



A Textron Company

# **Repair & Service Manual**

**ELECTRIC POWERED UTILITY VEHICLE**



# **625618**

**ISSUED JULY 2012**

**REVISED AUGUST 2012**

# SAFETY

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

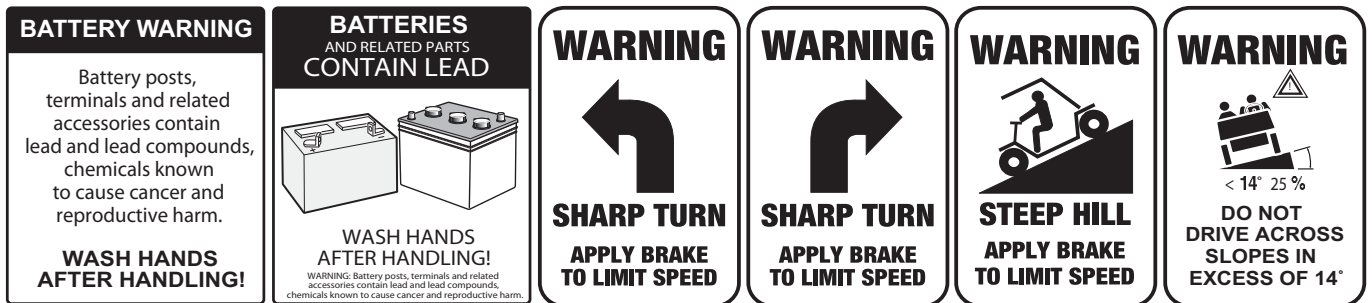
Read and understand all labels located on the vehicle. Always replace any damaged or missing labels.

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.

For towing/transporting vehicle, refer to "TRANSPORTING VEHICLE".

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

Observe these **NOTICES**, **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.

## NOTICE

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



## CAUTION

Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.



## WARNING

Indicates a hazardous situation which, if not avoided, could result in death or serious injury.



## DANGER

Indicates a hazardous situation which, if not avoided, will result in death or serious injury.



## WARNING

Engine exhaust from this product contains chemicals known, in certain quantities, to cause cancer, birth defects, or other reproductive harm.

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

## NOTICE

The exhaust emissions of this vehicles' engine complies with regulations set forth by the Environmental Protection Agency (EPA) of the United States of America (USA) at time of manufacture. Significant fines could result from modifications or tampering with the engine, fuel, ignition or air intake systems.



## WARNING

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

## NOTICE

This spark ignition system meets all requirements of the Canadian Interference-Causing Equipment Regulations.

Ce système d'allumage par étincelle de véhicule respecte toutes les exigences du Règlement sur le matériel brouilleur du Canada.

# **SERVICE AND REPAIR MANUAL**

## **ELECTRIC POWERED UTILITY VEHICLE**

### **TERRAIN 1000**

### **STARTING MODEL YEAR 2012**

E-Z-GO Division of TEXTRON Inc. reserves the right to incorporate engineering and design changes to products in this Manual, without obligation to include these changes on units leased/sold previously.

The information contained in this Manual may be revised periodically by E-Z-GO, and therefore is subject to change without notice.

E-Z-GO DISCLAIMS LIABILITY FOR ERRORS IN THIS MANUAL, and E-Z-GO **SPECIFICALLY DISCLAIMS LIABILITY FOR INCIDENTAL AND CONSEQUENTIAL DAMAGES** resulting from the use of the information and materials in this Manual.

#### **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: 001-706-798-4311, FAX: 001-706-771-4609**

# 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.**

**Tampering with or adjusting the governor to permit vehicle to operate at above factory specifications will void the vehicle warranty.**

**When servicing engines, all adjustments and replacement components must be per original vehicle specifications in order to maintain the United States of America Federal and State emission certification applicable at the time of manufacture.**

## **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).**

## **BATTERY DISPOSAL**

**Lead-acid batteries are recyclable. Return whole scrap batteries to distributor, manufacturer or lead smelter for recycling. For neutralized spills, place residue in acid-resistant containers with absorbent material, sand or earth and dispose of in accordance with local, state and federal regulations for acid and lead compounds. Contact local and/or state environmental officials regarding disposal information.**



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# SAFETY INFORMATION

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

This manual has been designed to assist 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 or property damage, the following must be carefully observed:



## CAUTION

Certain replacement parts can be used independently and/or in combination with other accessories to modify an E-Z-GO-manufactured vehicle to permit the vehicle to operate at or in excess of 20mph. When an E-Z-GO-manufactured vehicle is modified in any way by the Distributor, Dealer or customer to operate at or in excess of 20mph, UNDER FEDERAL LAW the modified product will be a Low Speed Vehicle (LSV) subject to the strictures and requirements of Federal Motor Vehicle Safety Standard 571.500. In these instances, pursuant to Federal law the Distributor or Dealer MUST equip the product with headlights, rear lights, turn signals, seat belts, top, horn and all other modifications for LSV's mandated in FMVSS 571.500, and affix a Vehicle Identification Number to the product in accordance with the requirements of FMVSS 571.565. Pursuant to FMVSS 571.500, and in accordance with the State laws applicable in the places of sale and use of the product, the Distributor, Dealer or customer modifying the vehicle also will be the Final Vehicle Manufacturer for the LSV, and required to title or register the vehicle as mandated by State law.

E-Z-GO will NOT approve Distributor, Dealer or customer modifications converting E-Z-GO products into LSV's.

The Company, in addition, recommends that all E-Z-GO products sold as personal transportation vehicles BE OPERATED ONLY BY PERSONS WITH VALID DRIVERS LICENSES, AND IN ACCORDANCE WITH APPLICABLE STATE REQUIREMENTS. This restriction is important to the SAFE USE AND OPERATION of the product. On behalf of E-Z-GO, I am directing that E-Z-GO Branch personnel, Distributors and Dealers advise all customers to adhere to this SAFETY RESTRICTION, in connection with the use of all products, new and used, the Distributor or Dealer has reason to believe may be operated in personal transportation applications.

Information on FMVSS 571.500 can be obtained at Title 49 of the Code of Federal Regulations, section 571.500, or through the Internet at the website for the U.S. Department of Transportation - at Dockets and Regulation, then to Title 49 of the Code of Federal Regulations (Transportation).

## 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 all users and maintenance personnel read this entire manual paying particular attention to the CAUTIONS and WARNINGS contained therein.

If you have any questions regarding this vehicle, 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(s) 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 of the United States of America (USA) 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.

Refer to GENERAL SPECIFICATIONS for vehicle seating capacity.

# SAFETY INFORMATION

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**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.
- Read and observe all warnings and operation instruction labels affixed to the vehicle.
- Follow all safety rules established in the area where the vehicle is being operated.
- Reduce speed to compensate for poor terrain or conditions.
- Apply service brake to control speed on steep grades.
- Maintain adequate distance between vehicles.
- Reduce speed in wet areas.
- Use extreme caution when approaching sharp or blind turns.
- Use extreme caution when driving over loose terrain.
- Use extreme caution in areas where pedestrians are present.

## MAINTENANCE

### Always:

- Maintain the vehicle in accordance with the manufacturer's periodic service schedule.
- Ensure that repairs are performed by those that are trained and qualified to do so.
- Follow the manufacturer's maintenance procedures for the 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.
- 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 battery or cover exposed terminals with an insulating material.
- Use specified replacement parts. Never use replacement parts of lesser quality.
- Use recommended tools.
- 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.
- Support the vehicle using wheel chocks and jack stands. Never get under a vehicle that is supported by a jack. Lift the vehicle in accordance with the manufacturer's instructions.
- Empty the fuel tank or plug fuel hoses to prevent fuel leakage.

# SAFETY INFORMATION

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

- Maintain the vehicle in an area away from exposed flame or persons who are smoking.
- Be aware that a vehicle that is not performing as designed is a potential hazard and must not be operated.
- 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.
- Replace damaged or missing warning, caution or information labels.
- Keep complete records of the maintenance history of the vehicle.

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.

## VENTILATION

Always store gasoline vehicles in a well ventilated area. Ventilation prevents gasoline fumes from accumulating.

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

Never work around or operate a vehicle in an environment that does not ventilate exhaust gases from the area. Carbon monoxide is a dangerous gas that can cause unconsciousness and is potentially lethal.

## SAFETY INFORMATION

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NOTES:

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## GENERAL INFORMATION & ROUTINE MAINTENANCE

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# GENERAL INFORMATION & ROUTINE MAINTANENCE

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## SERIAL NUMBER LABEL LOCATION

Two 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

#### WARNING

*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

#### WARNING

*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

#### 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.*

*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-2).

Vehicle batteries must be fully charged before initial use.

# GENERAL INFORMATION & ROUTINE MAINTANENCE

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

## ROUTINE MAINTENANCE

### NOTICE

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

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
Tires	Check air pressure (see SPECIFICATIONS)
Portable Charger	Remove from vehicle and properly mount

Fig. 1 Initial Service Chart

This vehicle will give years of satisfactory service provided 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 below).

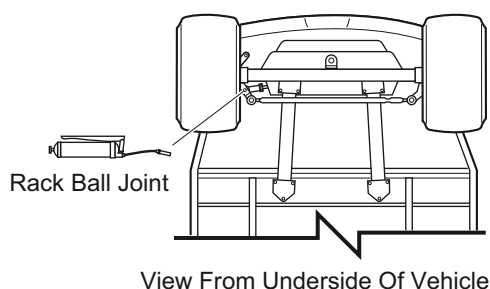


Fig. 2 Lubrication Points



### CAUTION

*Do not use more than three 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 to be only 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.

## VEHICLE CLEANING AND CARE



### CAUTION

*When pressure washing vehicle, do not use pressure in excess of 700 psi (4826 kPa). To prevent cosmetic damage, do not use any abrasive or reactive solvents to clean plastic parts.*

# GENERAL INFORMATION & ROUTINE MAINTANENCE

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

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 (4826 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 occasionally 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 28140G\*\* and 28432G\*\*).
- 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 606312).
- 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 607636).
- Battery Maintenance Kit for complete battery cleaning and watering, with battery maintenance instructions (P/N 25587G01).

- Plexus plastic cleaner and polish removes minor scratches from windshield (P/N 606314).

## SUN TOP AND WINDSHIELD



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

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

The sun 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.

## HARDWARE

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

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.

# GENERAL INFORMATION & ROUTINE MAINTANENCE

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

## TORQUE SPECIFICATIONS

ALL TORQUE FIGURES ARE IN FT. LBS. (Nm) 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.										
BOLT SIZE	1/4"	5/16"	3/8"	7/16"	1/2"	9/16"	5/8"	3/4"	7/8"	1"
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)
BOLT SIZE	M4	M5	M6	M8	M10	M12	M14			
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)			

**Fig. 3 Torque Specifications**

# GENERAL INFORMATION & ROUTINE MAINTANENCE

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

## PERIODIC SERVICE SCHEDULE

✓ - CHECK

C&A - CHECK & ADJUST

CL - CLEAN

R - REPLACE

REMARKS	before each use DAILY	20 rnds/20 hrs 100 miles/160 kms MONTHLY	60 rnds/60 hrs 300 miles/500 kms QUARTERLY	125 rnds/125 hrs 600miles/1000 kms SEMI-ANNUAL	250 rnds/250 hrs 1200miles/2000 kms ANNUAL	5 YEARS	PAGE
Tires - pressure, condition of tires & rims	✓	✓	✓	✓	✓		
Hardwares and Fasteners - loose or missing	✓	✓	✓	✓	✓		
Reverse Warning Indicator	✓	✓	✓	✓	✓		
Overall Vehicle Condition	✓	✓	✓	✓	✓		
Batteries - state of charge, condition, loose terminals, corrosion, hold down & hardware	✓	CL	CL	CL	CL		
Batteries* - check electrolyte level, fill if required		C&A	C&A	C&A	C&A		
Brakes - smooth operation of pedal, Fluid , stopping distance	✓	✓	✓	✓	✓		
Brakes - aggressive stop test, does brake hold on a hill		✓	✓	✓	✓		
Accelerator - smooth operation	✓	✓	✓	✓	✓		
Wiring - loose connections, broken or missing insulation		✓	✓	✓	✓		
Charger Receptacle - clean connections		CL	CL	CL	CL		
Steering Assembly - excessive play, loose or missing hardware		✓	✓	✓	✓		
Tie Rods - excessive play, bent rods, loose or missing hardware		✓	✓	✓	✓		
Rear Axle - oil leakage, noise, loose or missing hardware		✓	✓	✓	✓		
Rear Axle - drain & replace fluid						R	
Front Suspension - strut oil leakage, excessive play in hubs or kingpins, worn bushings, loose or missing hardware		✓	✓	✓	✓		
Front Wheel Alignment - unusual tire wear, missing lug nuts.			C&A	C&A	C&A		
Rear Suspension - shock oil leakage, worn bushings, loose or missing hardware			✓	✓	✓		
Motor Coupling - Add Anti - Sieze compound (Apporx 1 tablespoon)						20,000 AMP- Hrs	

Fig. 4 Periodic Service Schedule

## GENERAL INFORMATION & ROUTINE MAINTENANCE

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## SAFETY

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## Notes:

This image shows a full page of blank graph paper. The grid consists of small, equal-sized squares formed by thin gray lines. There are 20 columns and 20 rows of squares, creating a total of 400 square units. The margins are consistent on all sides, and there are no markings or text on the paper.



