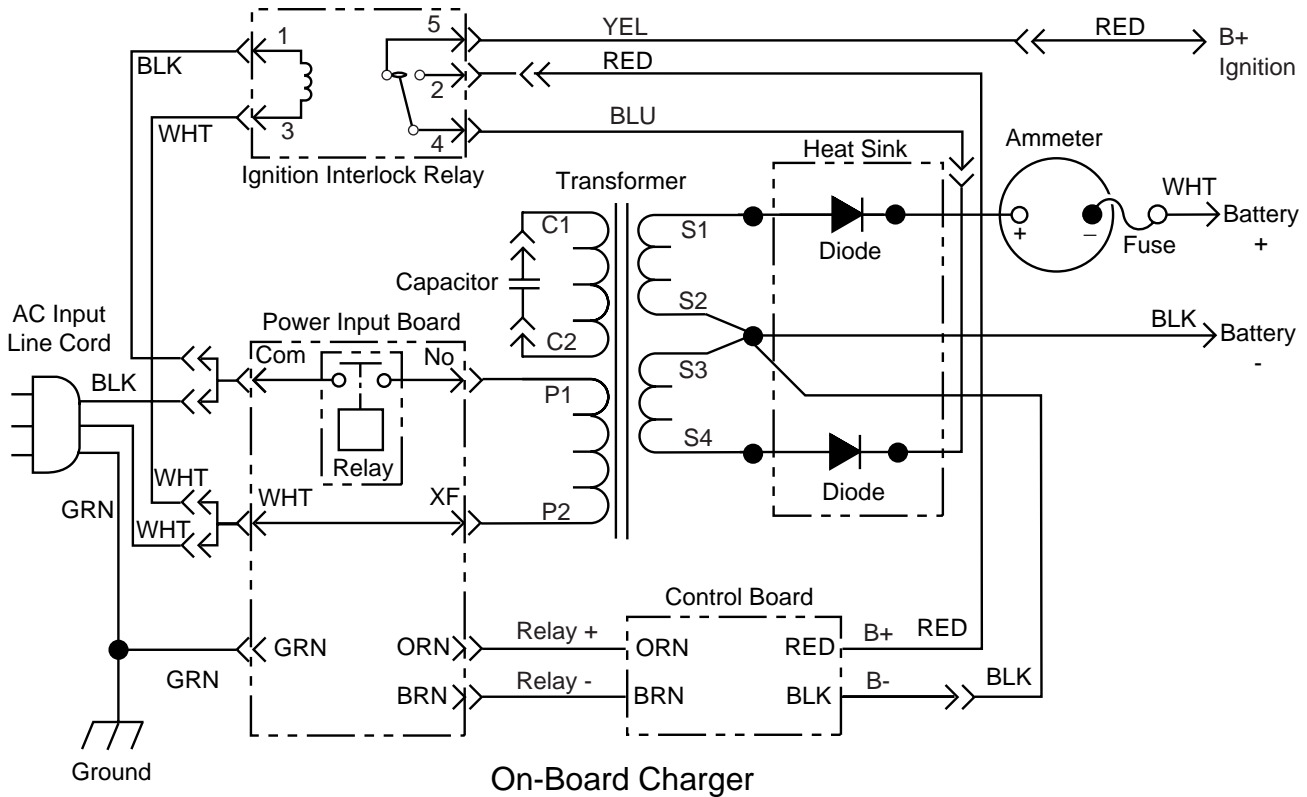
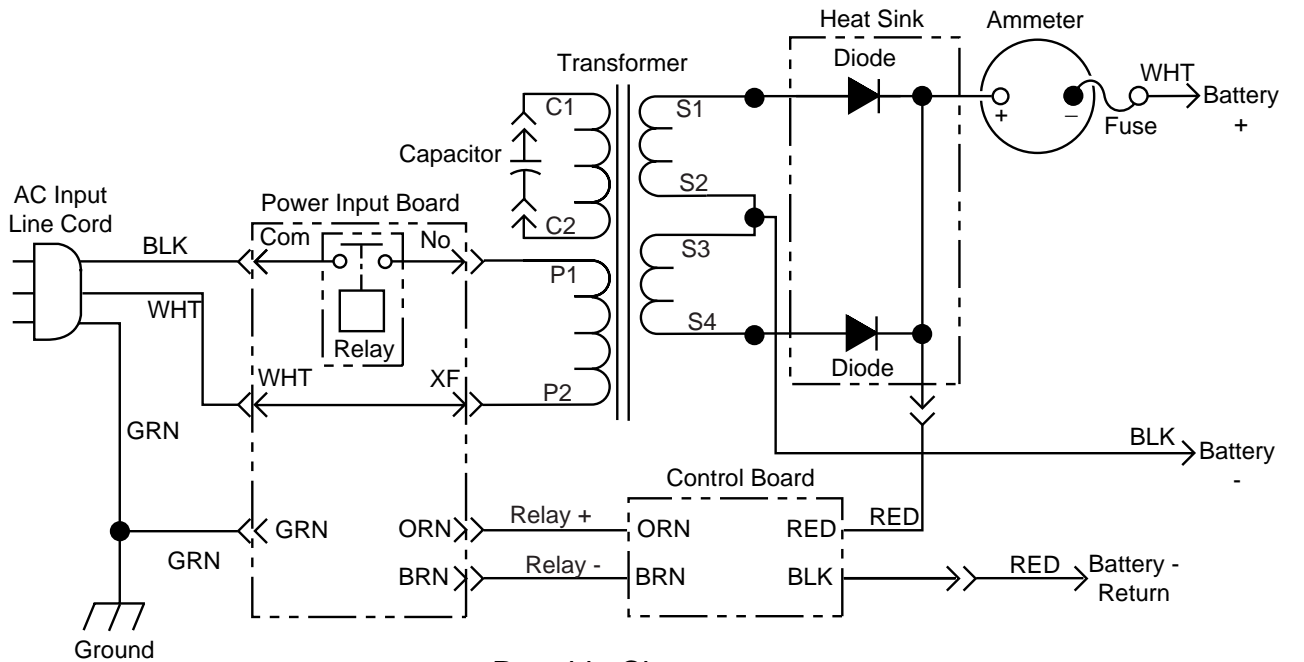


Fig. 8 PowerWise™ Wiring Diagram



## TABLE OF CONTENTS FOR SECTION 'M'

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REAR SUSPENSION.....	M - 1
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Shock Absorber Removal.....	M - 1
Shock Absorber Installation.....	M - 1
Rear Spring Removal.....	M - 1
Rear Spring Installation.....	M - 1

## LIST OF ILLUSTRATIONS

Fig. 1 Rear Suspension.....	M - 2
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# REAR SUSPENSION

Notes: \_\_\_\_\_  
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# REAR SUSPENSION

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

## REAR SUSPENSION

**NOTE** In the following text, there are references to removing/installing bolts etc. Additional hardware (nuts, washers etc.) that are removed must always be installed in their original positions unless otherwise specified. Non specified torque specifications are as shown in the table contained in Section "A".

### GENERAL

Tool List	Qty. Required
Wheel chocks.....	4
Jack stands.....	4
Floor jack.....	1
Wrench, 1/2".....	1
Insulated wrench, 9/16".....	1
Wrench, 3/4".....	1
Socket, 1/2", 3/8" drive.....	1
Socket, 9/16", 3/8" drive.....	1
Socket, 9/16", deepwell, 3/8" drive.....	1
Extension, 3", 3/8" drive.....	1
Ratchet, 3/8" drive.....	1
Torque wrench, in. lbs., 3/8" drive.....	1
Torque wrench, ft. lbs., 3/8" drive.....	1

The rear suspension consists of the rear axle and attachments that secure it to the springs and shock absorbers (Ref Fig. 1 on page M-2). Rear axle removal is covered in REAR AXLE section.

### Shock Absorber Removal

**⚠ WARNING ⚠** *To reduce the possibility of personal injury, follow the lifting procedure in Section "B" of this manual. Place wheel chocks in front and behind the front wheels and check the stability of the vehicle on the jack stands before starting any repair procedure. Never work on a vehicle that is supported by a jack alone.*

Raise the rear of the vehicle in accordance with the instructions provided in Section 'B' (SAFETY) of this manual and support the rear of the vehicle on the outer ends of the rear bumper.

Remove the bottom shock absorber vinyl cap (1), nut (2) (Ref Fig. 1 on page M-2).

Compress the shock absorber (3) and remove the top shock absorber vinyl cap (4) and nut (5).

Remove the shock absorber.

### Shock Absorber Installation

Shock absorber installation is in the reverse order of removal except that the shock absorber nuts (2,5) must be tightened until the shock absorber bushings (6) expand to the diameter of the shock absorber washer (7).

### Rear Spring Removal

**NOTE** *If both springs are to be replaced and the rear axle is not to be removed, it is important to remove and replace one spring at a time. Springs must be replaced in sets. Never replace just one.*

Remove the bottom shock absorber nut (2) (Ref Fig. 1 on page M-2).

Place a floor jack under the center section of the rear axle (13) and raise just enough to place a second set of jack stands under the axle tubes. With both the rear axle and the frame supported, the 'U' bolt (8) and the hardware (9) can be removed.

Remove the rear spring shackle assembly (10) and the front spring mounting hardware (11).

Remove the spring (12).

### Rear Spring Installation

Spring installation is in the reverse order of removal.

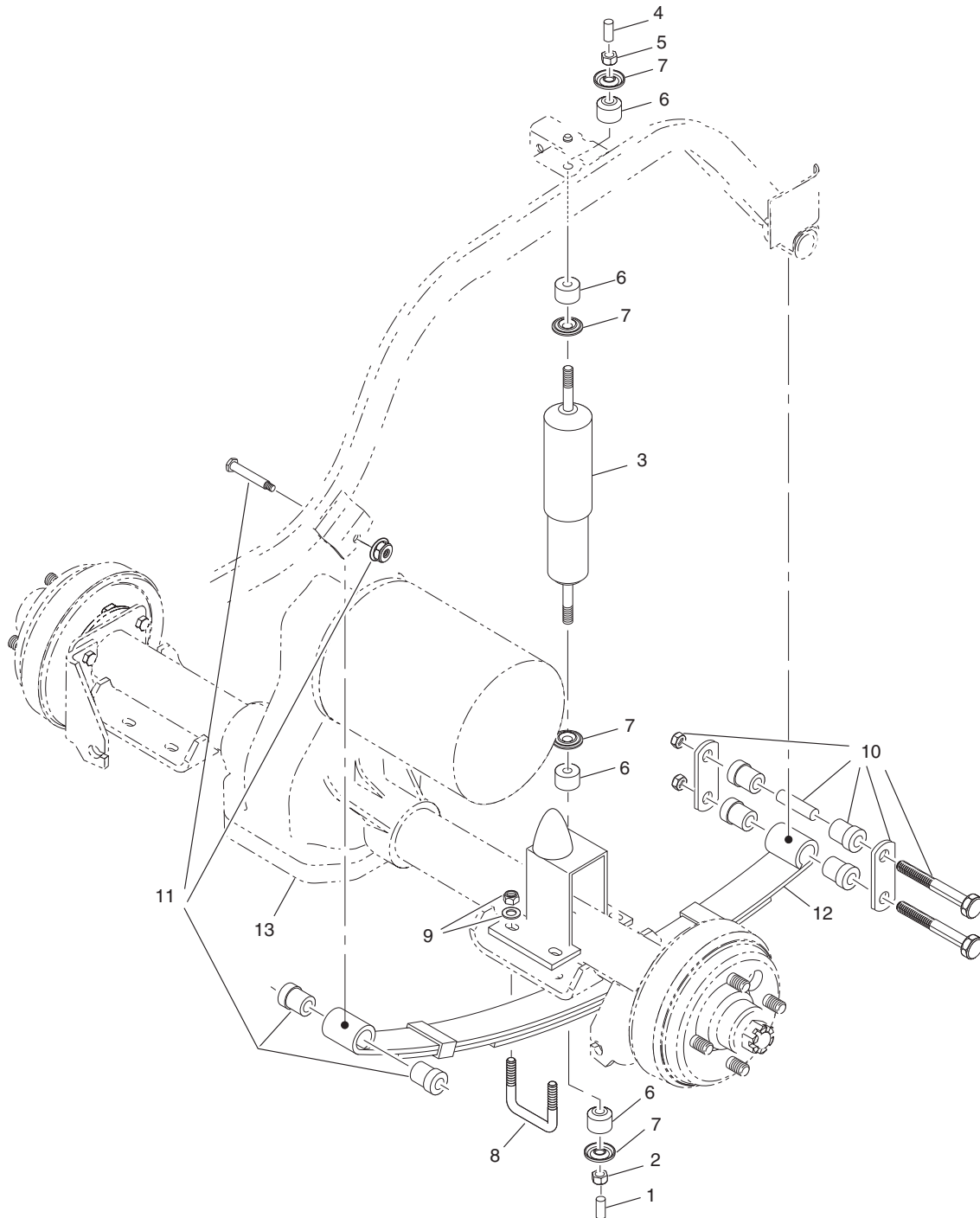
The shock absorber nuts (2,5) must be tightened until the shock absorber bushings (6) expand to the diameter of the shock absorber washer (7) (Ref Fig. 1 on page M-2).