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

## NOTICES, CAUTIONS, WARNINGS AND DANGERS

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

### NOTICE

A NOTICE 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.



### DANGER

**Indicates a hazardous situation which, if not avoided, will result in death or serious injury.**

## 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.

## BEFORE SERVICING THE VEHICLE

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



### WARNING

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

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

*Be sure that no loose clothing or hair can*

# SAFETY

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

*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.*

*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 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.*

## 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.

### **WARNING**

*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*

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



## 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.

Insulated wrench, 1/2" .....	1
Socket, 1/2" .....	1
Ratchet .....	1
Battery carrier .....	1
Torque wrench (in. lbs.) .....	1

## NOTICE

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. Nonspecified torques are as shown in table contained in Section "A".



## CAUTION

Before any electrical service is performed on PDS 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 PDS 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. **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 - 100 in. lbs. (10 - 11 Nm). Protect the battery terminals and battery cable terminals with a commercially available protective coating.

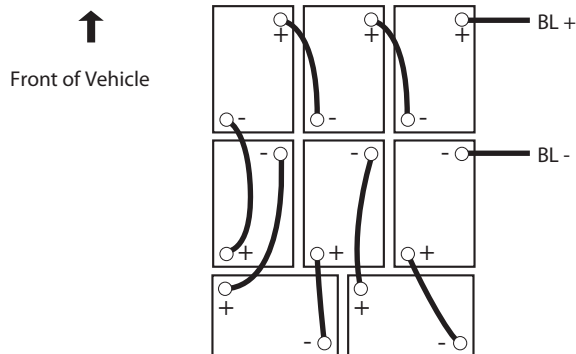


Fig. 1 48 Volt Battery Connections

# SAFETY

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

## LIFTING THE VEHICLE

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

Some servicing operations may require the vehicle to be raised.

### WARNING

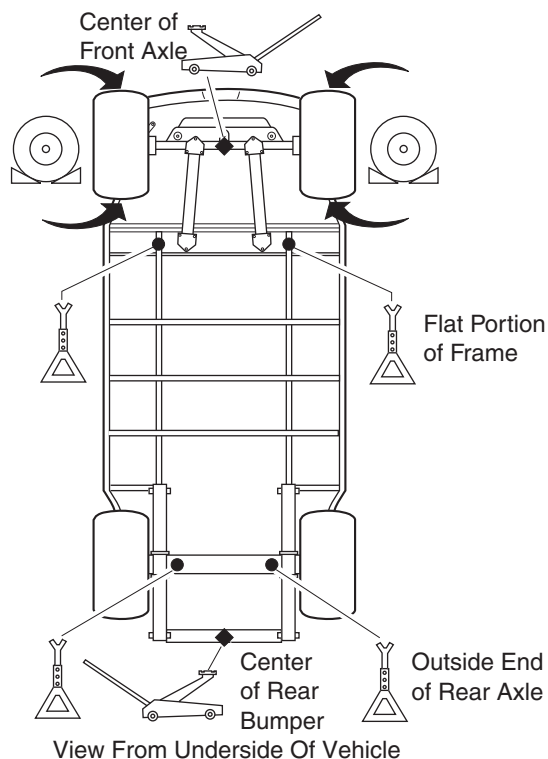
To prevent possible injury or death resulting from a vehicle falling from a jack, be sure the vehicle is on a firm and level surface. Never get under a vehicle while it is supported by a jack. Use jack stands and test the stability of the vehicle on the stands. Always place chocks in front and behind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

### CAUTION

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

To raise the entire vehicle, install chocks in front and behind each front wheel. 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.



**Fig. 2 Lifting the Vehicle**

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.

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

## Notes:

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## SAFETY

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

## Notes:

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## TABLE OF CONTENTS FOR SECTION 'C'

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<b>BODY</b> .....	<b>C - 1</b>
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Fig. 2 Front Body Components .....	C - 2
Fig. 3 Front and Rear Body Components .....	C - 3
Fig. 4 Seating and Battery Tray .....	C - 4
Fig. 5 Plastic Truck Bed Components (Manual Lift) .....	C - 5
Fig. 6 Plastic Truck Bed Components (Power Actuator) .....	C - 6
Fig. 7 Metal Truck Bed Components (Manual Lift) .....	C - 7
Fig. 8 Metal Truck Bed Components (Power Actuator) .....	C - 8

## BODY

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

## Notes:

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

## BODY

### NOTICE

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 component. 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). 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.

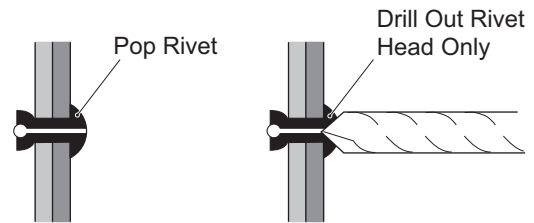


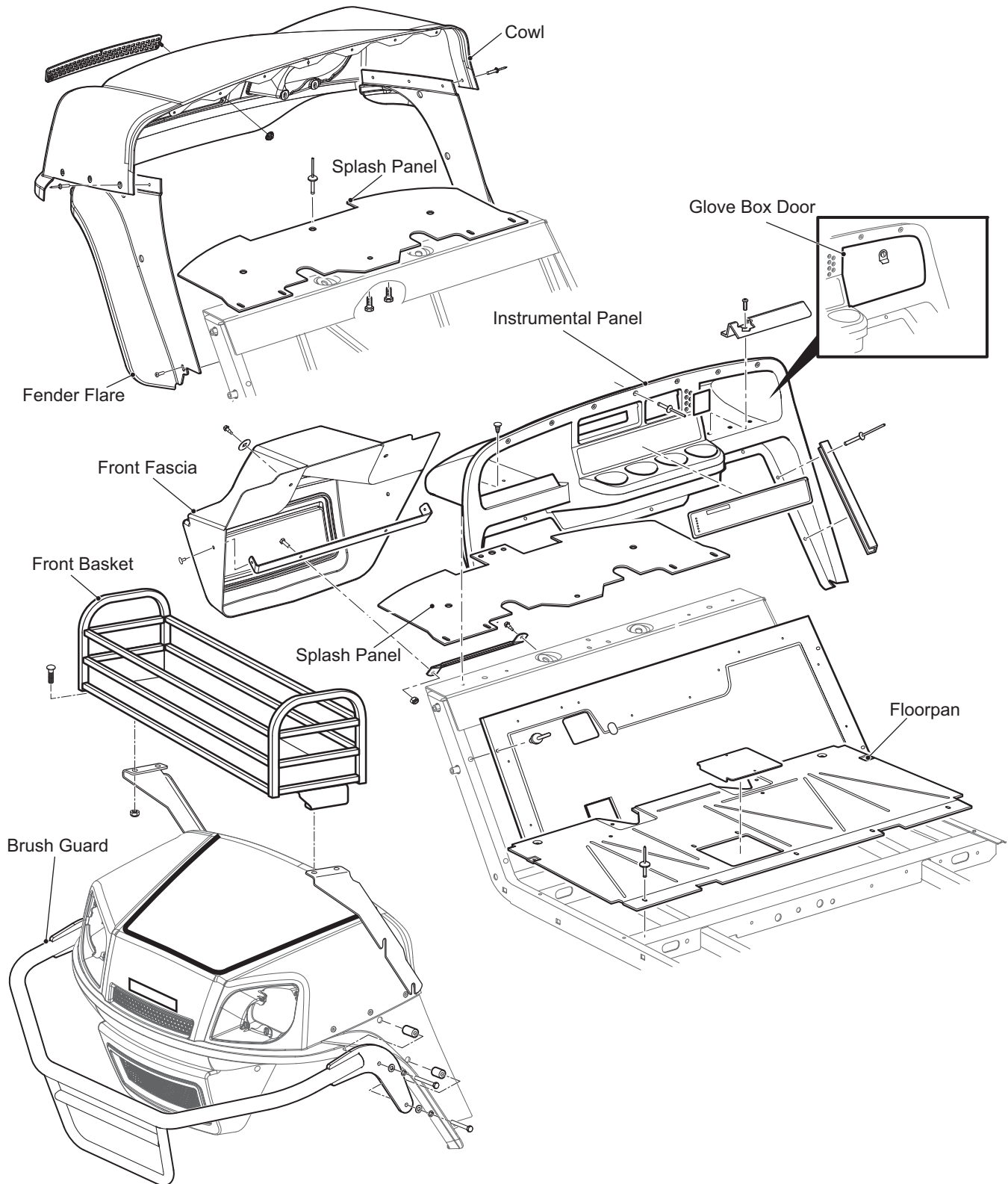
Fig. 1 Drill Out Metal Rivet

### 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.

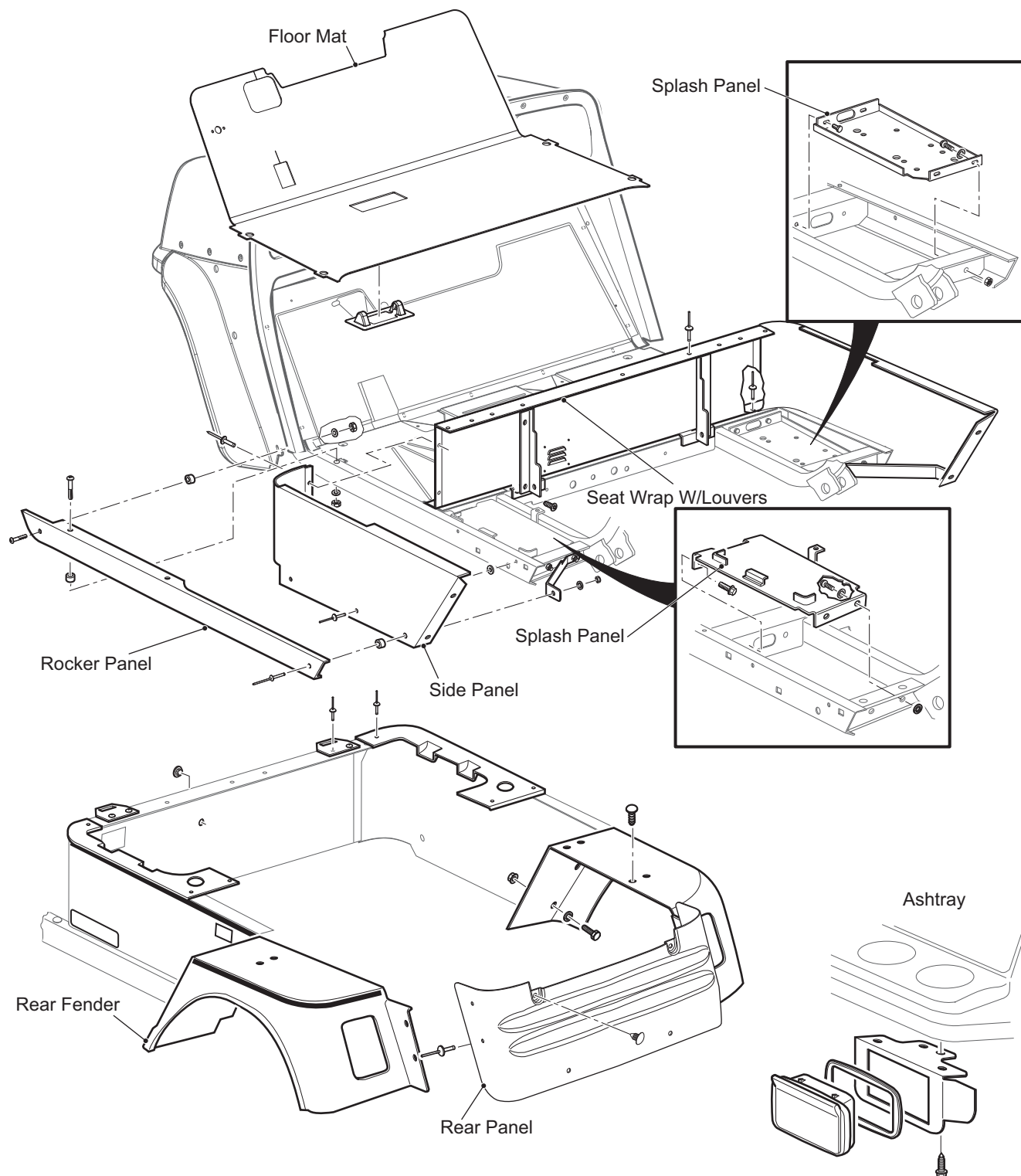
# BODY

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



**Fig. 2 Front Body Components**

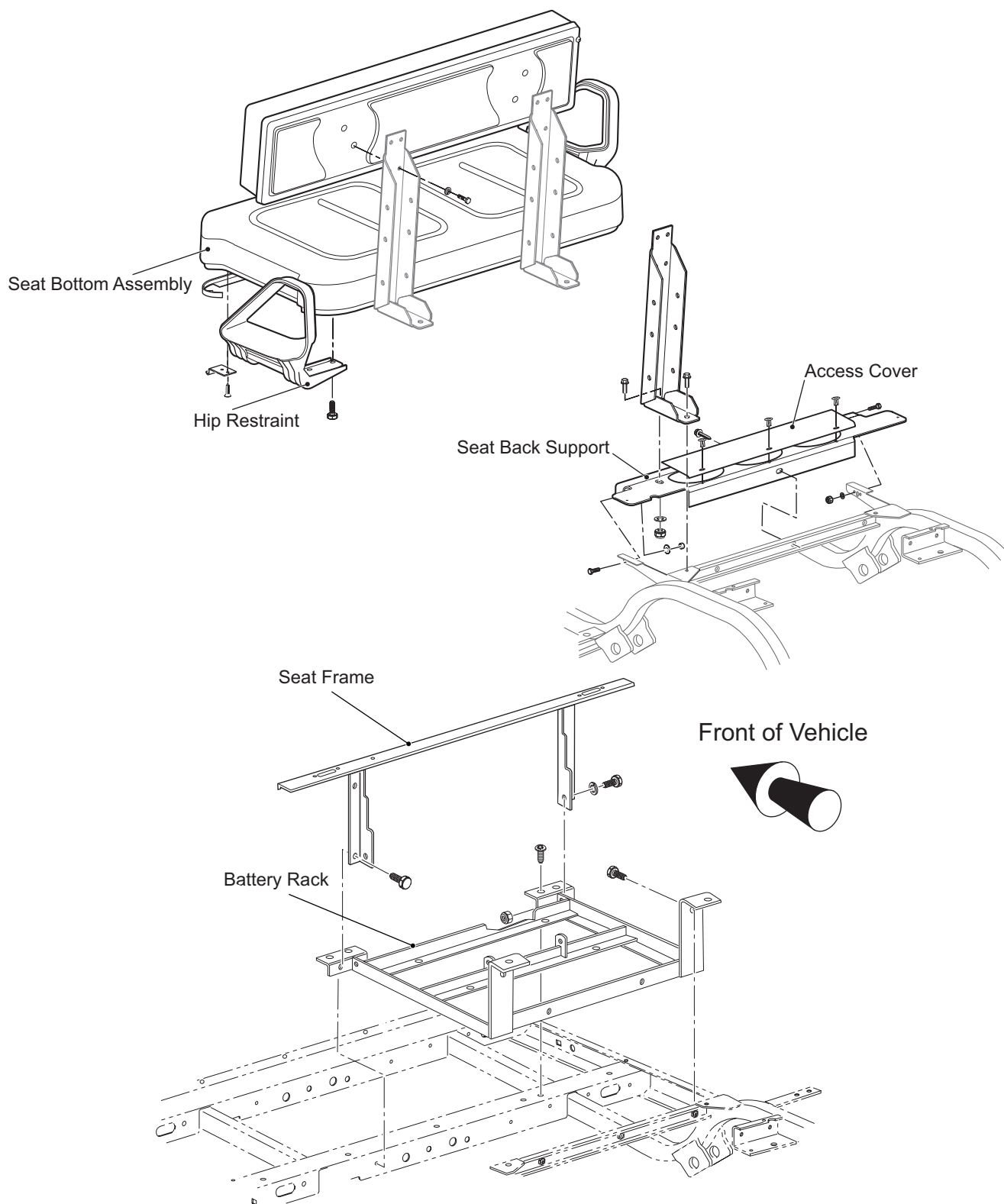
Read all of Section B and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.



**Fig. 3 Front and Rear Body Components**

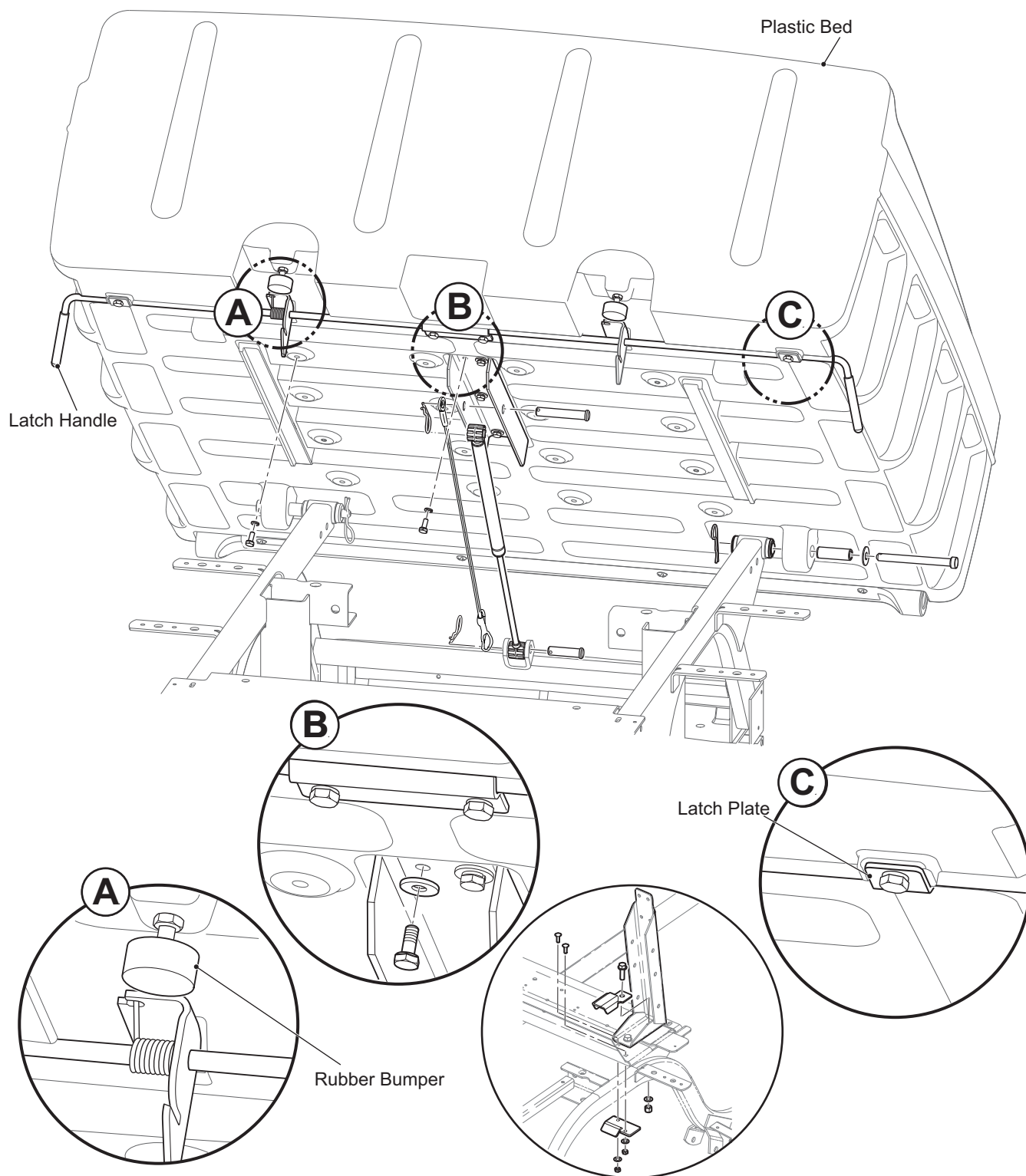
# BODY

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



**Fig. 4 Seating and Battery Tray**

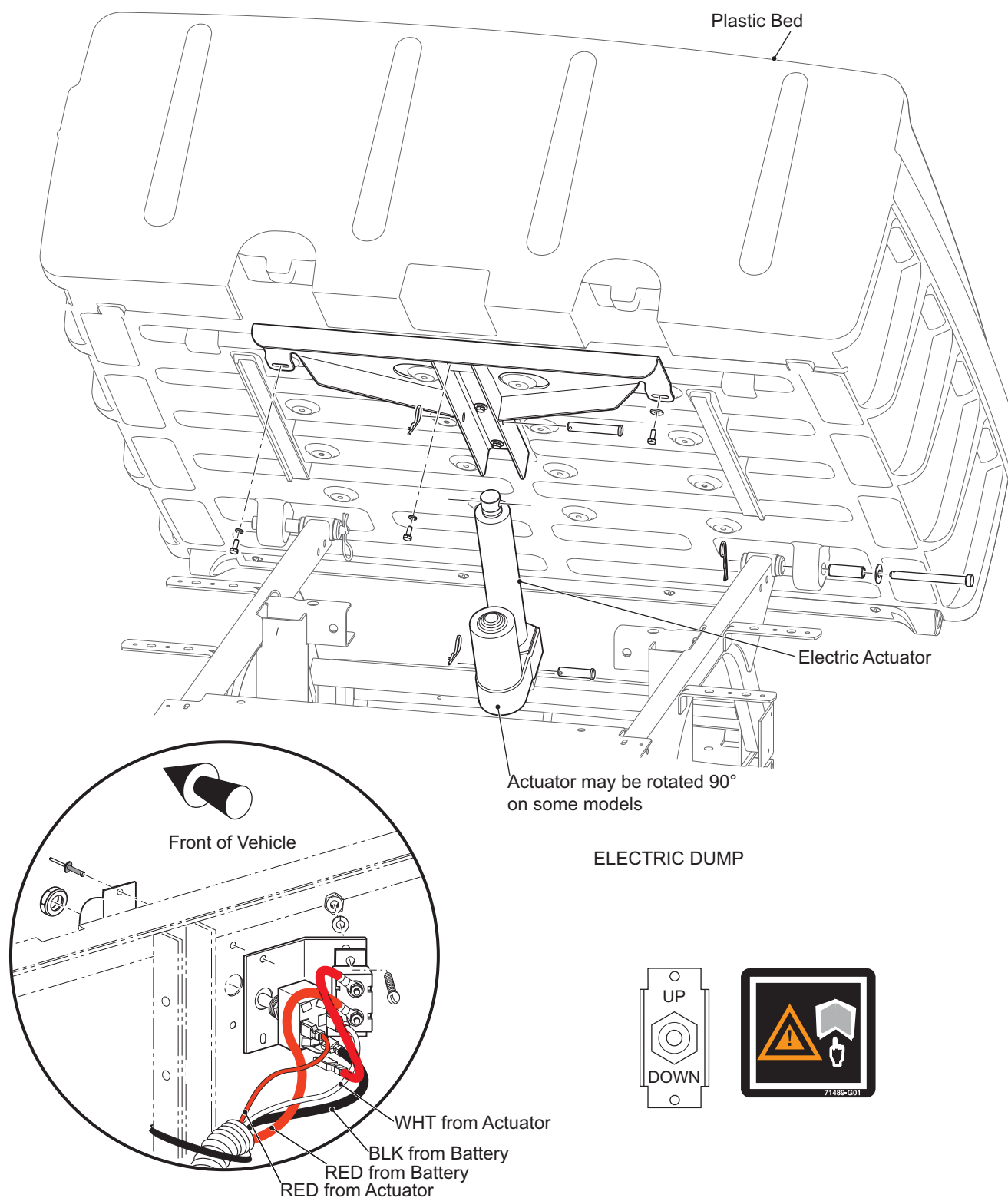
Read all of Section B and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.