Tighten front (11) and rear (10) spring mounting hardware to 18 - 23 ft. lbs. (24 - 31 Nm) torque.

Tighten axle mounting hardware (9) to 16 - 20 ft. lbs. (22 - 27 Nm) torque.

# REAR SUSPENSION

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings



**Fig. 1 Rear Suspension**



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Axle Shaft Removal and Disassembly.....	N - 2
Axle Shaft Seal Removal and Replacement.....	N - 2
Axle Shaft Replacement.....	N - 3

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Fig. 9 Cut Away of Outer Bearing and Brake Drum .....	N - 3



## REAR AXLE

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

### Rear Axle Removal



**The rear axle assembly is top heavy. To reduce the possibility of personal injury while removing the rear axle, be sure to support the axle and motor assembly when removing the springs.**

**If no lifting device is available, a second person should hold the motor in the correct position until the springs are removed. Both persons should remove the rear axle and motor assembly.**

**Disconnect the negative (BL-) battery cable with an insulated wrench before attempting to remove wires from the motor (see safety procedures in SAFETY section of this manual). The shorting of motor wires could cause an explosion.**

Disable the electrical system to the motor by turning the key switch to the 'OFF' position and disconnect negative (-) battery cable from the battery.

Remove the wires to the motor, being careful to prevent the axle assembly from rotating, remove the bottom shock mounting hardware and the springs from the rear axle as detailed elsewhere in the REAR SUSPENSION section.

Disconnect brake cables at rear wheel and axle bracket.

The rear axle and motor assembly can now be lifted from the jack stands and lowered to the floor.

**NOTE** To remove the rear axle assembly will require the use of an overhead hoist that can support the motor. The position of the motor will cause the rear axle assembly to rotate when the 'U' bolts (7) are removed. If no hoist is available, the motor may be held in position by a second person. With the springs removed, both persons can lift the entire assembly from the jack stands and lower it to the floor.

### Rear Axle Installation

Installation is in the reverse order of removal. Tighten motor terminal hardware to 66 in. lbs. (8 Nm) torque (Ref Fig. 1 on page N-1)(Ref Fig. 2 on page N-1).

Install new cotter pins.

### REAR AXLE DISASSEMBLY

**CAUTION** The rear axle is a precision assembly, and therefore any repair or replacement of parts must be done with extreme care in a clean environment. Before attempting to perform any service on the axle, read and

#### 36 VOLT MOTOR WIRING

MOTOR TERMINAL	WIRE MARKER	FROM
S1	S1	Direction Selector "D"
S2	S2	Direction Selector "B"
A1	A1	Controller "M-"
A2	A2	Direction Selector "C"

Fig. 1 Motor Wiring - 36 Volt

#### 48 VOLT MOTOR WIRING

MOTOR TERMINAL	WIRE MARKER	FROM
S1	S1	Direction Selector "D"
S2	S2	Direction Selector "B"
A1	A1	Controller "B+"
A2	A2	Controller "A2"

Fig. 2 Motor Wiring - 48 Volt

understand all of the following text and illustrations before disassembling the unit.

Handle all splines with extreme care.

Snap rings must be removed/installed with care to prevent damage of bearings, seals and bearing bores.

**NOTE** It is recommended that whenever a bearing, seal or 'O' ring is removed, it be replaced with a new one regardless of mileage. Always wipe the seals and 'O' rings with a light oil before installing.



**To reduce the possibility of personal injury, follow the lifting procedure in SAFETY section of this manual. Place wheel chocks in front and behind the front wheels and check the stability of the vehicle on the jack stands before starting any repair procedure. Never work on a vehicle that is supported by a jack alone.**

# REAR AXLE

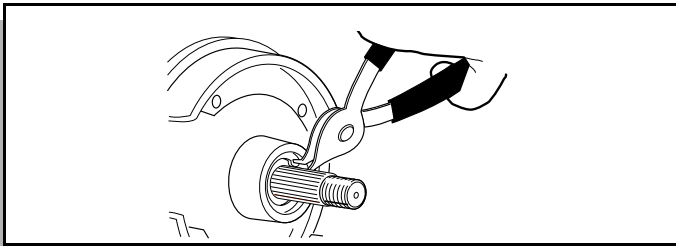
Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

## Axle Shaft Removal and Disassembly

Tool List	Qty. Required
Arbor press.....	1
Bearing separator.....	1
Needle nose pliers.....	1
Internal snap ring pliers.....	1
Slide hammer, P/N 18753-G1.....	1

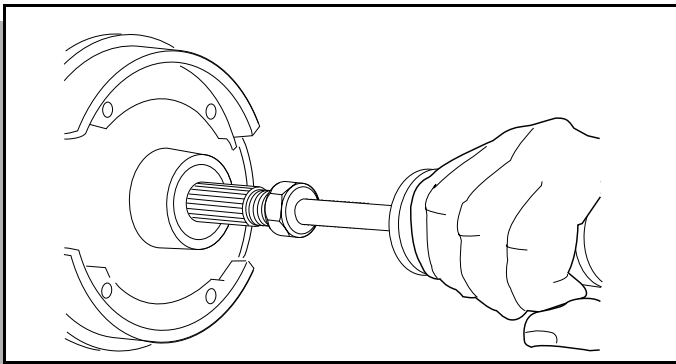
For brake drum removal, see BRAKE section.

Remove the outer snap ring from the axle tube (Ref Fig. 3 on page N-2).



**Fig. 3 Removing/Installing Outer Snap Ring**

Attach a slide hammer to the axle shaft thread and remove the axle and bearing from the axle tube (Ref Fig. 4 on page N-2).

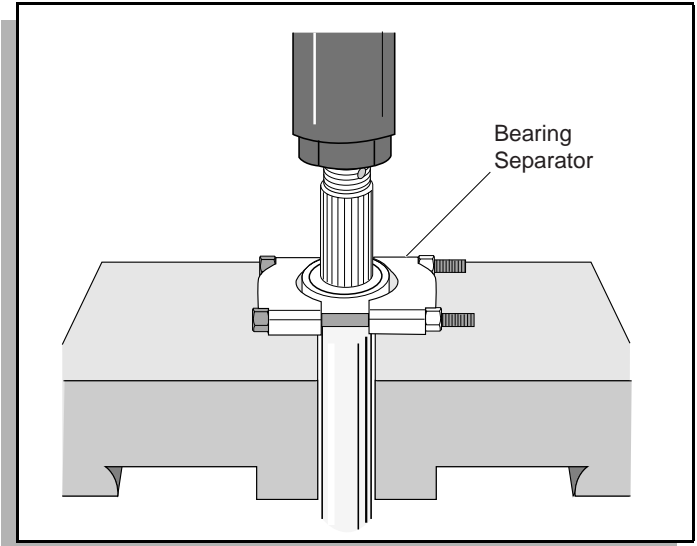


**Fig. 4 Removing/Installing Axle Shaft**

Remove the bearing by supporting the inner race of the bearing on an arbor press bed and apply pressure to the threaded end of the axle shaft (Ref Fig. 5 on page N-2).

## Axle Shaft Seal Removal and Replacement

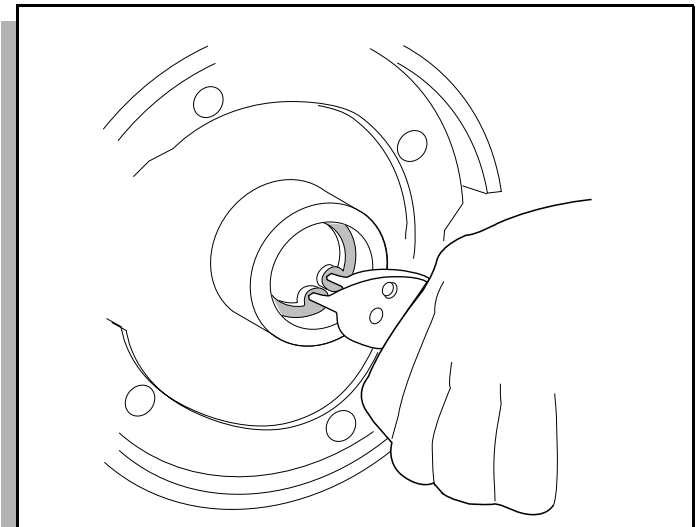
Tools List	Qty. Required
Internal snap ring pliers.....	1
Seal puller.....	1
Seal installer, P/N 18739-G1.....	1
Ball peen hammer.....	1



**Fig. 5 Pressing Bearing from Axle Shaft**

**CAUTION** Use care to prevent damage to the inner surface of the axle tube at the sealing area.

Remove the inner snap ring (Ref Fig. 6 on page N-2).



**Fig. 6 Removing/Installing Inner Snap Ring**

Use a puller to remove the seal (Ref Fig. 7 on page N-3).

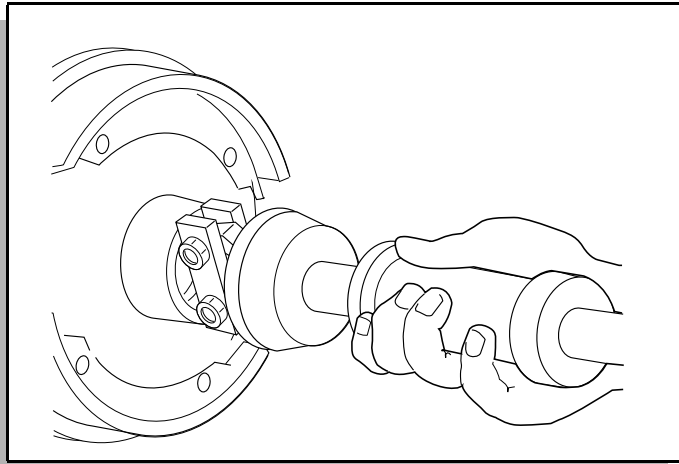
To install the seal, use the special seal installer to drive the seal into its correct position (Ref Fig. 8 on page N-3).