**Fig. 5 Plastic Truck Bed Components (Manual Lift)**

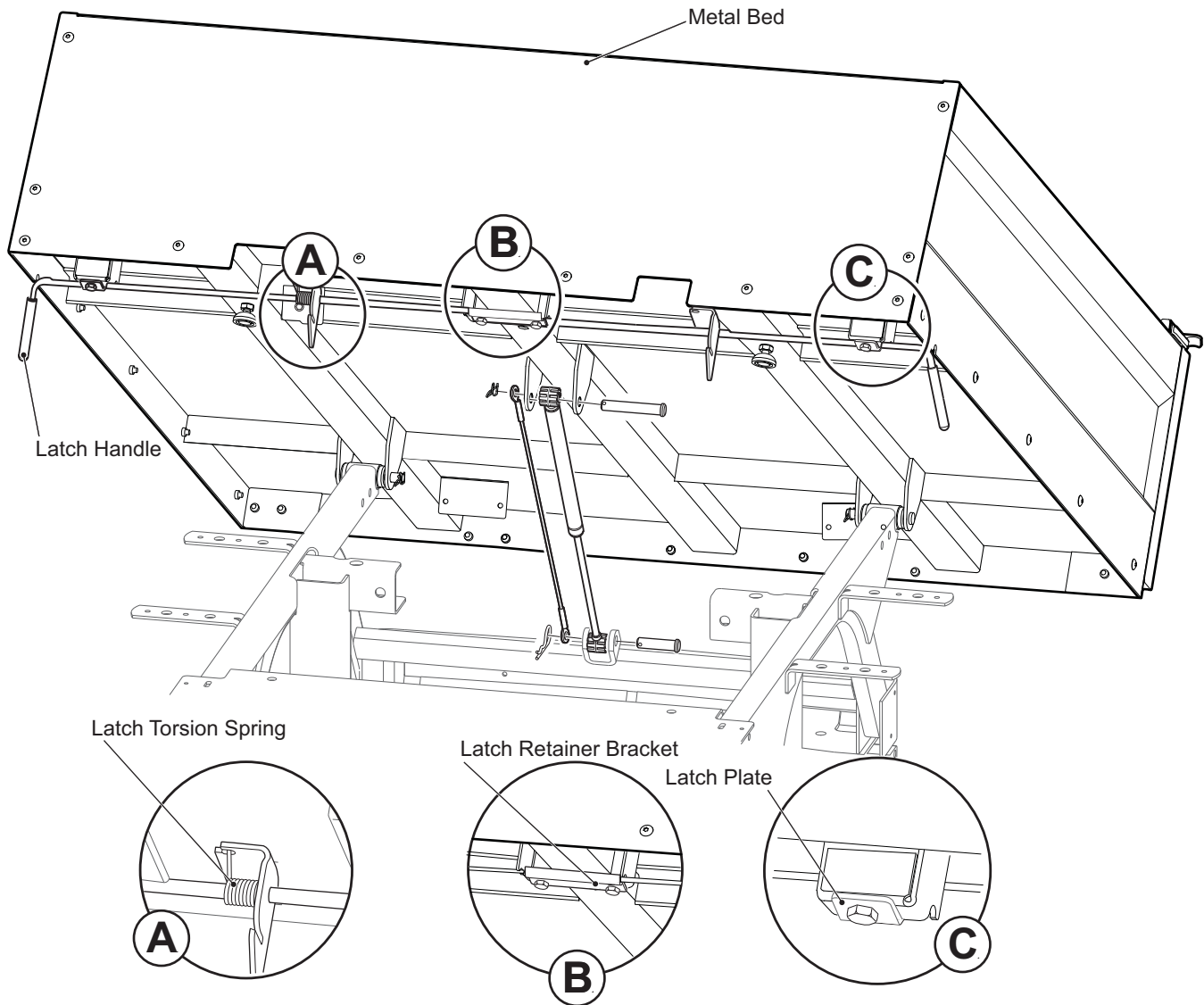
# BODY

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



**Fig. 6 Plastic Truck Bed Components (Power Actuator)**

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

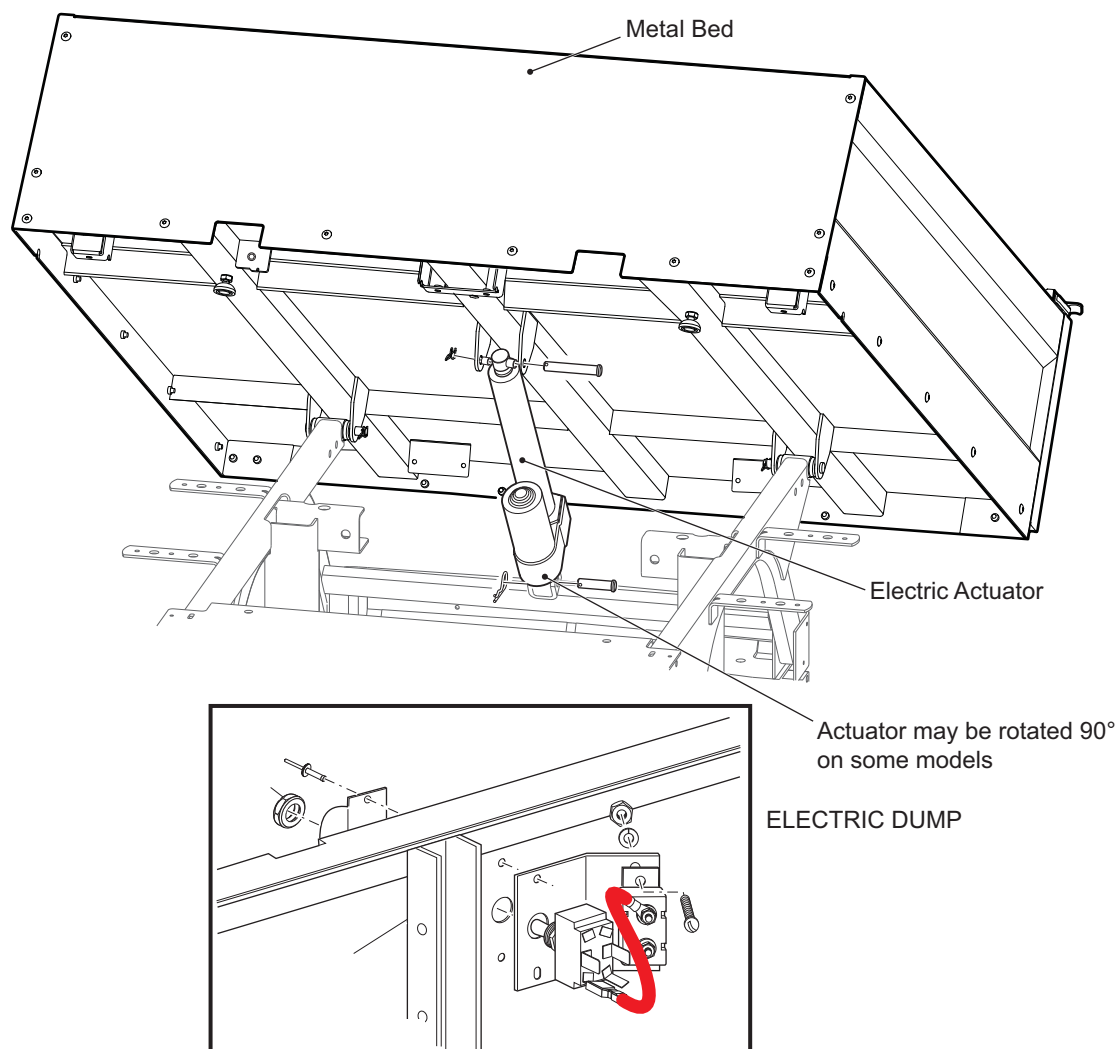


**Fig. 7 Metal Truck Bed Components (Manual Lift)**



# BODY

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



**Fig. 8 Metal Truck Bed Components (Power Actuator)**



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

## PAINTING

Follow the paint manufacturer's recommendations for specific painting procedures and information.



### WARNING

*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 airborne 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:

1. Thoroughly clean the surface to be repaired with alcohol and dry.
2. 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.
3. 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.
4. Clean with alcohol and dry.
5. (Optional but recommended) Follow this process with clear coat to renew and protect depth of finish.
6. 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:

1. Thoroughly clean the surface to be repaired with alcohol and dry.
2. Mask the area to be painted (common masking tape is adequate) prior to repair and use aerosol type touch-up paint.

3. 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.
4. 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.
5. Clean with alcohol and dry.
6. (Optional but recommended) Follow this process with clear coat to renew and protect depth of finish.
7. 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.

## BODY

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

NOTES:

[illegible]

## TABLE OF CONTENTS FOR SECTION 'D'

SECTION TITLE	PAGE NO.
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## WHEELS AND TIRES

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

NOTES:

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

## WHEEL AND TIRE SERVICE

Tools List	Qty.
Lug Wrench, 3/4" .....	1
Impact Wrench .....	1
Impact Socket, 3/4" .....	1
Torque Wrench, 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 per the Periodic Service Schedule. Inflation pressures should be checked when the 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.*

*Do not use low inflation pressure tires on any E-Z-GO vehicle. Do not use any tire which has a recommended inflation pressure less than the inflation pressure recommended in Owner's Manual*

Use caution when inflating tires. Due to the low volume of these small tires, over inflation can occur in a matter of

seconds. Over inflation 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 over inflate. Due to the low volume of these small tires, over inflation 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.

### NOTICE

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.*



# WHEELS AND TIRES

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

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.

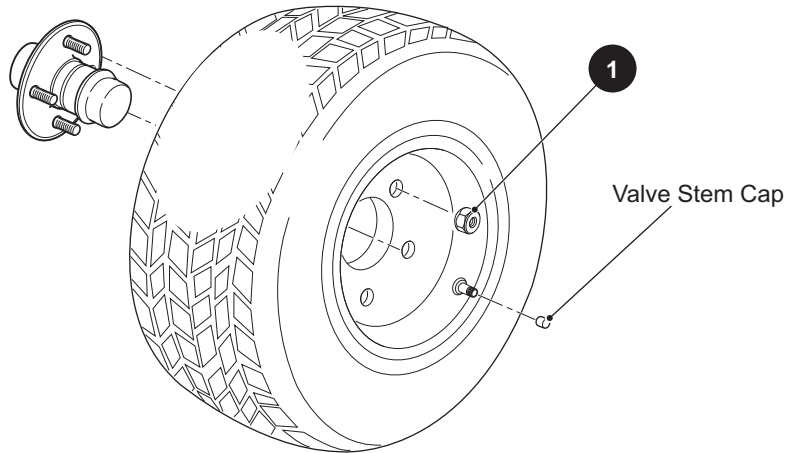
### NOTICE

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

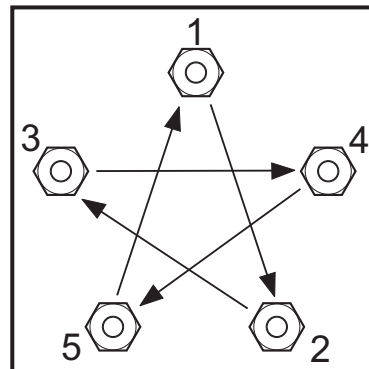
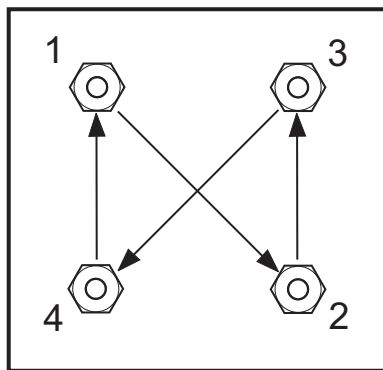
With the valve stem to the outside, mount the wheel onto the hub with lug nuts. Finger tighten lug nuts as shown. Then, tighten lug nuts to 50 - 85 ft. lbs. (70 - 115 Nm) torque in 20 ft. lbs. (30 Nm) increments following the same pattern.

ITEM NO	TORQUE SPECIFICATION
---------	----------------------

1	50 - 85 ft. lbs. (70 - 115 Nm)
---	--------------------------------



Wheel and/or Tire style may vary



'Cross Sequence'

**Fig. 1 Wheel and Tire Installation**

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

NOTES:

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## WHEELS AND TIRES

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# FRONT SUSPENSION AND STEERING

## TABLE OF CONTENTS FOR SECTION 'E'

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Fig. 24 Small Retaining Ring Orientation .....	E - 18

## FRONT SUSPENSION AND STEERING

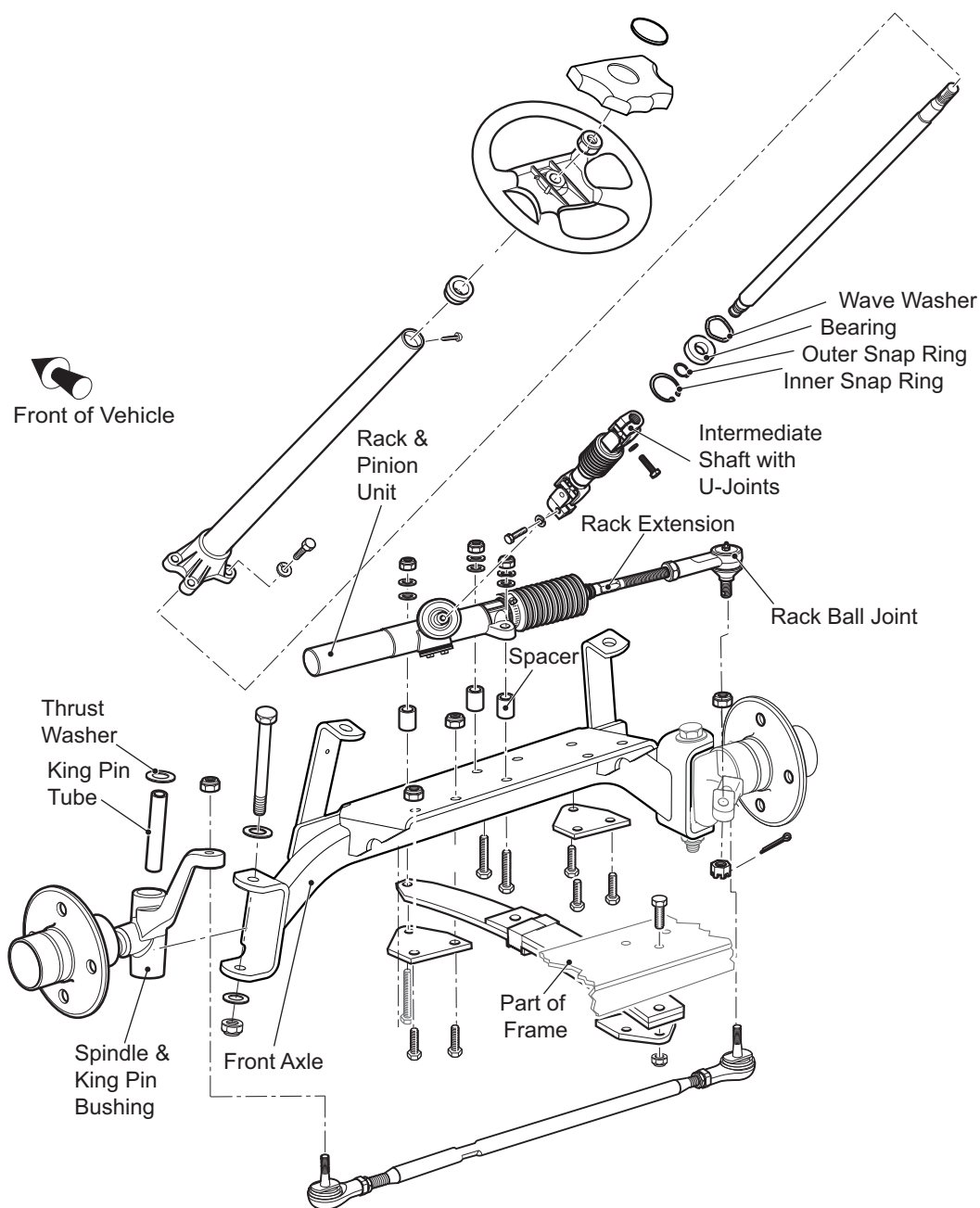
*Read all of Section B and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.*

NOTES:

This image shows a full page of blank graph paper. The grid consists of thin, light gray horizontal and vertical lines that intersect to form small squares across the entire surface. There are no margins, text, or other markings on the paper.

# FRONT SUSPENSION AND STEERING

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



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

# FRONT SUSPENSION AND STEERING

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

## MAINTENANCE

### NOTICE

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.
Grease Gun .....	1
Shop Towels .....	AR

Grease the rack ball joint (1) (Ref Fig. 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.

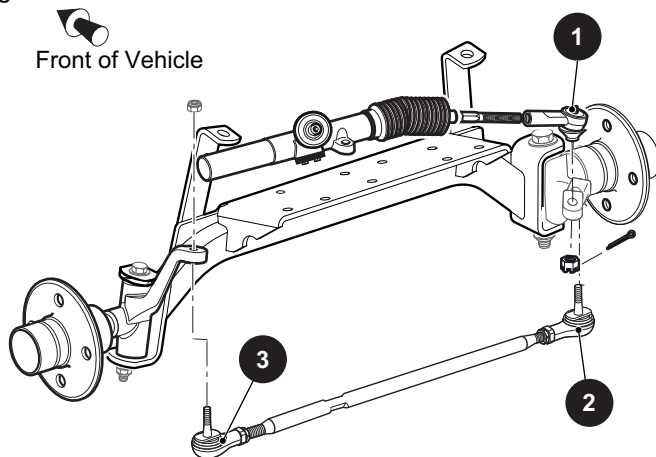


Fig. 2 Lubrication Points

### 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.

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.

### NOTICE

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

If the wheel bearing is in good condition a worn spindle bearing is indicated. The spindle bearings can not be replaced, the spindle with bearings installed is available through service parts (Ref. "Spindle Replacement" on page E - 13).

### Wheel Bearing Packing

Tool List	Qty.
Grease Gun .....	1
Bearing Packer (Recommended) .....	1

# FRONT SUSPENSION AND STEERING

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

Remove hub from spindle and disassemble. See Illustration "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 Replacement" on page E-9.

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

## NOTICE

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.
Socket, 1 1/2" .....	1
Ratchet .....	1
Torque Wrench, ft. lbs. ....	1
Adapter .....	1
Torque Wrench, 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).

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.

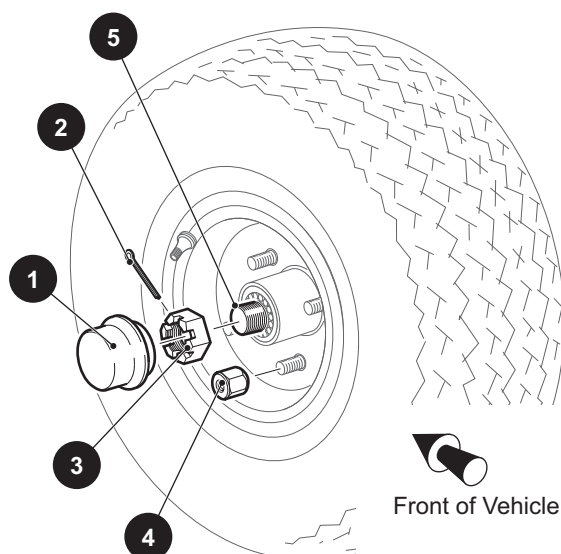


Fig. 3 Bearing Adjustment

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

## Wheel Alignment

Tool List	Qty.
Tape Measure .....	1
Chalk .....	1
Wrench, 9/16" .....	1
Wrench, 3/4" .....	1
Crowfoot Socket, 3/4" .....	1
Torque Wrench, ft. lbs. ....	1
Socket, 13 mm, .....	1
Ratchet .....	1
Torque Wrench, in. lbs. ....	1

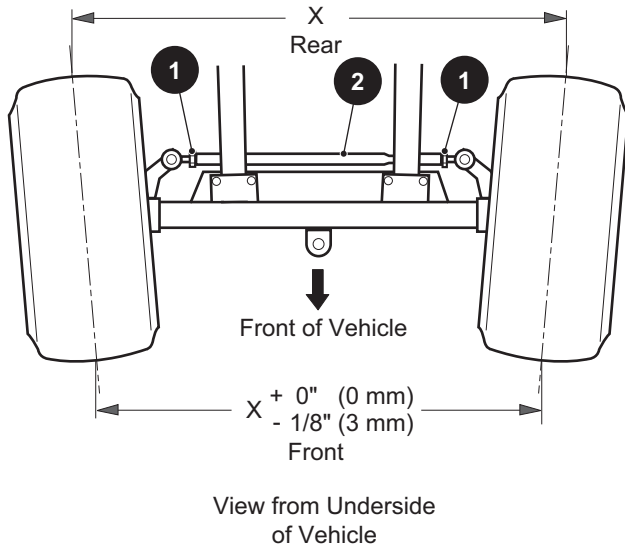
Lift the front of the vehicle and support on jack stands as per SAFETY section. Confirm the alignment of the front springs. See "Front Spring Replacement" on page E - 7.

# FRONT SUSPENSION AND STEERING

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

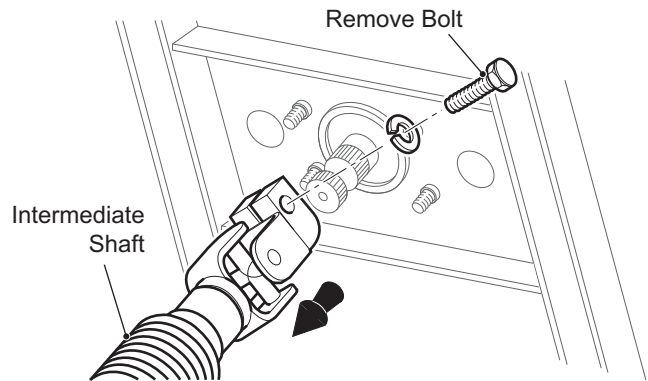
Rotate each wheel and scribe a chalk line around the circumference of the tire at the center of the tread pattern. Lower vehicle and, with tires in the straight ahead position, roll it forward approximately five feet in order to allow the tires to take their normal running position.

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



**Fig. 4 Wheel Alignment**

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). Reconnect intermediate shaft and tighten bolt to 155 - 215 in. lbs. (18 - 24 Nm) torque.



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

## NOTICE

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.

# FRONT SUSPENSION AND STEERING

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

## FRONT SUSPENSION

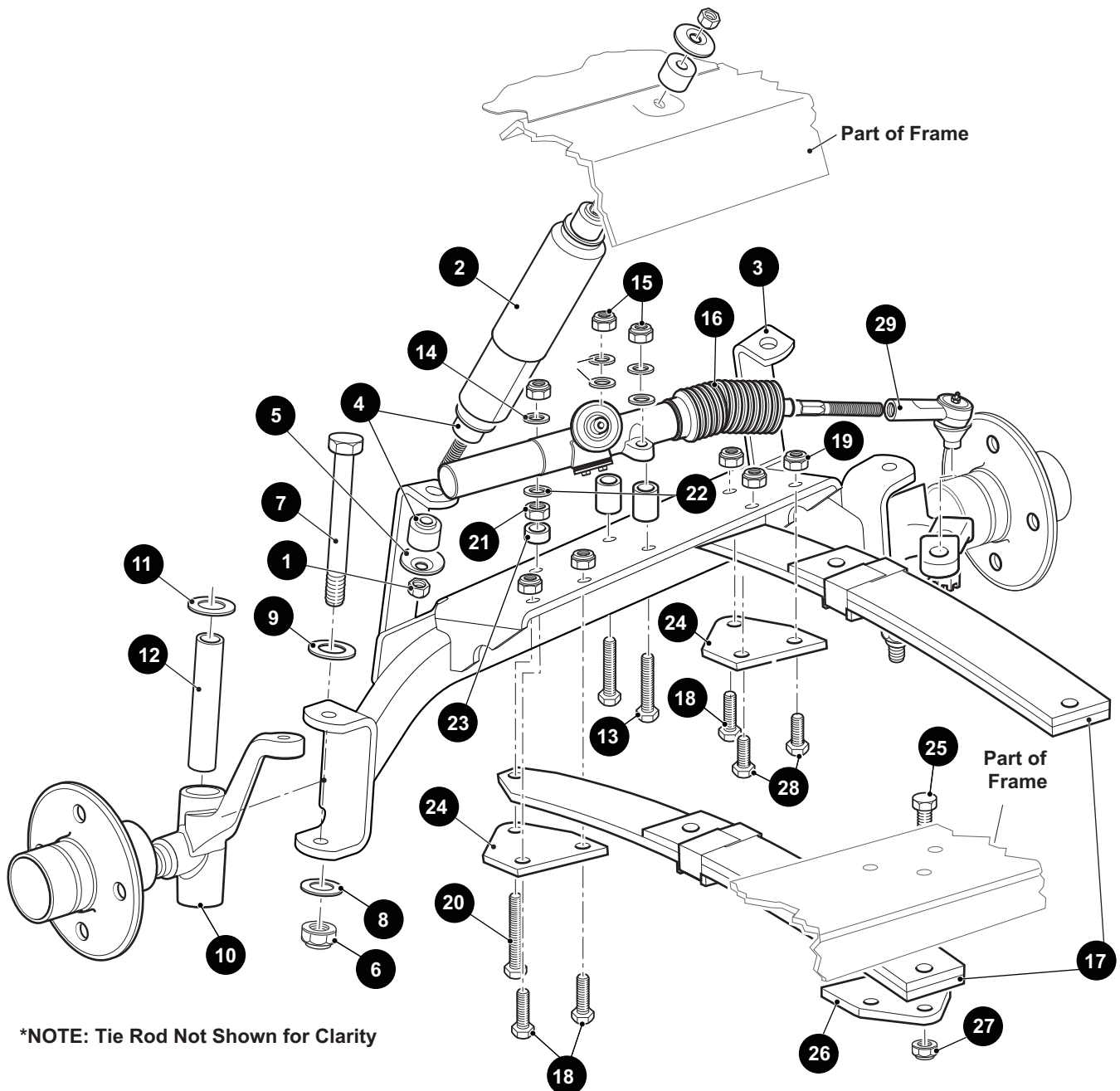


Fig. 6 Front Suspension Components

### Front Shock Absorber Replacement

#### Tool List

	Qty.
Wrench, 9/16" .....	1

Remove the nut (1) from the bottom of the shock absorber (2) at the front axle (3) (Ref Fig. 6).

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.



# FRONT SUSPENSION AND STEERING

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

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 Axle Replacement

Tool List	Qty.
Ratchet .....	1
Socket, 3/4" .....	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
Socket, 5/8" .....	1
Torque Wrench, 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.*

## NOTICE

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. 5 on Page E-4).