**CAUTION** To prevent seal damage, lightly coat the axle shaft with bearing grease and support the shaft during installation.

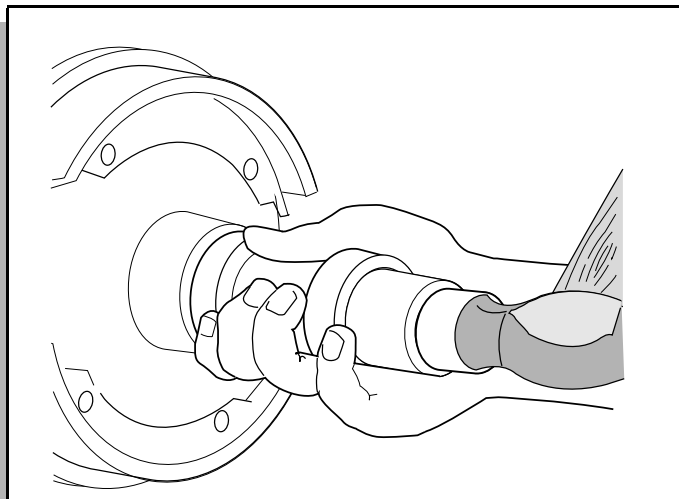
Install the inner snap ring (Ref Fig. 6 on page N-2).

## REAR AXLE

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings



**Fig. 7 Removing Seal**



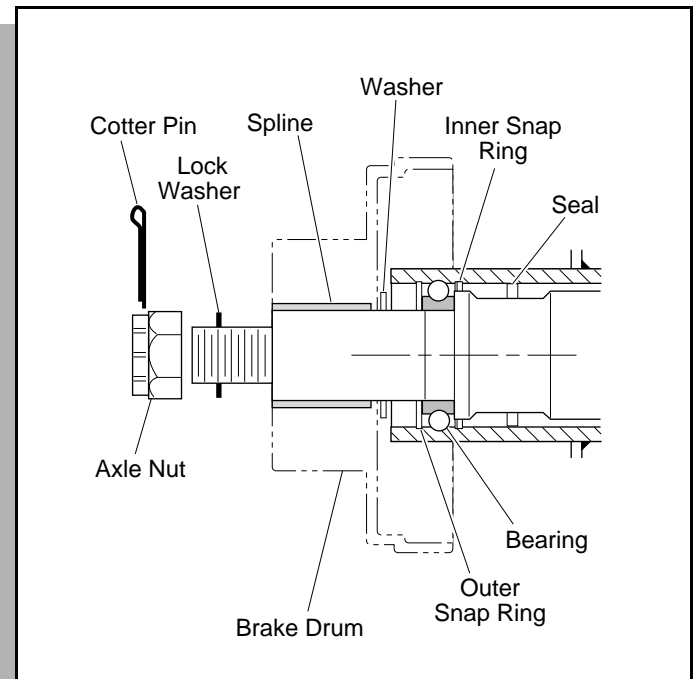
**Fig. 8 Installing Seal**

### Axle Shaft Replacement

Carefully insert the axle shaft and bearing through the oil seal. Rotate the shaft until the spline engages with the differential side gears. Install the outer snap ring.

Coat the outboard spline of the axle with a commercially available anti-seize compound. Install the brake hub and drum, thrust washer, nut and new cotter pin (Ref Fig. 9 on page N-3).

**NOTE** Tighten the castellated axle nut to 70 ft. lbs. (95 Nm) torque minimum, 140 ft. lbs. (190 Nm) torque maximum. Continue to tighten until the slot in the nut aligns with the cotter pin hole. Do not back off on the nut install cotter pin, to do so will result in damage to the hub and drum assembly.



**Fig. 9 Cut Away of Outer Bearing and Brake Drum**

# REAR AXLE

*Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings*

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Fig. 3 One Piece Windshield .....	P - 4





# WEATHER PROTECTION



Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

## TOP AND WINDSHIELD



***The top does not provide protection from roll over or falling objects.***

***The windshield does not provide protection from tree limbs or flying objects.***

The top and windshield are designed for weather protection only.

Clean with lots of water and a clean cloth. Minor scratches may be removed using a commercial plastic polish or Plexus plastic cleaner.

### Trailer



***Personal injury to occupants of other highway vehicles may occur if***

***vehicle and contents are not adequately secured to trailer.***

***Do not ride on vehicle being trailed.***

***Remove windshield before trailering. Maximum speed with top is 50 mph (80 kph).***

If the vehicle is to be transported on a trailer at highway speeds, the windshield and top must be removed and the seat bottoms secured. Always check that the vehicle and contents are adequately secured before trailering the vehicle.

## SUN TOP

### Rear Support Installation

1. Using a plastic faced hammer, tap end caps (item 17) into the top of each rear strut (item 2) (Ref Fig. 1 on page P-2).
2. Place washer (item 3) onto bolt (item 4) and insert bolt just through the top hole in the seat back support (3 - 4 threads).
3. Insert rear strut (item 2) in the seat back support and push the bolt through the top hole in the rear strut. Place washer (item 3) and lock nut (item 6) on the end of the bolt just enough to prevent the bolt from falling out.
4. Repeat for the lower hole.
5. Repeat steps for the other side.

### Front Strut

1. Remove and discard the four bolts from the front cowl.
2. At the upper hole (both sides of vehicle), install the front strut (item 7) with bolt (item 8) and lock washer (item 9) on the outside of strut, and a spacer (item 10) between the front cowl and strut and a washer on the inside. Finger tighten hardware to allow for adjustment.
3. At the lower hole, secure the strut with bolt (item 8) and lock washer (item 9) on the outside of strut as shown. Finger tighten hardware to allow for adjustment.

### Sun Top

1. Place sun top (item 1) onto struts.
2. Secure sun top loosely with screws (item 16 at front and item 12 at rear), plastic spacers (item 13), washers (item 14), and lock nut (item 15). See illustrations for installation sequence.
3. Tighten all sun top hardware to 3 - 5 ft. lbs. (4 - 7 Nm) torque.
4. Tighten all rear strut hardware to 13 - 15 ft. lbs. (18 - 20 Nm) torque.
5. Tighten all front strut hardware to 17 - 19 ft. lbs. (23 - 26 Nm) torque.

# WEATHER PROTECTION

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

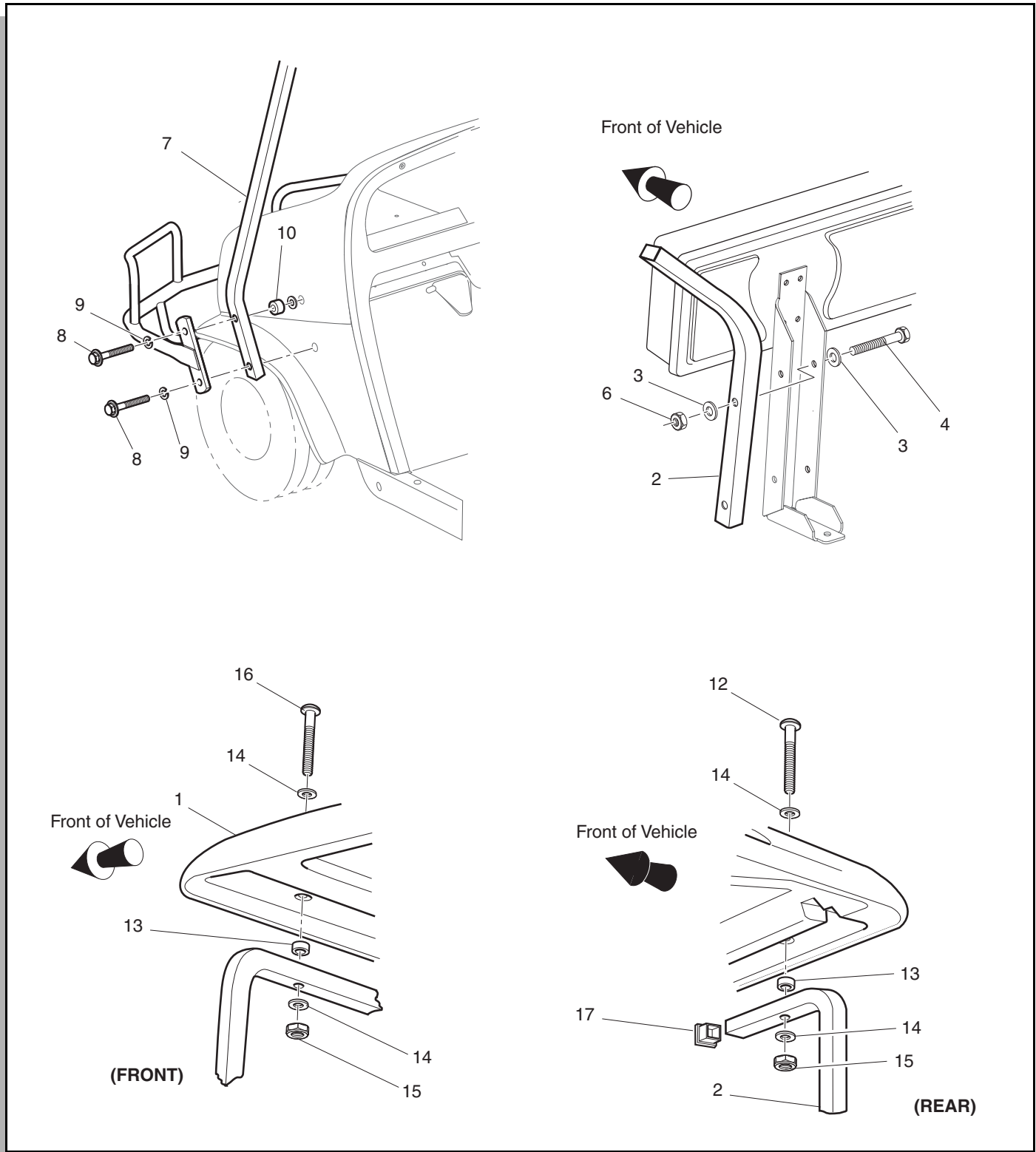


Fig. 1 Sun Top

# WEATHER PROTECTION

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

## SPLIT WINDSHIELD

Remove protective covering from the windshield (item 3 or 4) (Ref Fig. 2 on page P-3).

Install sash (item 11) on each side of the lower section of windshield. Be sure sashes are centered vertically on the bottom section. Using a rubber mallet, gently tap sash to ensure windshield seats properly (Detail A).

Insert screw, washer and rubber grommet (item 10) through existing hole in front strut. Secure with washer and lock nut (item 10) (Detail B). **Do not over-tighten grommet.**

Place bottom section of windshield on rubber grommets and press the sash, starting at the bottom, onto the front strut so that it snaps into place. Repeat for opposite side of windshield.