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-8). 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 SUSPENSION AND STEERING

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

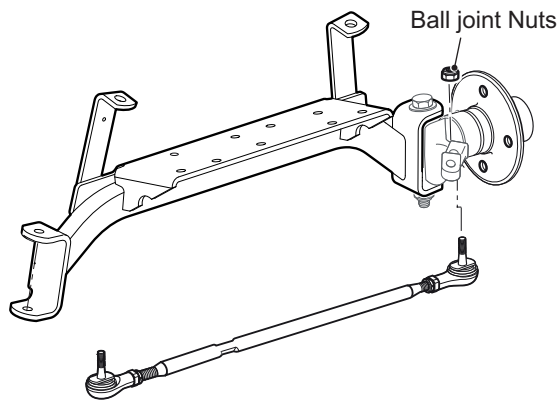


Fig. 7 Replacing Axle Linkage Rod

## Front Spring Replacement

### Tool List

	Qty.
Jack Stands.....	4
Ratchet.....	1
Socket, 3/4".....	1
Socket, 5/8".....	1
Wrench, 5/8".....	1
Torque Wrench ft. lbs. ....	1
Tape Measure.....	1

## NOTICE

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). (See 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.

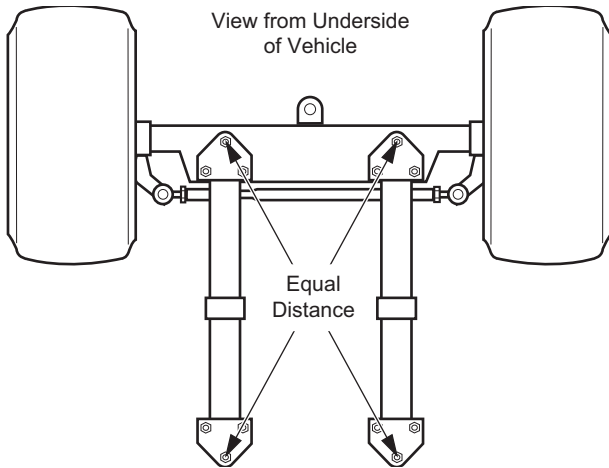
## NOTICE

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-8). 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.

# FRONT SUSPENSION AND STEERING

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



**Fig. 8 Front Axle Alignment**

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.
Socket, 3/4" .....	1
Ratchet .....	1
Straight Blade Screwdriver .....	1
Ball Peen Hammer .....	1
Needle Nose Pliers .....	1
Socket, 1 1/2" .....	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). While holding outer wheel bearing (4) in place, slide hub (5) from spindle (6) and discard.

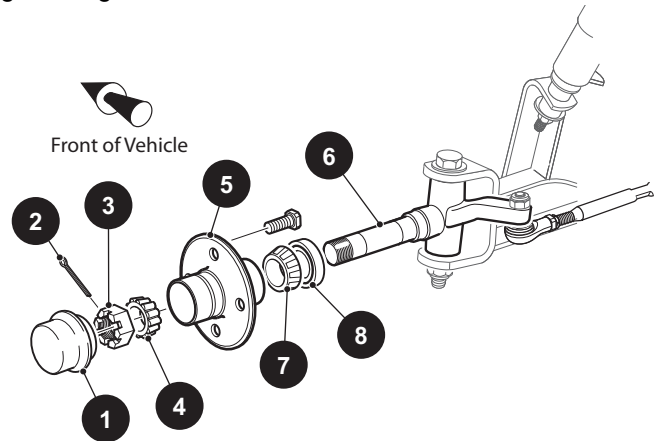
Clean spindle and new hub thoroughly with solvent.

Pack new bearings with grease. See "Wheel Bearing Packing" on page E-3.

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).

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.



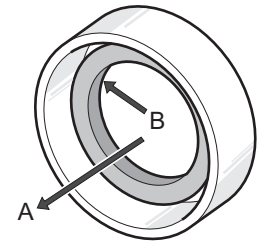
**Fig. 9 Replacing Hub**

Adjust bearing. "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.

- A - Install this side of seal into housing
- B - Lubricate lip of seal



**Fig. 10 Seal Installation**

## Wheel Bearing and Race Replacement

### Tool List

	Qty.
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".

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.

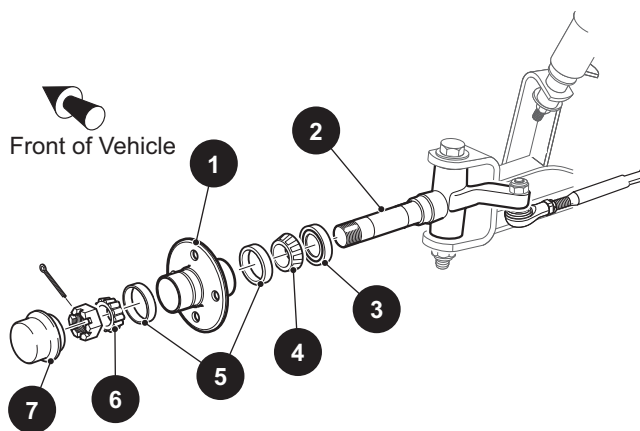
# FRONT SUSPENSION AND STEERING

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

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-3.



**Fig. 11 Replacing Wheel Bearing**

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.

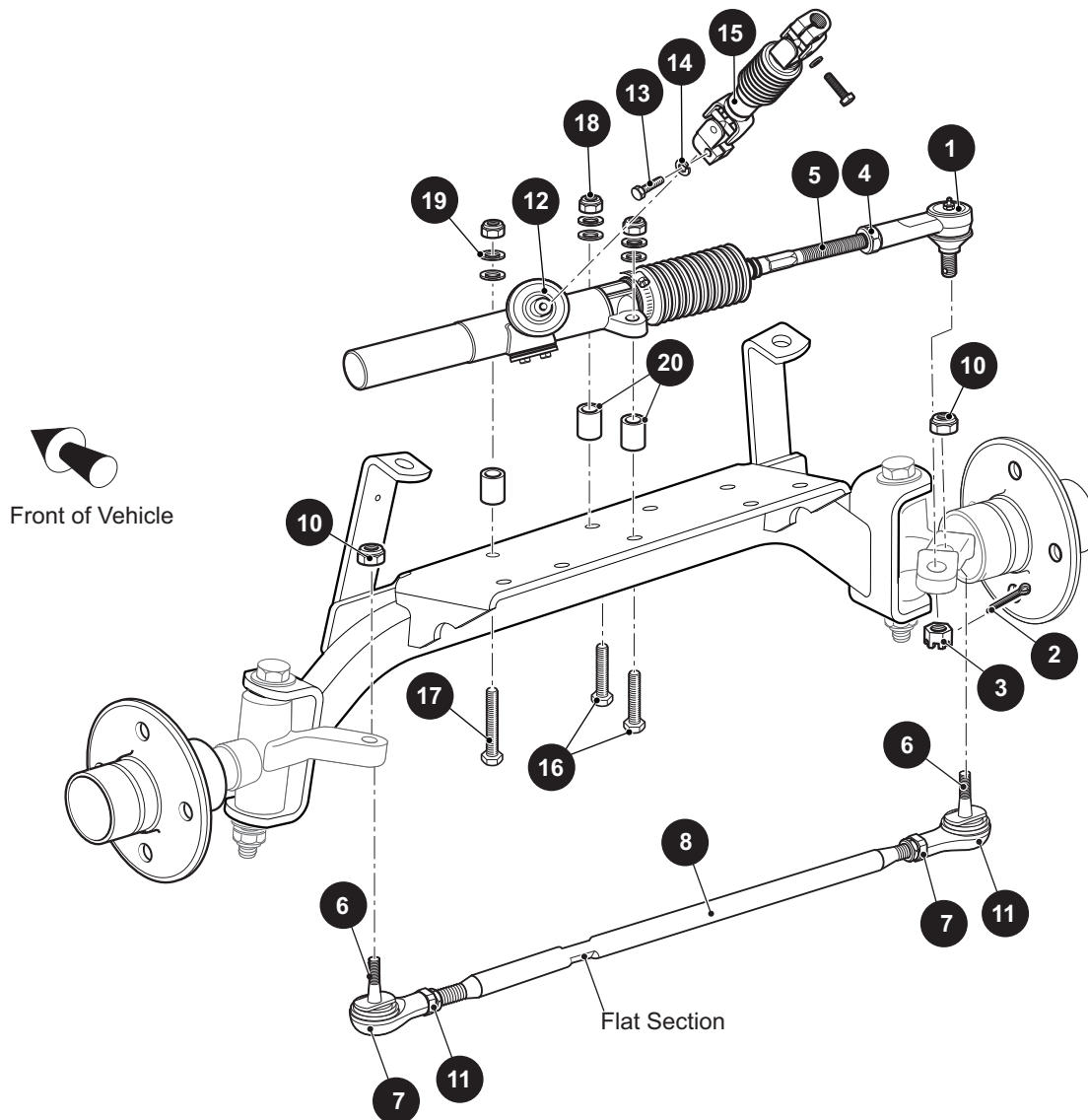
Replace the dust cap (7).

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 Notices, Cautions, Warnings and Dangers.

## STEERING



**Fig. 12 Steering Components**

### Rack Ball Joint Replacement

#### Tool List

	Qty.
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, ft. lbs.....	1
Socket, 11/16".....	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).

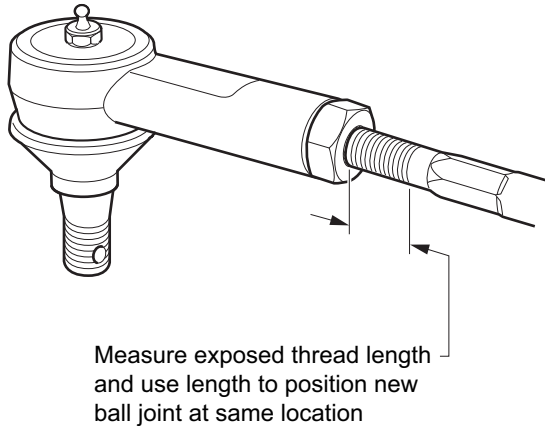
Remove passenger side front wheel and turn steering wheel fully to the left.

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.

# FRONT SUSPENSION AND STEERING

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

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



**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. 20 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.

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
Torque Wrench, ft. lbs. ....	1
Crowfoot Socket, 3/4" .....	1

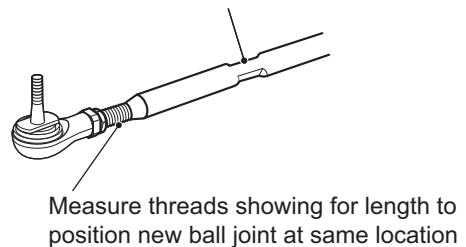
Grasp the tie rod (8) at ball joints (6) and check for any vertical motion which would indicate a worn condition and require replacement (Ref Fig. 12 on Page E-10).

To remove tie rod, loosen wheels 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).

Flat section towards end identifies end with left hand threads



**Fig. 14 Replacing Tie Rod**

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

## NOTICE

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

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).

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.

# FRONT SUSPENSION AND STEERING

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

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.

## NOTICE

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.
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, ft. lbs.....	1
Socket, 11/16".....	1

To replace bellows (1) (Ref Fig. 15), 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.

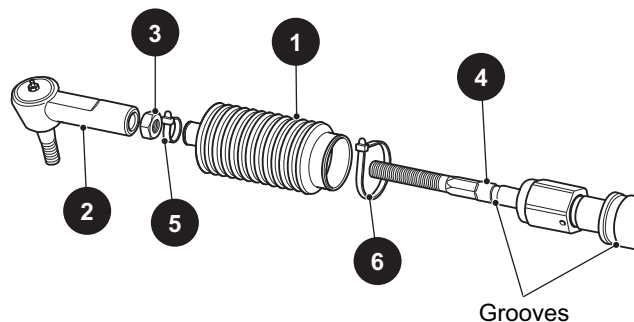


Fig. 15 Replacing Bellows

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.
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



## CAUTION

Secure rack and pinion unit in vice by the mounting ears



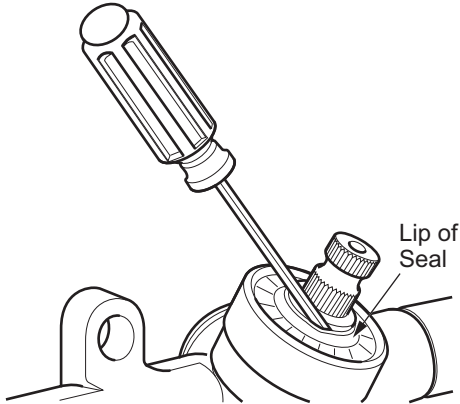
# FRONT SUSPENSION AND STEERING

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

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 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).



**Fig. 16 Replacing Pinion Seal**

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.

## NOTICE

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.
Needle Nose Pliers.....	1
Wrench, 11/16" .....	1
Ball Joint Separator .....	1
Plastic Faced Hammer .....	1
Wrench, 3/4" .....	1
Socket, 3/4" .....	1
Socket, 11/16" .....	1
Torque Wrench, 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.

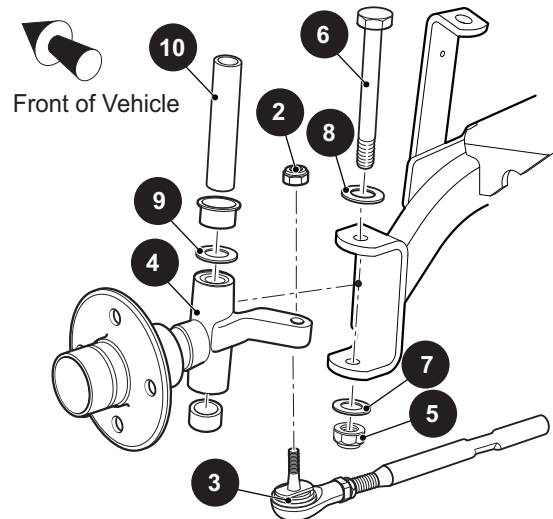
Loosen front wheel. Lift and support front of vehicle per SAFETY section and remove front wheel.

To remove tie rod, loosen lock nut (2) until tie rod ball joint (3) threads are protected (Ref Fig. 17). 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.



**Fig. 17 Replacing Spindle**

# FRONT SUSPENSION AND STEERING

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

## NOTICE

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.

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.

Vice.....	1
Socket, 3/8" .....	1
Ratchet .....	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

## NOTICE

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. 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. 18). 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 - 13 Remove internal retaining ring (11) from rack and pinion unit and pull out pinion (4) and ball bearing (12) as an assembly.

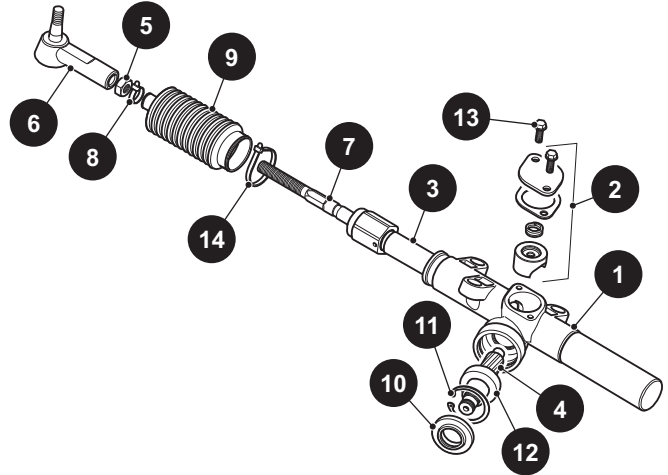


Fig. 18 Disassembling of Rack and Pinion Unit

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 -13. 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 pinion 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. (11 - 14 Nm) 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.



# FRONT SUSPENSION AND STEERING

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



## 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.
Socket, 13 mm .....	1
Ratchet .....	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
Ratchet .....	1
Torque Wrench, ft. lbs. ....	1
Socket, 11/16" .....	1
Torque Wrench, in. lbs.....	1

To remove rack and pinion unit (12) (Ref Fig. 12), 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. (18 - 24 Nm) 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

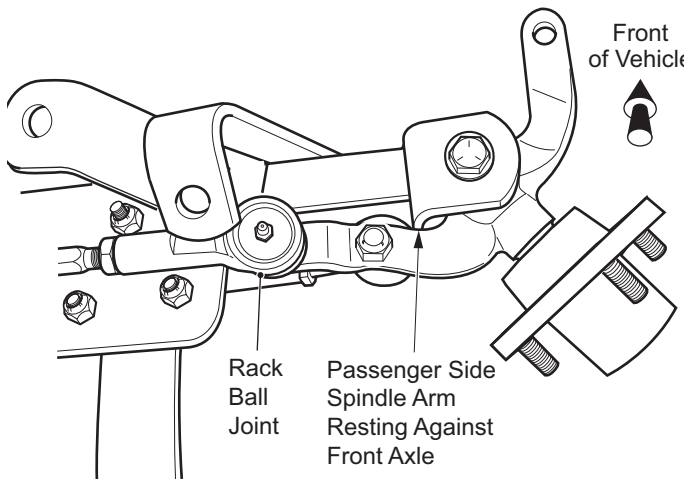
Tool List	Qty.
Wrench, 11/16" .....	1
Wrench, 3/4" .....	1
Wrench, 1/2" .....	1
Wire Cutter.....	1
Washer, 1/8" Thick.....	1
Crowfoot Socket, 3/4" .....	1
Torque Wrench, ft. lbs. ....	1
Wire Tie, 10" long .....	1

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. 19 on page E-16). If it does not, all adjustment is made at the rack ball joint (6) (Ref Fig. 32). Loosen jam nut (5) at rack ball joint and use wrench to thread shaft of rack extension (7) further

# FRONT SUSPENSION AND STEERING

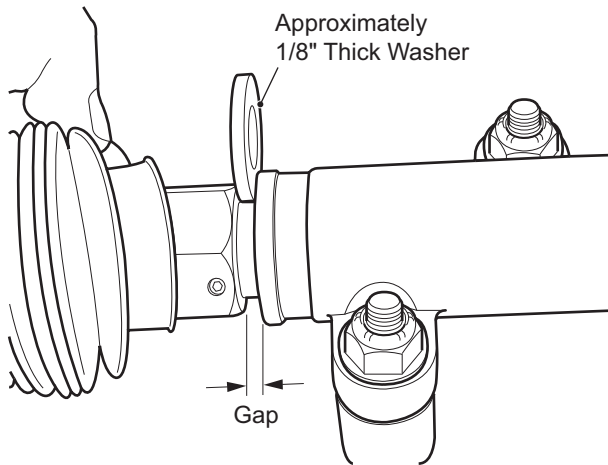
Read all of Section B and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.

into rack ball joint. This will provide more travel for the steering wheel to be turned to the right.



**Fig. 19 Spindle Contact with Front Axle**

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.



**Fig. 20 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.
Socket, 15/16" .....	1
Ratchet, 1/2" drive .....	1
Plastic Faced Hammer .....	1
Ball Peen Hammer.....	1
Anti-seize Compound .....	1
Torque Wrench, ft. lbs.....	1

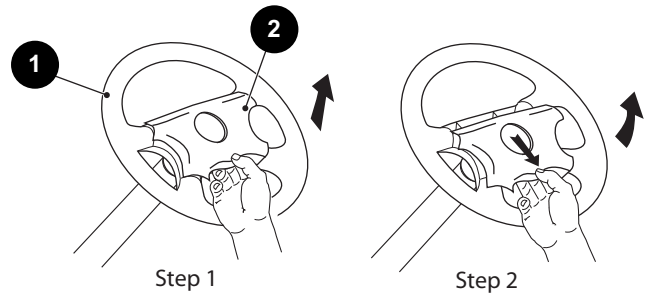
### NOTICE

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

### CAUTION

To prevent damage to the Wheel cover, 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 (1), remove the wheel cover (2) by first pulling straight up on the bottom of the hub cover 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 steering wheel cover retaining tabs (Ref Fig. 21).



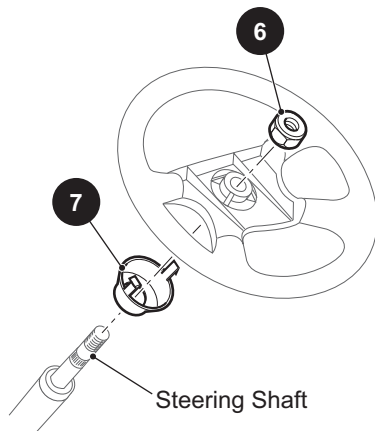
**Fig. 21 Removing Steering Wheel Cover**

Loosen the steering wheel retaining nut (3) two to three turns. 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

# FRONT SUSPENSION AND STEERING

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

Loosen the steering wheel retaining nut (6) two to three turns (Ref Fig. 22). 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. 22 Replacing Steering Wheel**



## CAUTION

Do not strike steering nut or end of steering shaft directly with ball peen 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 steering wheel cover (5) for white stress lines (Ref Fig. 21). 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.
Ratchet .....	1
Socket, 3/4" .....	1
Socket, 13 mm.....	1
Ratchet .....	1
Socket, 9/16" .....	1
Snap Ring Pliers.....	1
Bearing Separator.....	1
Gear Puller.....	1
Arbor Press.....	1
Bearing Driver Set .....	1
Torque Wrench, ft. lbs. ....	1
Torque Wrench, in. lbs. ....	1
Wheel Bearing Grease .....	AR

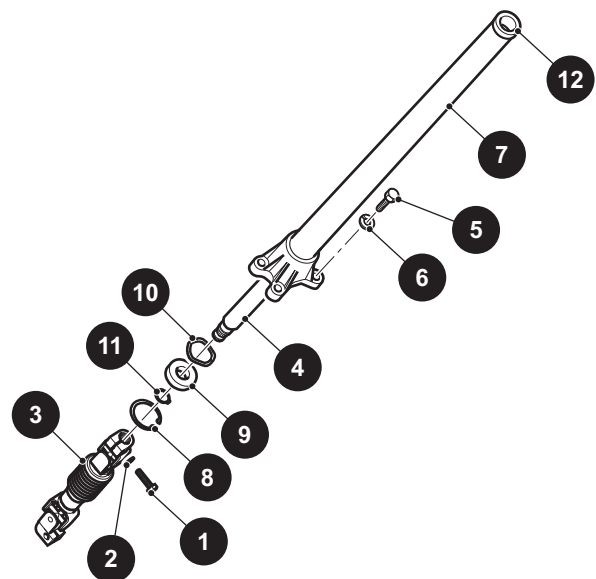
To remove steering shaft (4) (Ref Fig. 23), remove the steering wheel. See "Steering Wheel Replacement" on page E-16.

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).

### Steering Shaft

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



**Fig. 23 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

# FRONT SUSPENSION AND STEERING

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

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. 24). Use fingers to push retaining ring fully into groove.

Slide wave washer into base of steering column.

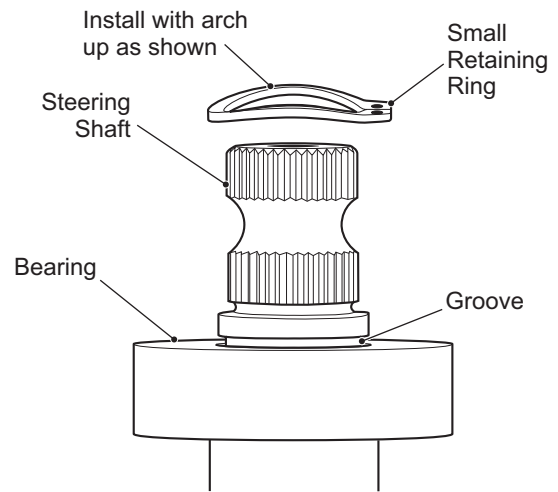
To install steering shaft and bearing assembly, apply wheel bearing grease to lip of seal in bushing (12) at top of column and press steering shaft and bearing assembly into column base. Secure with large retaining ring making sure it is fully seated in groove of column.

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. (17 - 25 Nm) 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.



**Fig. 24 Small Retaining Ring Orientation**

## FRONT SUSPENSION AND STEERING

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

## NOTES:

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## FRONT SUSPENSION AND STEERING

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

## NOTES:

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## ELECTRONIC SPEED CONTROL

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

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Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notices, Cautions, Dangers 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).

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’.)

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.

# ELECTRONIC SPEED CONTROL

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

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

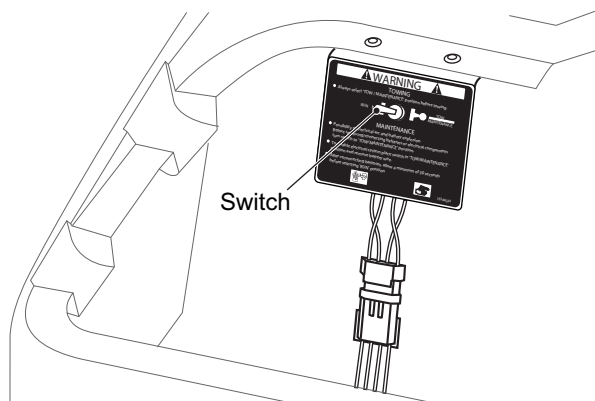


Fig. 1 Run-Tow/Maintenance Switch

## 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

## NOTICE

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. 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 braking 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

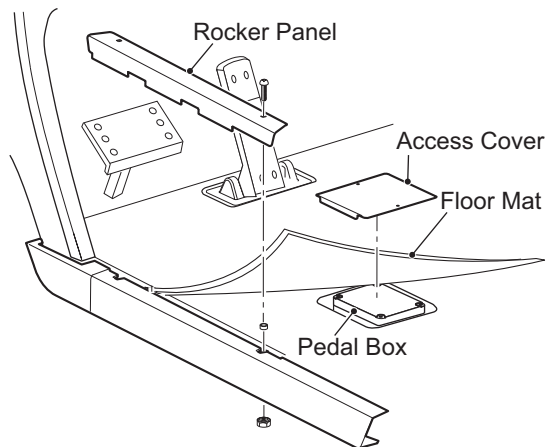
*Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notices, Cautions, Dangers and Warnings.*

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). The ITS and plunger are accessed by removing the four screws and top cover from the enclosed pedal box.