Swing the top section of windshield up and secure by hooking the top grip on each side of windshield around the strut.

To secure windshield when lowered, press edge of windshield firmly into bottom grip.

**CAUTION** Take care not to warp windshield when raising and lowering the top section of windshield.

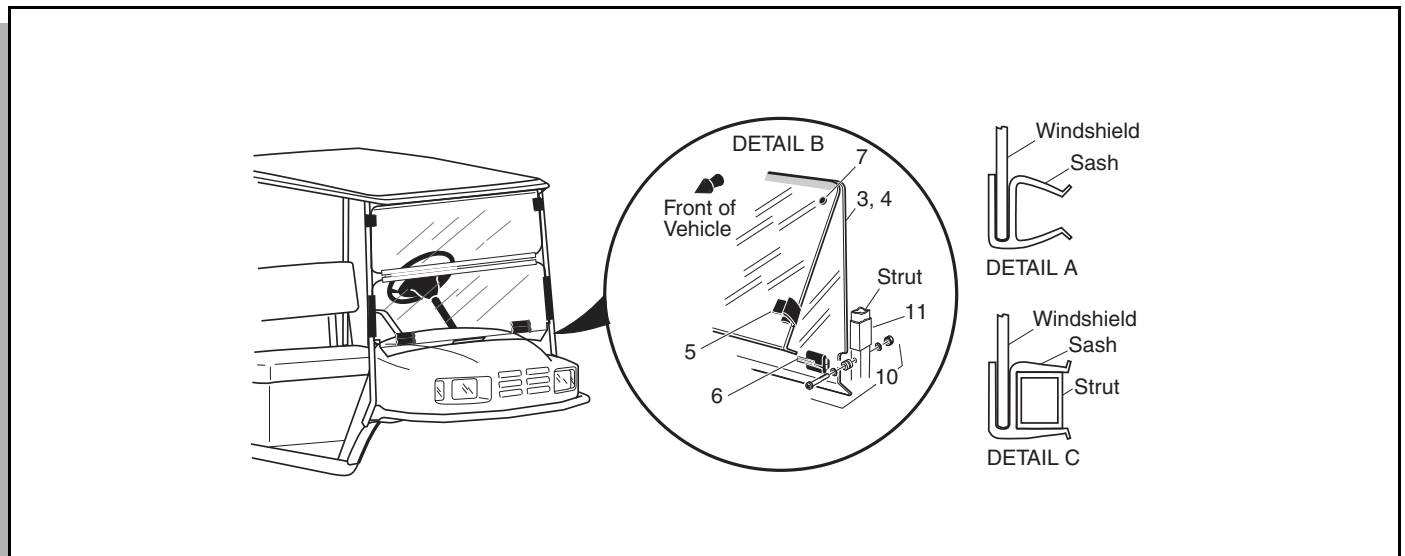


Fig. 2 Split Windshield

## ONE-PIECE WINDSHIELD

Remove protective covering from the windshield (item 2) (Ref Fig. 3 on page P-4).

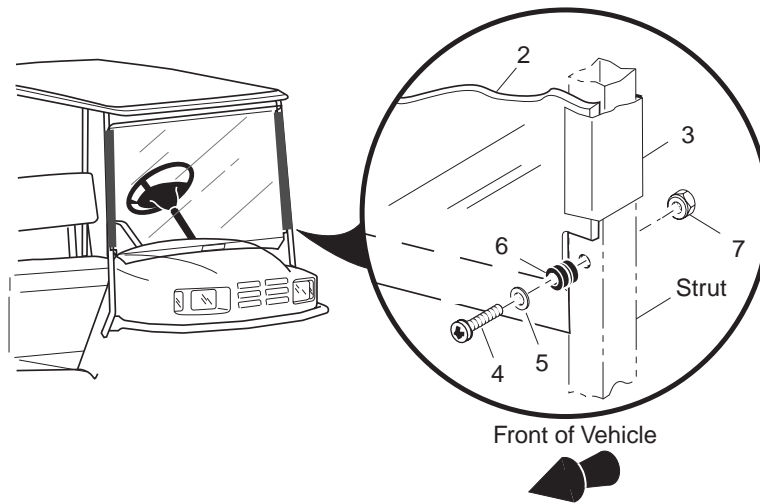
Install sash (item 3) on each side of the windshield. Using a rubber mallet, gently tap sash to ensure windshield seats properly.

Insert screw (item 4) through washer (item 5), rubber grommet (item 6) and existing hole in front strut. Secure with lock nut (item 7). **Do not over-tighten or squeeze grommet.**

Place bottom section of windshield on rubber grommets and press the sash, starting at the bottom, onto the front strut so that it snaps into place. Repeat for opposite side of windshield.

# WEATHER PROTECTION

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings



**Fig. 3 One Piece Windshield**



**PAINT**

**TABLE OF CONTENTS FOR SECTION 'Q'**

<b>SECTION TITLE</b>	<b>PAGE NO.</b>
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Minor Scratches.....	Q - 1
Larger Scratches .....	Q - 1
Complete Panel Repair .....	Q - 1



# PAINT

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings



## PAINTING

Follow the paint manufacturer's recommendations for specific painting procedures and information.



**All painting must be done in an area with adequate ventilation to safely**

**disperse harmful vapors.**

**Wear eye protection and respirator, following manufacturer's instructions to protect from overspray and air borne mist.**

## CAUTION

Provide protection from overspray to vehicle and surrounding area.

### Minor Scratches

For minor scratches, the manufacturer suggests the following steps be taken to repair the Durashield™ body:

- I. Thoroughly clean the surface to be repaired with alcohol and dry.
- II. Touch up damaged area with sequential coats (two coats minimum recommended, allowing 30 - 45 minutes between coats, increasing to 45 - 60 minutes in higher humidity) using brush on touch-up paint, until coating layer is visible, slightly above the surface of the part.
- III. Use 400 grit "wet" sand paper to blend touch up area level with the rest of the part being repaired. Use a polishing compound (3M Finesse or automotive grade) to renew gloss and to further blend and transition newly painted surface.
- IV. Clean with alcohol and dry.
- V. (Optional but recommended) Follow this process with clear coat to renew and protect depth of finish.
- VI. Wax or polish with Carnauba base product, available at any automotive parts distributor.

### Larger Scratches

For larger scratches, the manufacturer suggests the following steps be taken to repair the Durashield™ body:

- I. Thoroughly clean the surface to be repaired with alcohol and dry.
- II. Mask the area to be painted (common masking tape is adequate) prior to repair and use aerosol type touch-up paint.

- III. Apply spray touch up paint in light even overlapping strokes. Multiple coats may be applied to provide adequate coverage and finish. Always remember to shake the can for a minimum of one minute to mix the paint and achieve the best color match.
- IV. After painting, allow to dry overnight. Smooth the mask lines using 400 grit "wet" sand paper to blend touch up area level with the rest of the part being repaired. Use a polishing compound (3M Finesse or automotive grade) to renew gloss and to further blend and transition newly painted surface.
- V. Clean with alcohol and dry.
- VI. (Optional but recommended) Follow this process with clear coat to renew and protect depth of finish.
- VII. Wax or polish with Carnauba base product, available at any automotive parts distributor.

### Complete Panel Repair

In situations where large panels or areas must be painted, touch up paint is not recommended. In such cases professional painting or panel replacement is called for. The manufacturer suggests body panel replacement be considered as a cost effective alternative to painting. If the decision to repaint is taken, the task can be accomplished by any paint and body shop with experience in painting 'TPE' panels. TPE is a common material in modern automobile bodies and all body shops should be familiar with the materials and processes required.

The finish will include an application of a primer coat, a base color coat and a clear coat. The manufacturer does not supply these materials due to the variety of paint manufacturers and the preferences of the individual painter.

Most paint manufacturers can perform a computer paint match to assure accurate color matching.

# **PAINT**

*Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings*

**Notes:** \_\_\_\_\_

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# TROUBLESHOOTING



## TABLE OF CONTENTS FOR SECTION 'R'

SECTION TITLE	PAGE NO.
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Basic Electrical Troubleshooting for Accessories .....	R - 2
SUSPENSION AND STEERING .....	R - 3

# TROUBLESHOOTING

**Notes:** \_\_\_\_\_

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# TROUBLESHOOTING



Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

## ELECTRICAL SYSTEM

Condition	Possible Cause	Correction
VEHICLE WILL NOT MOVE (36VOLT VEHICLES) Refer to Section F (Electronic Speed Control (48Volt) for 48 Volt vehicles	Key 'OFF' or no direction selected	Turn key 'ON' and select direction
	Batteries discharged	Charge batteries
	Batteries unable to be charged	Load test and replace batteries that cannot be charged
	Corroded or loose battery connections	Clean and tighten battery connections Apply a coat of commercial terminal protectant to all terminals
	Corroded or loose battery connections to ESC controller, direction switch or motor	Repair or replace faulty wiring
	Solenoid has failed	Replace solenoid
	Key switch has failed	Replace key switch
	Micro switch at direction selector switch has failed	Replace micro switch
	Connector loose or separated	Install connector correctly
	Faulty motor	Repair or replace motor
	Faulty ESC system	Test and replace components as indicated by test procedure
VEHICLE SPEED ERRATIC	Ignition interlock switch has failed	Replace reed switch (portable) Replace relay (on-board charger)
NO REDUCED SPEED IN REVERSE	Faulty ESC system	Test and replace components as indicated by test procedure
MOTOR NOISY	Damaged bearing	Replace bearing
	Raised commutator bar(s)	Replace motor
	Loose motor mounting hardware	Tighten
BATTERIES WILL NOT CHARGE	Charger not functioning correctly	Repair or replace charger
	Vehicle charging wiring faulty	Repair or replace wiring

# TROUBLESHOOTING

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

Condition	Possible Cause	Correction
BATTERIES WILL NOT CHARGE (Continued)	Vehicle/charger connector damaged	Replace connector
	Battery case damaged	Replace battery
	Low electrolyte level	Maintain correct electrolyte level
	Battery capacity deficient	Hydrometer/load test Replace battery if required
	Damaged battery	Replace battery

## Basic Electrical Power System Troubleshooting

To diagnose electrical problems in the electrical power system, refer to the ELECTRONIC SPEED CONTROL (36 VOLT) section or the ELECTRONIC SPEED CONTROL (48 VOLT) section.

## Basic Electrical Troubleshooting for Accessories

To diagnose electrical problems in the vehicle electrical wiring system, refer to the ELECTRICAL SYSTEM section.

# TROUBLESHOOTING

*Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings*

## SUSPENSION AND STEERING

Condition	Possible Cause	Correction
UNEVEN TIRE WEAR	Incorrect tire pressure	Inflate to recommended pressure
	Improper alignment (Incorrect toe in)	Align front tires
STIFF STEERING	Water has entered steering box and may freeze in cold conditions	Remove steering column, pinion and bearing and remove water before adding grease Inspect gasket for good seal
	Excessive grease in steering box has migrated into steering rack bellows or rack cover	Raise the vehicle and observe the rack bellows while moving the steering from lock to lock Any distortion of the bellows may indicate that an excess of grease has built up in the bellows Remove the bellows and remove excess grease
	Insufficient lubricant in king pins, rod ends, idler bushing or steering box	Add one pump of lubricant to each grease fitting and operate steering from lock to lock. <b>Do not over grease</b> If steering does not return to acceptable condition proceed to next step
	Bent rack	Remove rack and place on flat surface with rack teeth up If a .015" (.381 mm) feeler gauge will pass under the rack, the rack must be replaced
PLAY IN STEERING	Steering wheel loose	Inspect splines - replace steering wheel, if required Tighten steering wheel nut
	Steering components worn	Replace
	Loose wheel bearings	Adjust or replace
VIBRATION	Steering components worn	Replace
	Damaged wheel bearings	Replace
	Out of round tires, wheels or brake drums	Inspect and replace if out of round
	Loose lug nuts	Tighten to 50 - 85 ft. lbs. (68 - 115 Nm)

## **TROUBLESHOOTING**

*Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings*

<b>Condition</b>	<b>Possible Cause</b>	<b>Correction</b>
STEERING PULLS TO ONE SIDE	Incorrect tire pressure	Inflate to recommended pressure
	Dragging wheel brake	Service brake system
	Suspension component failure	Repair
	Improper alignment	Align



# LIGHTNING PROTECTION AND GROUNDING

## TABLE OF CONTENTS FOR SECTION 'S'

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# LIGHTNING PROTECTION AND GROUNDING

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

GS-726-006	REVISION: A	TITLE:
EFFECTIVE: 10/19/92	SUPERCEDES: Rev -, ECN 027194	General Specification: Lightning Protection and Grounding

## 1. Grounding Requirements

For the purpose of this specification, building ground systems should serve two primary functions: personal safety and equipment protection. In order to be effective, all elements and functions of building ground system must receive equal consideration in design and installation. Once installed, it is up to the owner to adequately maintain the system by implementing periodic inspections and ground tests in order to determine its effectiveness.

## 2. Ground Systems

All electronic equipment is inherently related to earth by capacitive coupling, accidental or incidental contact and intentional connection. The earth forms a natural readily available form of common potential reference for all electrical circuits. For maximum effectiveness, grounding must be looked at from a total system viewpoint, with various sub-systems comprising the total facility ground system. The interconnection of the various sub-systems into a building ground system will provide a direct path, of known low impedance, between earth and the various electrical and other equipment. This effectively extends an approximation of ground reference throughout the building. The total building ground system is composed of an earth electrode system, a lightning protection system and an equipment fault protective system.

Resistance To Earth: The resistance to earth of the ground system should not exceed 10 ohms. Where the resistance of 10 ohms cannot be obtained due to high soil resistivity, rock formations or other abnormal conditions, alternate methods for reducing the resistance to earth must be considered.

Chemical Treatments: No salt, coke or other chemicals may be used to treat the soil in order to obtain the required ground resistance readings. Approved methods of enhancement are bentonite clay or the GEM product for ground enhancement as manufactured by Erico Products of Solon, Ohio.

Ground Tests: The resistance to earth of the ground system shall be measured by the "Fall of Potential Method". Acceptable resistance meters/testers are those manufactured by Biddle or AEMC.

## 3. Lightning Protection Requirements

The external lightning protection system shall be designed and installed by a contractor who specializes in the lightning protection field. The contractor must be listed with Underwriters Laboratories Inc. and be in good standing. All work shall be under the direct supervision of a Certified Master Installer with current credentials from the Lightning Protection Institute.

The materials and design for the structure will comply with the most recent edition of the National Fire Protection Association Lightning Protection Code, NFPA 780 and the Materials Standard for Safety from Underwriters Laboratories UL96. Materials for this project may be those of Harger Lightning Protection, 1066 Campus Drive, Mundelein, Illinois (800-842-7437).

Upon completion of the project, the contractor will supply to the owner the Master Label issued by Underwriters Laboratories.

## 4. Equipment Fault and Personal Safety System

The standard method of providing an equipment fault protection ground network is to run a good ground conductor (green wire) through the conduit together with the AC distribution system. This method is required for all types of conduit, including metallic.

## 5. Ground Network Requirements

Install the conduit in accordance with local regulations or as prescribed by the National Electrical Code.

# LIGHTNING PROTECTION AND GROUNDING

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

GS-726-006	REVISION: A	TITLE:
EFFECTIVE: 10/19/92	SUPERCEDES: Rev -, ECN 027194	General Specification: Lightning Protection and Grounding

## 6. External Grounding Requirements

For optimum results, earth electrode installation must be accomplished early in the construction of a new site. The earth electrode system should be established at the same time utilities are installed to insure proper interconnection of all utility grounds/systems.

For existing sites, the earth electrode installation shall be constructed using the most economical means possible in order to meet the intent of this specification.

Prior to the installation or design of the ground system, a survey should be taken in order to determine the earth resistivity, types of soil or any manmade features that may have a significant effect upon the efficiency of the grounding system. Based on the information gathered, deviations from this specification (Exceeding normal requirements) may be necessary in order to achieve desired results.

## 7. Materials

**Ground Rod Electrodes:** Ground rod electrodes shall have a minimum diameter of 5/8" and be no less than 10'-0" in length. Rods may be copper, copper-clad steel or stainless steel. Galvanized steel rods are not permitted unless it is determined that the galvanized rod will have a longer life expectancy due to soil conditions.

**Ground Rod Spacing:** Ground rods shall not be spaced at intervals exceeding 60'-0" around the perimeter of the structure.

**Ground Loop Conductor:** In no case shall the ground loop conductor be smaller than a 2/0 AWG bare, stranded, soft drawn copper wire. The ground loop must be installed at least 24" below grade and be at least 24" away from the structure. All bends in the conductor shall have a minimum radius of 8" and be no less than 90 degrees.

**Ground Mats:** In areas where electrodes cannot be driven, a ground mat consisting of a #6 solid copper or a copper-copper clad steel mesh, utilizing a 12" x 12" cross pattern may be used. All inter-connections in the mesh shall be brazed or silver soldered.

**Ground Plates:** Ground plates if utilized shall be 24" x 24" x .032" thick solid copper. Ground plates should only be used if a ground rod cannot be driven.

**Ground Connections:** Unless otherwise specified or approved by the owner, all connections below grade shall be by exothermic weld (Cadweld). Where exothermic welds may not be practical, UL approved grounding clamps that utilize two bolts for pressure may be used. NOTE: Prior approval must be obtained in order to use a mechanical connection below grade.

## 8. Earth Electrode System

The earth electrode system consists of a network of earth electrode rods, plates, mats or grids and their interconnecting conductors. The extensions into the building are used as the principle grounding point for connecting to the ground system serving the building. Ground potential is established by electrodes in the earth.

An electrode may be a metallic water pipe that has no isolation joints, a system of buried, driven rods interconnected with a bare wire that normally forms a ring around the building or a ground plane of horizontal buried wires. Depending upon soil conditions, building design and the existing water pipe networks, an electrode may be a combination of any of the above mentioned systems.

# LIGHTNING PROTECTION AND GROUNDING

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

GS-726-006	REVISION: A	TITLE:
EFFECTIVE: 10/19/92	SUPERCEDES: Rev -, ECN 027194	General Specification: Lightning Protection and Grounding

## 9. Lightning Protection System

The lightning protection system provides a non-destructive path to ground for lightning energy contacting or induced onto or in a building. To effectively protect from lightning damage, air terminals are installed according to the National Fire Protection Association Lightning Protection Code (NFPA 780). Air terminals will intercept the discharge to keep it from penetrating or structurally damaging the building. This is done by providing a low impedance path from the air terminals to the earth electrode system.

## 10. Equipment Fault and Personal Safety System

The equipment fault protective system ensures that personnel are protected from shock hazard and equipment is protected from damage or destruction resulting from faults (lightning induced surges) that may develop in the electrical system. Deliberately engineered ground conductors (green wire safety ground) shall be provided throughout the AC distribution system to afford electrical paths of sufficient capacity, so that protective devices can operate promptly and efficiently. The use of conduit for grounding in lieu of a dedicated green wire is unacceptable.

Install the green wire ground (#6 stranded) with the AC power distribution conductors. There shall be no green wires spliced within the conduit. All splices shall be performed at the appropriate junction boxes.

Bond the ground conductor to all pull boxes, junction boxes and power panels.

In existing facilities where an existing conduit is not large enough to accommodate an additional ground conductor, or where a conduit section is insulated from other conduit sections, an external ground conductor may be installed to maintain continuity. All mounting hardware and connectors shall be UL approved.

All DC chargers are to be grounded to the green wire ground using UL approved connectors. At no point should the chargers be isolated from the grounding system.

All interior grounding should return to a single ground point. From this location it is then connected to the exterior ground system. Optional Interior Ground Halo: If an interior ground halo is to be installed around the inside perimeter of the structure, this conductor (#2/0 green insulated minimum) shall be securely fastened to the structure.

All connections to the halo shall be made using UL listed connectors.

Transient Voltage Surge Suppression: TVSS shall be provided at the main electrical service entrance panel. Protection at this point shall be as follows:

- UL 1449 Listed device

- 25,000 ampere surge capacity with maximum 495 volt clamping voltage

- Protection should be Line to Ground, Neutral to Ground and Line to Neutral

- Internally fused for safety

- Failure mode indicator lights

Suppression may be as the 14000 series of Harger Lightning Protection, Inc., 1066 Campus Drive, Mundelein, IL (800-842-7437), or MBP 120EFI series from EFI Electronics Corporation, 2415 South 2300 West, Salt Lake City, UT (801-977-9009).

# LIGHTNING PROTECTION AND GROUNDING

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notes, Cautions and Warnings

GS-726-006	REVISION: A	TITLE:
EFFECTIVE: 10/19/92	SUPERCEDES: Rev -, ECN 027194	General Specification: Lightning Protection and Grounding

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# GENERAL SPECIFICATIONS



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# GENERAL SPECIFICATIONS

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# GENERAL SPECIFICATIONS



## MPT™ 800

### STANDARD EQUIPMENT:

WEIGHT (without batteries)	675 lbs. (306 kg)
TIRES	18 x 8.50 x 8 (4 ply rated)
TIRE PRESSURE	18 - 22 psi (120 - 150 kPa)
LOAD CAPACITY	800 lbs. (362 kg) (including operator, passenger, cargo and accessories)
GROUND CLEARANCE	4.75 in. (12 cm) at differential
MAXIMUM HEIGHT	65 in. (165 cm) with top
CHASSIS	Welded high yield strength tubular steel with powder coat paint
BODY AND FINISH	Front: Flexible, impact resistant panels. Color coat/clear coat finish Rear: Lightweight, replaceable steel panels
SAFETY	Dash mounted key switch, reverse warning indicator, 'deadman' accelerator control, integral handgrip on hip restraints, manual forward/reverse selector with 'neutral', electric horn
STEERING WHEEL	Dual handgrips
BRAKES	Dual rear wheel mechanical, self-adjusting drum brakes. Combination service / park brake with automatic parking brake release (accelerator kick-off)
FRONT SUSPENSION	Heavy duty leaf springs with hydraulic shock absorbers
REAR SUSPENSION	Heavy duty leaf springs with hydraulic shock absorbers
STEERING	Self-compensating single reduction rack and pinion
DASH PANEL	Scuff resistant with four drink holders
SEATING	Formed fabric backed vinyl covers over cushion foam. Seating for operator and one passenger
MOTOR	36 volt DC high efficiency series wound, brazed armature, solid copper windings. 2.5 hp (1.9 kw) at 2700 rpm
DRIVE TRAIN	Direct motor shaft connected to transaxle pinion shaft
ELECTRICAL SYSTEM	36 volt DC, six, 6 volt deep cycle storage batteries
SPEED CONTROL	Solid State continuously variable speed controller, 300 amp rated
TRANSAXLE	High efficiency differential with helical gears, 12.44:1 ratio
SPEED	13 mph ± .5 mph (21 kph ± .8 kph)
CHARGER	PowerWise™ portable, fully automatic For locations outside US and Canada, refer to charger manufacturer for specifications and recommendations.

Specifications subject to change without notice

# GENERAL SPECIFICATIONS

## MPT™ 1000

### STANDARD EQUIPMENT:

WEIGHT (without batteries)	809 lbs. (374 kg)
TIRES (4 ply rated)	18 x 8.50 x 8 (4 ply rated)
TIRE PRESSURE	18 - 22 psi (120 - 150 kPa)
LOAD CAPACITY	1000 lbs. (454 kg) (including operator, passenger, cargo and accessories)
GROUND CLEARANCE	4.75 in. (12 cm) at differential
MAXIMUM HEIGHT	65 in. (165 cm) with top
CHASSIS	Welded high yield strength tubular steel with powder coat paint
BODY AND FINISH	Front: Flexible, impact resistant panels. Color coat/clear coat finish Rear: Lightweight, replaceable steel panels
SAFETY	Dash mounted key switch, reverse warning indicator, 'deadman' accelerator control, integral handgrip on hip restraints, manual forward/reverse selector with 'neutral', electric horn
STEERING WHEEL	Dual handgrips and pencil holder integrated with clipboard
BRAKES	Dual rear wheel mechanical, self-adjusting drum brakes. Combination service / park brake with automatic parking brake release (accelerator kick-off)
FRONT SUSPENSION	Heavy duty leaf springs with hydraulic shock absorbers
REAR SUSPENSION	Heavy duty leaf springs with hydraulic shock absorbers
STEERING	Self-compensating single reduction rack and pinion
DASH PANEL	Scuff resistant with four drink holders
SEATING	Formed fabric backed vinyl covers over cushion foam. Seating for operator and one passenger
MOTOR	48 volt DC high efficiency shunt wound, brazed armature, solid copper windings
DRIVE TRAIN	Direct motor shaft connected to transaxle pinion shaft
ELECTRICAL SYSTEM	48 volt DC, eight, 6 volt deep cycle storage batteries
SPEED CONTROL	Solid State continuously variable speed controller, 400 amp rated
TRANSAXLE	High efficiency differential with helical gears, 14.7:1 ratio
SPEED	13 ± .5 mph (21 ± .8 kph)
CHARGER	Fully automatic line compensating, 48 volt output

Specifications subject to change without notice



# GENERAL SPECIFICATIONS

## INDUSTRIAL™ 800

### STANDARD EQUIPMENT:

WEIGHT (without batteries)	675 lbs. (306 kg)
TIRES	18 x 5.70 x 8 (4 ply rated)
TIRE PRESSURE	35 - 45 psi (241 - 310 kPa)
LOAD CAPACITY	800 lbs. (362 kg) (including operator, passenger, cargo and accessories)
GROUND CLEARANCE	4.75 in. (12 cm) at differential
MAXIMUM HEIGHT	65 in. (165 cm) with top
CHASSIS	Welded high yield strength tubular steel with powder coat paint
BODY AND FINISH	Front: Flexible, impact resistant panels. Color coat/clear coat finish Rear: Replaceable steel panels
SAFETY	Dash mounted key switch, reverse warning indicator, 'deadman' accelerator control, integral handgrip on hip restraints, manual forward/reverse selector with 'neutral', electric horn
LIGHTING PACKAGE	Dual halogen headlights
CONVENIENCE	State of Charge meter, Hour meter
STEERING WHEEL	Dual handgrips
BRAKES	Dual rear wheel mechanical, self-adjusting drum brakes. Combination service / park brake with automatic parking brake release (accelerator kick-off)
FRONT SUSPENSION	Heavy duty leaf springs with hydraulic shock absorbers
REAR SUSPENSION	Heavy duty leaf springs with hydraulic shock absorbers
STEERING	Self-compensating single reduction rack and pinion
DASH PANEL	Scuff resistant with four drink holders
SEATING	Formed fabric backed vinyl covers over cushion foam. Seating for operator and one passenger
MOTOR	36 volt DC high efficiency series wound, brazed armature, solid copper windings. 2.5 hp (1.9 kw) at 2700 rpm
DRIVE TRAIN	Direct motor shaft connected to transaxle pinion shaft
ELECTRICAL SYSTEM	36 volt DC, six, 6 volt deep cycle storage batteries
SPEED CONTROL	Solid State continuously variable speed controller, 300 amp rated
TRANSAXLE	High efficiency differential with helical gears, 12.44:1 ratio
SPEED	13 mph ± .5 mph (21 kph ± .8 kph)
CHARGER	PowerWise™ portable, fully automatic For locations outside US and Canada, refer to charger manufacturer for specifications and recommendations.

Specifications subject to change without notice

# GENERAL SPECIFICATIONS

## INDUSTRIAL™ 1000

### STANDARD EQUIPMENT:

WEIGHT (without batteries)	809 lbs. (374 kg)
TIRES (4 ply rated)	18 x 5.70 x 8 (4 ply rated)
TIRE PRESSURE	35 - 45 psi (241 - 310 kPa)
LOAD CAPACITY	1000 lbs. (454 kg) (including operator, passenger, cargo and accessories)
GROUND CLEARANCE	4.75 in. (12 cm) at differential
MAXIMUM HEIGHT	65 in. (165 cm) with top
CHASSIS	Welded high yield strength tubular steel with powder coat paint
BODY AND FINISH	Front: Flexible, impact resistant panels. Color coat/clear coat finish Rear: Replaceable steel panels
SAFETY	Dash mounted key switch, reverse warning indicator, 'deadman' accelerator control, integral handgrip on hip restraints, manual forward/reverse selector with 'neutral', electric horn
LIGHTING PACKAGE	Dual halogen headlights
CONVENIENCE	State of Charge meter, Hour meter
STEERING WHEEL	Dual handgrips and pencil holder integrated with clipboard
BRAKES	Dual rear wheel mechanical, self-adjusting drum brakes. Combination service / park brake with automatic parking brake release (accelerator kick-off)
FRONT SUSPENSION	Heavy duty leaf springs with hydraulic shock absorbers
REAR SUSPENSION	Heavy duty leaf springs with hydraulic shock absorbers
STEERING	Self-compensating single reduction rack and pinion
DASH PANEL	Scuff resistant with four drink holders
SEATING	Formed fabric backed vinyl covers over cushion foam. Seating for operator and one passenger
MOTOR	48 volt DC high efficiency shunt wound, brazed armature, solid copper windings
DRIVE TRAIN	Direct motor shaft connected to transaxle pinion shaft
ELECTRICAL SYSTEM	48 volt DC, eight, 6 volt deep cycle storage batteries
SPEED CONTROL	Solid State continuously variable speed controller, 400 amp rated
TRANSAXLE	High efficiency differential with helical gears, 14.7:1 ratio
SPEED	13 ± .5 mph (21 ± .8 kph)
CHARGER	Fully automatic line compensating, 48 volt output For locations outside US and Canada, refer to charger manufacturer for specifications and recommendations.

Specifications subject to change without notice

# GENERAL SPECIFICATIONS

## Commander™ 280

### STANDARD EQUIPMENT:

WEIGHT (without batteries)	675 lbs. (306 kg)
TIRES	18 x 8.50 x 8 (4 ply rated)
TIRE PRESSURE	18 - 22 psi (120 - 150 kPa)
LOAD CAPACITY	800 lbs. (362 kg) (including operator, passenger, cargo and accessories)
GROUND CLEARANCE	4.75 in. (12 cm) at differential
MAXIMUM HEIGHT	65 in. (165 cm) with top
CHASSIS	Welded high yield strength tubular steel with powder coat paint
BODY AND FINISH	Front: Flexible, impact resistant panels. Color coat/clear coat finish Rear: Lightweight, replaceable steel panels
SAFETY	Dash mounted key switch, reverse warning indicator, 'deadman' accelerator control, integral handgrip on hip restraints, manual forward/reverse selector with 'neutral', electric horn
STEERING WHEEL	Dual handgrips
BRAKES	Dual rear wheel mechanical, self-adjusting drum brakes. Combination service / park brake with automatic parking brake release (accelerator kick-off)
FRONT SUSPENSION	Heavy duty leaf springs with hydraulic shock absorbers
REAR SUSPENSION	Heavy duty leaf springs with hydraulic shock absorbers
STEERING	Self-compensating single reduction rack and pinion
DASH PANEL	Scuff resistant with four drink holders
SEATING	Formed fabric backed vinyl covers over cushion foam. Seating for operator and one passenger
MOTOR	36 volt DC high efficiency series wound, brazed armature, solid copper windings. 2.5 hp (1.9 kw) at 2700 rpm
DRIVE TRAIN	Direct motor shaft connected to transaxle pinion shaft
ELECTRICAL SYSTEM	36 volt DC, six, 6 volt deep cycle storage batteries
SPEED CONTROL	Solid State continuously variable speed controller, 300 amp rated
TRANSAXLE	High efficiency differential with helical gears, 12.44:1 ratio
SPEED	13 mph ± .5 mph (21 kph ± .8 kph)
CHARGER	PowerWise™ portable, fully automatic For locations outside US and Canada, refer to charger manufacturer for specifications and recommendations.

Specifications subject to change without notice

# GENERAL SPECIFICATIONS

## Commander™ 2100

### STANDARD EQUIPMENT:

WEIGHT (without batteries)	809 lbs. (374 kg)
TIRES (4 ply rated)	18 x 8.50 x 8 (4 ply rated)
TIRE PRESSURE	18 - 22 psi (120 - 150 kPa)
LOAD CAPACITY	1000 lbs. (454 kg) (including operator, passenger, cargo and accessories)
GROUND CLEARANCE	4.75 in. (12 cm) at differential
MAXIMUM HEIGHT	65 in. (165 cm) with top
CHASSIS	Welded high yield strength tubular steel with powder coat paint
BODY AND FINISH	Front: Flexible, impact resistant panels. Color coat/clear coat finish Rear: Lightweight, replaceable steel panels
SAFETY	Dash mounted key switch, reverse warning indicator, 'deadman' accelerator control, integral handgrip on hip restraints, manual forward/reverse selector with 'neutral', electric horn
STEERING WHEEL	Dual handgrips and pencil holder integrated with clipboard
BRAKES	Dual rear wheel mechanical, self-adjusting drum brakes. Combination service / park brake with automatic parking brake release (accelerator kick-off)
FRONT SUSPENSION	Heavy duty leaf springs with hydraulic shock absorbers
REAR SUSPENSION	Heavy duty leaf springs with hydraulic shock absorbers
STEERING	Self-compensating single reduction rack and pinion
DASH PANEL	Scuff resistant with four drink holders
SEATING	Formed fabric backed vinyl covers over cushion foam. Seating for operator and one passenger
MOTOR	48 volt DC high efficiency shunt wound, brazed armature, solid copper windings. 3.0 hp (2.2 kw) at 3800 rpm
DRIVE TRAIN	Direct motor shaft connected to transaxle pinion shaft
ELECTRICAL SYSTEM	48 volt DC, eight, 6 volt deep cycle storage batteries
SPEED CONTROL	Solid State continuously variable speed controller, 400 amp rated
TRANSAXLE	High efficiency differential with helical gears, 14.7:1 ratio
SPEED	13 ± .5 mph (21 ± .8 kph)
CHARGER	Fully automatic line compensating, 48 volt output

Specifications subject to change without notice

# GENERAL SPECIFICATIONS

## Jacobsen Hauler™ 800

### STANDARD EQUIPMENT:

WEIGHT (without batteries)	675 lbs. (306 kg)
TIRES	18 x 8.50 x 8 (4 ply rated)
TIRE PRESSURE	18 - 22 psi (120 - 150 kPa)
LOAD CAPACITY	800 lbs. (362 kg) (including operator, passenger, cargo and accessories)
GROUND CLEARANCE	4.75 in. (12 cm) at differential
MAXIMUM HEIGHT	65 in. (165 cm) with top
CHASSIS	Welded high yield strength tubular steel with powder coat paint
BODY AND FINISH	Front: Flexible, impact resistant panels. Color coat/clear coat finish Rear: Lightweight, replaceable steel panels
SAFETY	Dash mounted key switch, reverse warning indicator, 'deadman' accelerator control, integral handgrip on hip restraints, manual forward/reverse selector with 'neutral', electric horn
STEERING WHEEL	Dual handgrips
BRAKES	Dual rear wheel mechanical, self-adjusting drum brakes. Combination service / park brake with automatic parking brake release (accelerator kick-off)
FRONT SUSPENSION	Heavy duty leaf springs with hydraulic shock absorbers
REAR SUSPENSION	Heavy duty leaf springs with hydraulic shock absorbers
STEERING	Self-compensating single reduction rack and pinion
DASH PANEL	Scuff resistant with four drink holders
SEATING	Formed fabric backed vinyl covers over cushion foam. Seating for operator and one passenger
MOTOR	36 volt DC high efficiency series wound, brazed armature, solid copper windings. 2.5 hp (1.9 kw) at 2700 rpm
DRIVE TRAIN	Direct motor shaft connected to transaxle pinion shaft
ELECTRICAL SYSTEM	36 volt DC, six, 6 volt deep cycle storage batteries
SPEED CONTROL	Solid State continuously variable speed controller, 300 amp rated
TRANSAXLE	High efficiency differential with helical gears, 12.44:1 ratio
SPEED	13 mph ± .5 mph (21 kph ± .8 kph)
CHARGER	PowerWise™ portable, fully automatic For locations outside US and Canada, refer to charger manufacturer for specifications and recommendations.

Specifications subject to change without notice

# GENERAL SPECIFICATIONS

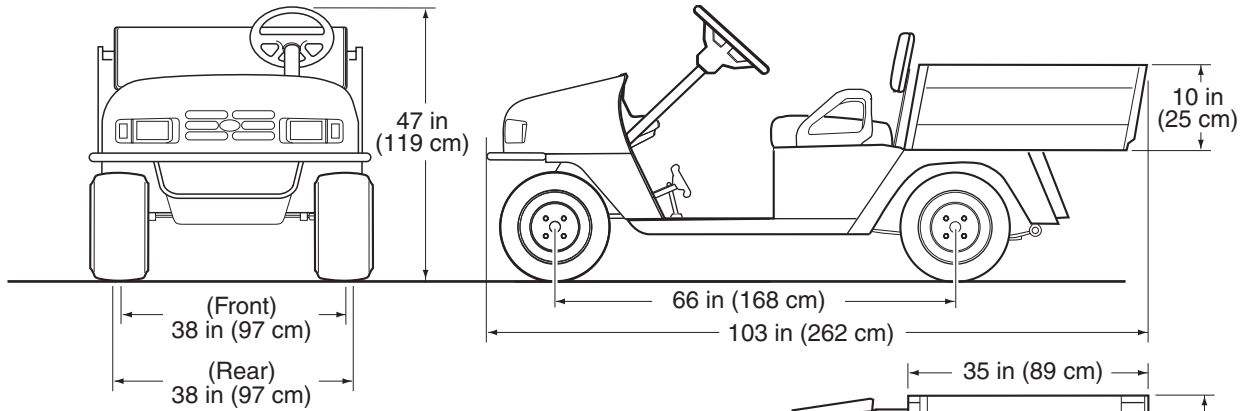
## Jacobsen Hauler™ 1000

### STANDARD EQUIPMENT:

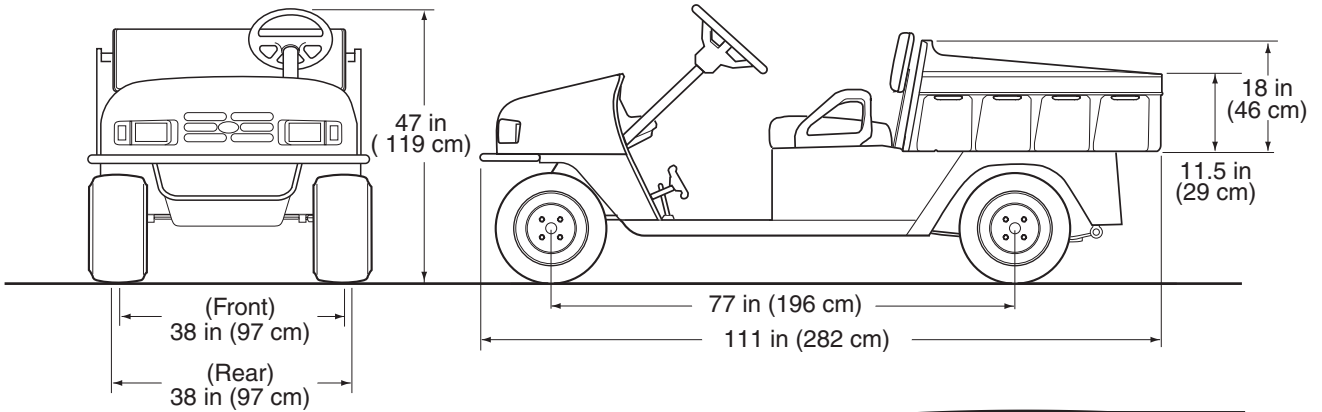
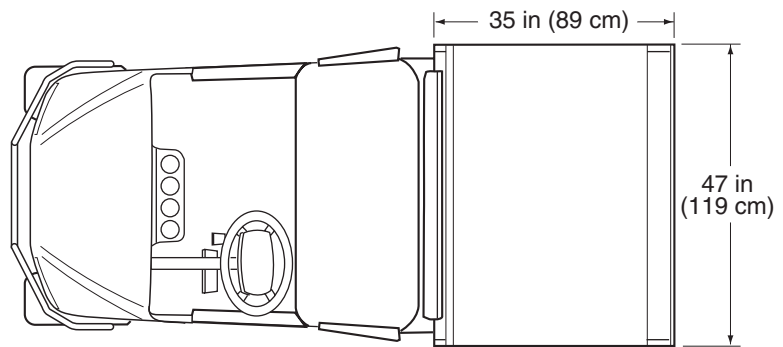
WEIGHT (without batteries)	809 lbs. (374 kg)
TIRES (4 ply rated)	18 x 8.50 x 8 (4 ply rated)
TIRE PRESSURE	18 - 22 psi (120 - 150 kPa)
LOAD CAPACITY	1000 lbs. (454 kg) (including operator, passenger, cargo and accessories)
GROUND CLEARANCE	4.75 in. (12 cm) at differential
MAXIMUM HEIGHT	65 in. (165 cm) with top
CHASSIS	Welded high yield strength tubular steel with powder coat paint
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STEERING WHEEL	Dual handgrips and pencil holder integrated with clipboard
BRAKES	Dual rear wheel mechanical, self-adjusting drum brakes. Combination service / park brake with automatic parking brake release (accelerator kick-off)
FRONT SUSPENSION	Heavy duty leaf springs with hydraulic shock absorbers
REAR SUSPENSION	Heavy duty leaf springs with hydraulic shock absorbers
STEERING	Self-compensating single reduction rack and pinion
DASH PANEL	Scuff resistant with four drink holders
SEATING	Formed fabric backed vinyl covers over cushion foam. Seating for operator and one passenger
MOTOR	48 volt DC high efficiency shunt wound, brazed armature, solid copper windings
DRIVE TRAIN	Direct motor shaft connected to transaxle pinion shaft
ELECTRICAL SYSTEM	48 volt DC, eight, 6 volt deep cycle storage batteries
SPEED CONTROL	Solid State continuously variable speed controller, 400 amp rated
TRANSAXLE	High efficiency differential with helical gears, 14.7:1 ratio
SPEED	13 ± .5 mph (21 ± .8 kph)
CHARGER	Fully automatic line compensating, 48 volt output

Specifications subject to change without notice

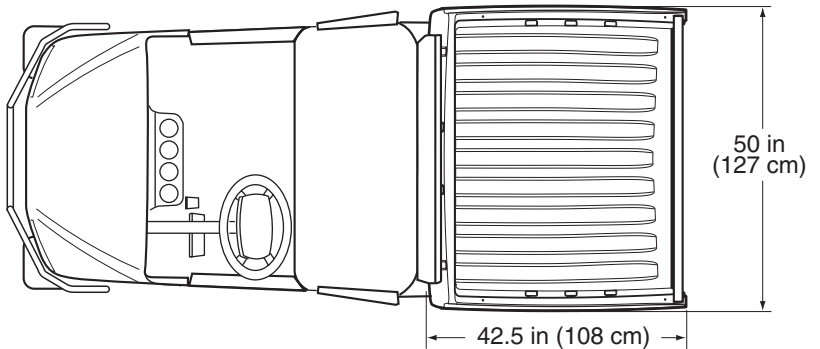
# GENERAL SPECIFICATIONS



**MPT™ 800**  
**INDUSTRIAL™ 800**  
**CUSHMAN™ 280**  
**JACOBSEN™ 800**

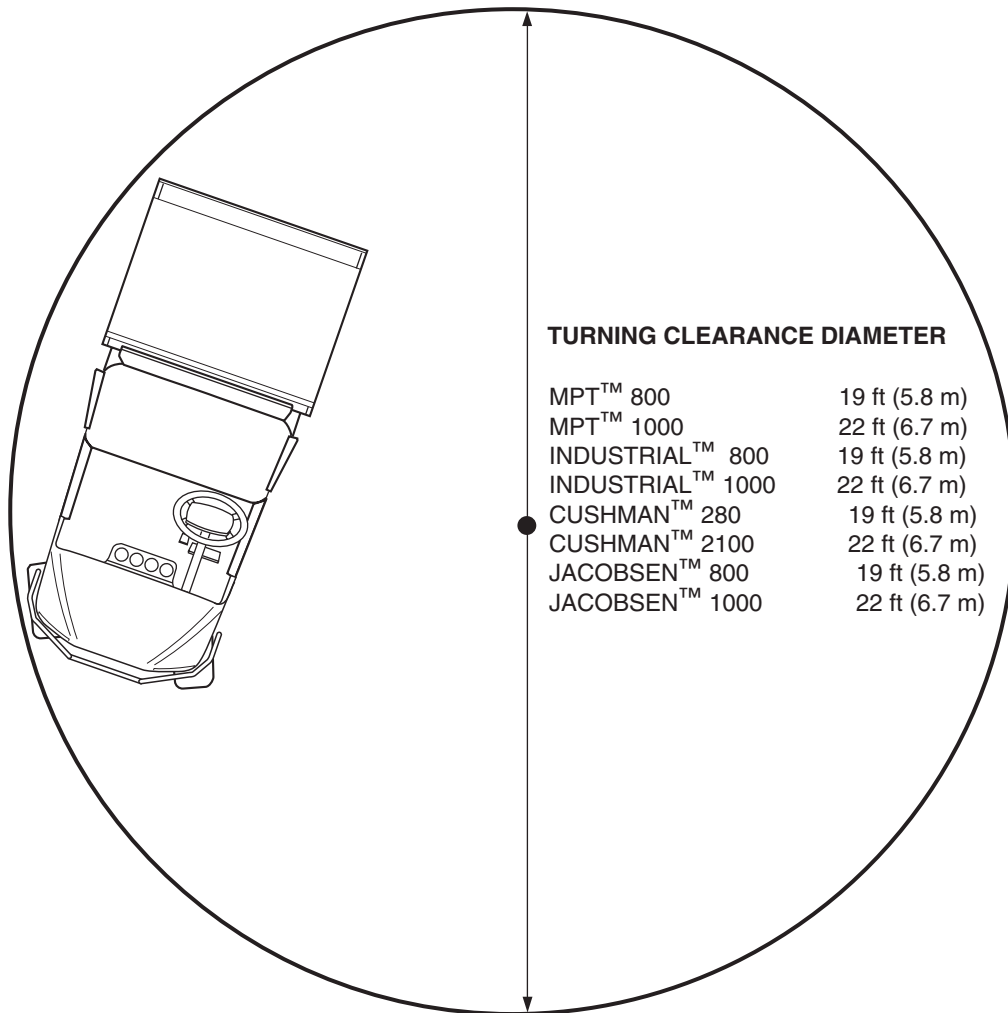
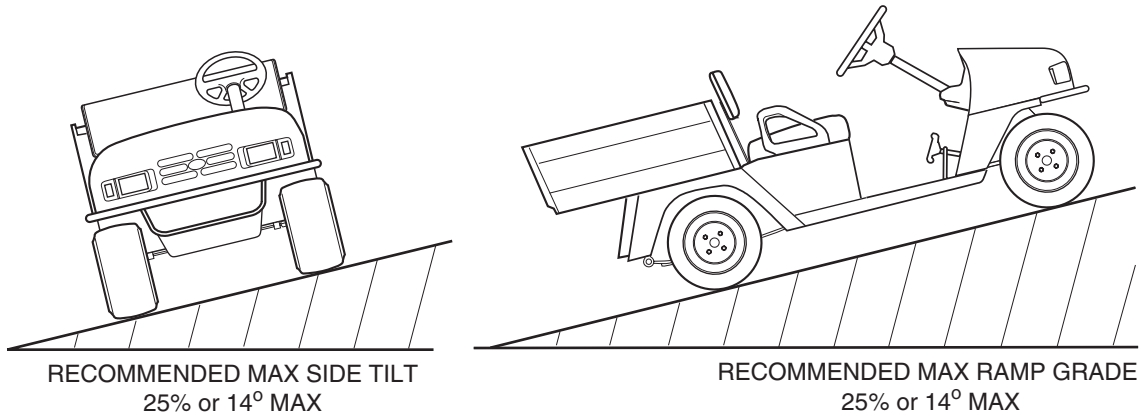


**MPT™ 1000**  
**INDUSTRIAL™ 1000**  
**CUSHMAN™ 2100**  
**JACOBSEN™ 1000**



**Fig. 1 Vehicle Dimensions**

# GENERAL SPECIFICATIONS



**Fig. 2 Vehicle Dimensions, Incline Specifications and Turning Clearance Diameter**



# GENERAL SPECIFICATIONS

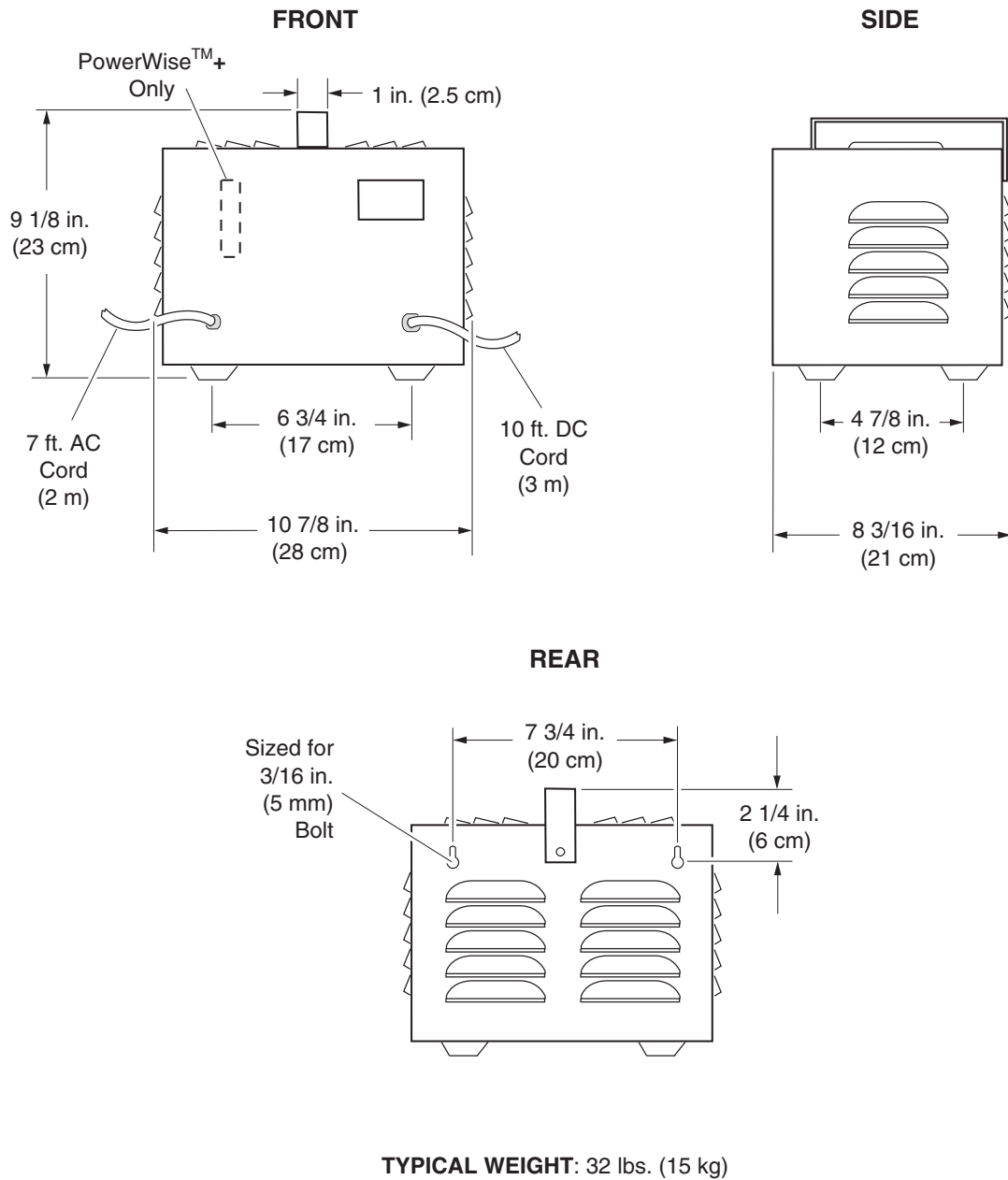


Fig. 3 PowerWise™ Portable Battery Charger Dimensions

## **GENERAL SPECIFICATIONS**

**NOTE**

Read and understand the following warnings before attempting to operate the vehicle:

**⚠ WARNING ⚠**

*To prevent personal injury or death, observe the following:*

*When vehicle is to be left unattended, engage parking (PARK) brake, move direction selector to neutral, turn key to 'OFF' position and remove key.*

*Drive vehicle only as fast as terrain and safety considerations allow. Consider the terrain and traffic conditions. Consider environmental factors which effect the terrain and the ability to control the vehicle.*

*Avoid driving fast down hill. Sudden stops or change of direction may result in a loss of control. Use service brake to control speed when traveling down an incline.*

*Use extra care and reduced speed when driving on poor surfaces, such as loose dirt, wet grass, gravel, etc.*

*All travel should be directly up or down hills.*

*Use extra care when driving the vehicle across an incline.*

*Stay in designated areas and avoid steep slopes. Use the parking brake whenever the vehicle is parked.*

*Keep feet, legs, hands and arms inside vehicle at all times.*

*Avoid extremely rough terrain.*

*Check area behind the vehicle before operating in reverse.*

*Make sure the direction selector is in correct position before attempting to start the vehicle.*

*Slow down before and during turns. All turns should be executed at reduced speed.*

*Always bring vehicle to a complete stop before shifting the direction selector.*

*See GENERAL SPECIFICATIONS for standard vehicle load and seating capacity.*

**NOTE**

Read and understand the following text and warnings before attempting to service vehicle:

In any product, components will eventually fail to perform properly as the result of normal use, age, wear or abuse. It is virtually impossible to anticipate all possible component failures or the manner in which each component may fail.

Be aware that a vehicle requiring repair indicates that the vehicle is no longer functioning as designed and therefore should be considered potentially hazardous. Use extreme care when working on any vehicle. When diagnosing, removing or replacing any components that are not operating correctly, take time to consider the safety of yourself and others around you should the component move unexpectedly.

Some components are heavy, spring loaded, highly corrosive, explosive or may produce high amperage or reach high temperatures. Battery acid and hydrogen gas could result in serious bodily injury to the technician/mechanic and bystanders if not treated with the utmost caution. Be careful not to place hands, face, feet or body in a location that could expose them to injury should an unforeseen situation occur.

**⚠ WARNING ⚠**

*To prevent personal injury or death, observe the following:*

*Before working on the vehicle, remove all jewelry (rings, watch, necklaces, etc.).*

*Be sure no loose clothing or hair can contact moving parts.*

*Use care not to touch hot objects.*

*Raise rear of vehicle and support on jack stands before attempting to run or adjust powertrain.*

*Wear eye protection when working on or around the vehicle. In particular, use care when working around batteries, using solvents or compressed air.*

*Hydrogen gas is formed when charging batteries. Do not charge batteries without adequate ventilation.*

*Do not permit open flame or anyone to smoke in an area that is being used for charging batteries. A concentration of 4% hydrogen gas or more is explosive.*



A Textron Company

E-Z-GO Division Of Textron, Inc.,  
1451 Marvin Griffin Road, Augusta, Georgia USA 30906-3852

**TO CONTACT US**

**North America:**

Technical Assistance & Warranty Phone: 1-800-774-3946, FAX: 1-800-448-8124  
Service Parts Phone: 1-888-GET-EZGO (1-888-438-3946), FAX: 1-800-752-6175

**International:**

Phone: 010-1-706-798-4311, FAX: 010-1-706-771-4609

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