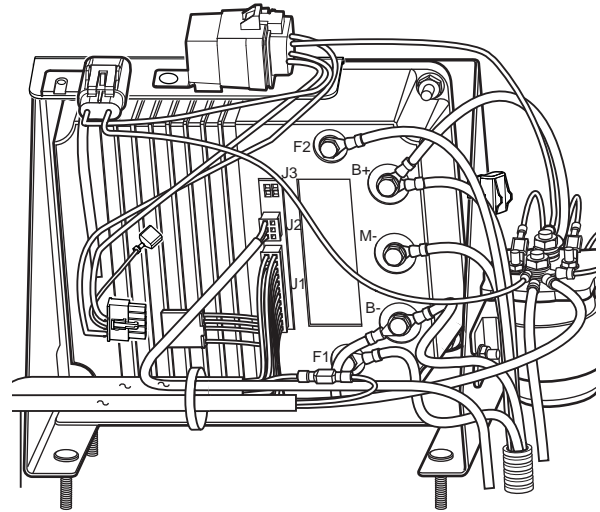
**Fig. 2 Access to Pedal Box**

## 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)



**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-8).

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

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

## GENERAL TROUBLESHOOTING

Tool List	Qty.
Floor Jack .....	1
Jack Stands .....	2
Wheel Chocks .....	4
Jumper Wire (with Alligator Clips) .....	1
DVOM .....	1
Socket .....	1
Ratchet .....	1
Torque Wrench, in. lbs. ....	1
Torque Wrench, ft. lbs. ....	1
Extension, 6" .....	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-7), 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 27481G01. 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.

## WARNING

*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-5). 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.



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

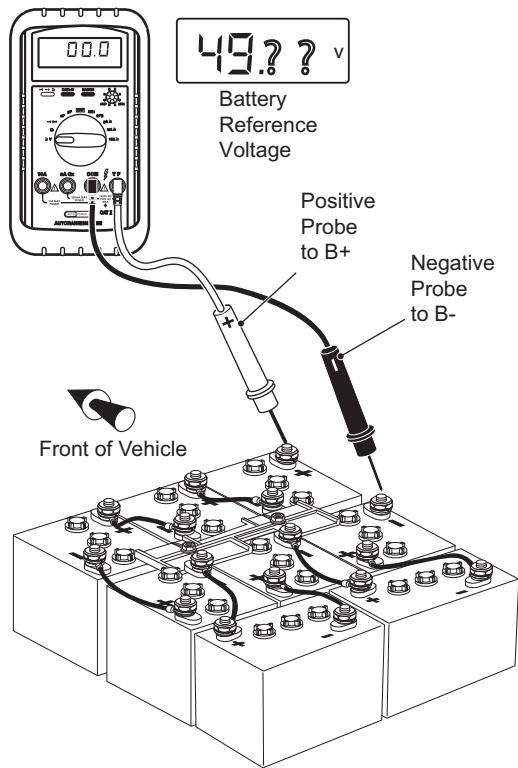


Fig. 4 Battery Reference Voltage

## 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 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. 5).

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.

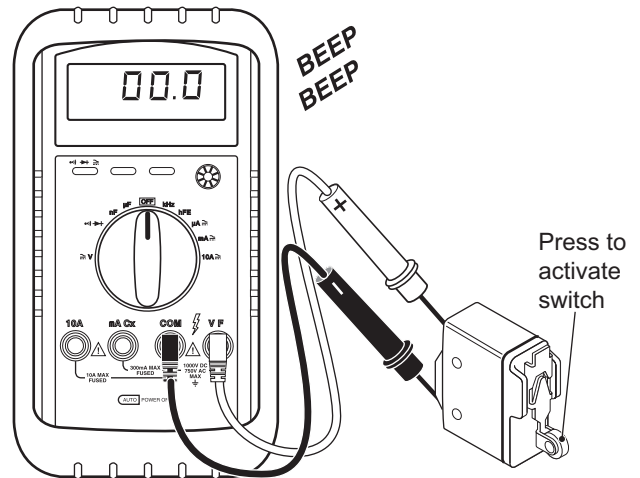


Fig. 5 Continuity Check of Switch

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

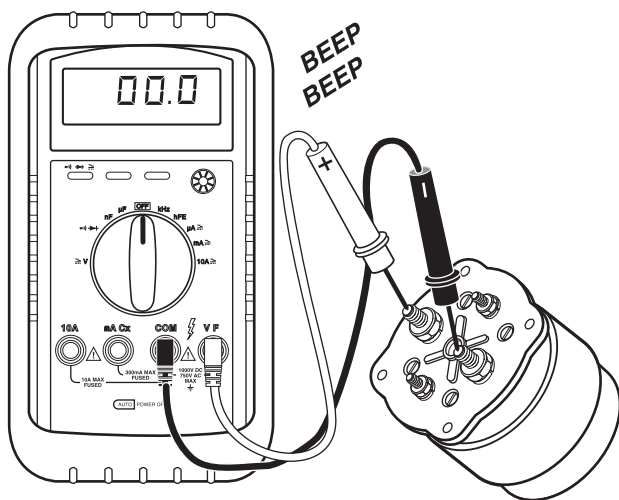
## Testing a Solenoid for Continuity

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

# ELECTRONIC SPEED CONTROL

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

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. 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-9). The following 6 flow charts will assist in diagnosing and correcting problems not diagnosed through the Fault Codes.

# ELECTRONIC SPEED CONTROL

Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notices, Cautions, Dangers 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>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	Aux coil fault	Vehicle will not run	<ul style="list-style-type: none"> <li>Check Walkaway relay wiring</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	Aux driver off	Vehicle will not run	<ul style="list-style-type: none"> <li>Check Walkaway relay wiring; Replace controller</li> </ul>
4 - 1	Current sense fault	Vehicle will not run	<ul style="list-style-type: none"> <li>Replace controller</li> </ul>

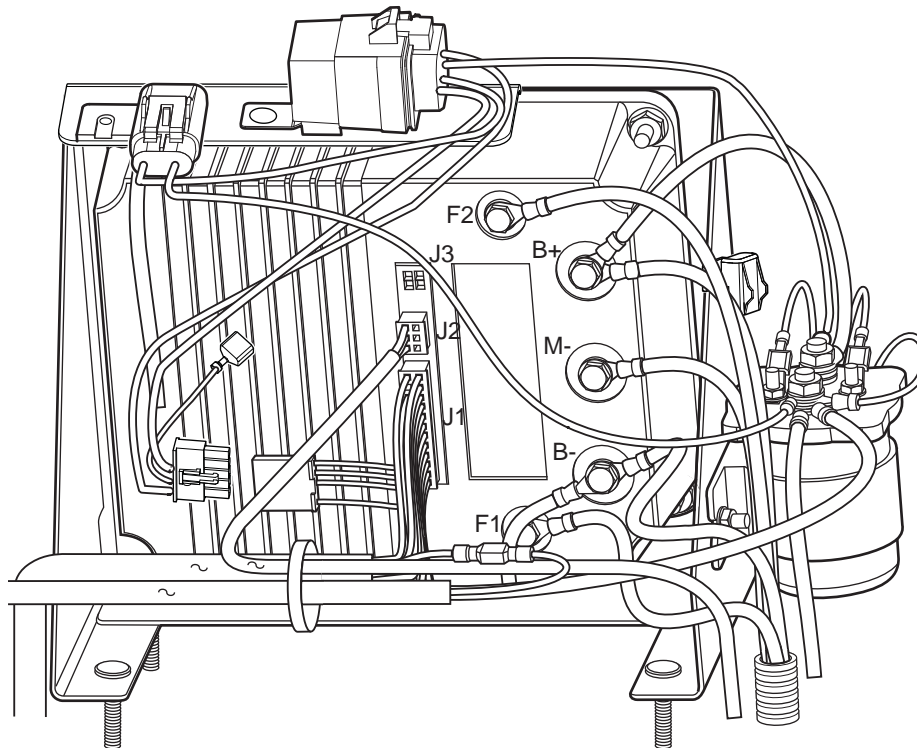
**Fig. 7 48 volt Fault Codes**

# ELECTRONIC SPEED CONTROL

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

4 - 3	M- fault	Vehicle will not run	• Check M- wiring and repair; Replace controller
4 - 4	Auxiliary contact did not close	Vehicle will not run	• Replace controller
4 - 5	Welded auxiliary contact	Vehicle runs slowly	• Replace controller
5 - 1	Keyswitch SRO	Vehicle will not run	• Check keyswitch wiring; Replace keyswitch
5 - 2	Main coil open	Vehicle will not run	• Check coil connections/wiring; Replace solenoid if necessary
5 - 3	Aux driver on	Vehicle will not run	• Check walkaway relay wiring; Replace controller
5 - 5	Missing contactor	Vehicle stops	• Check all solenoid wiring; Replace solenoid if necessary

**Fig. 7 48 volt Fault Codes Continued**



**Fig. 8 Controller Connectors and Connections**



# ELECTRONIC SPEED CONTROL

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

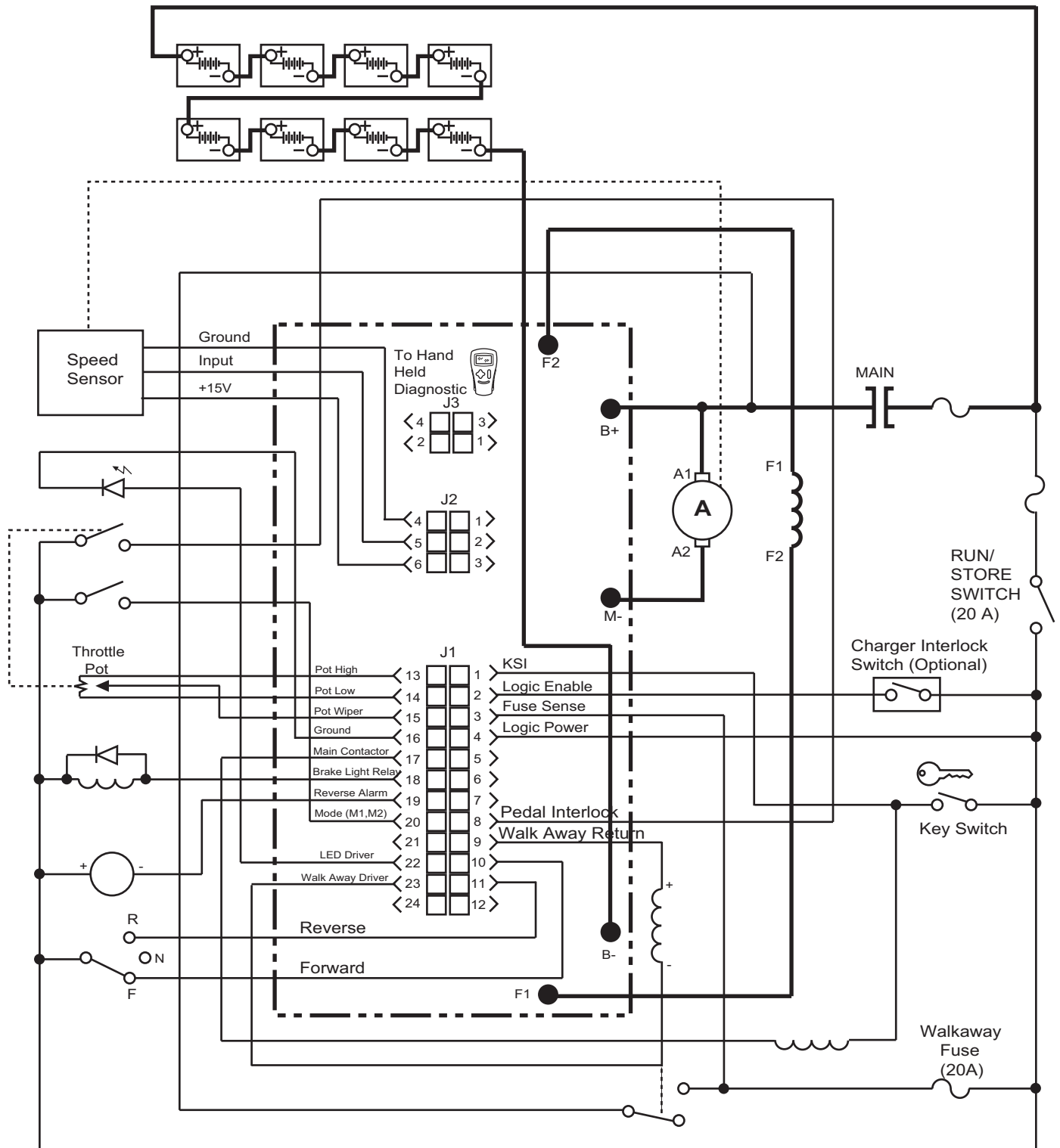


Fig. 9 48 Volt Wiring Diagram

# ELECTRONIC SPEED CONTROL

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

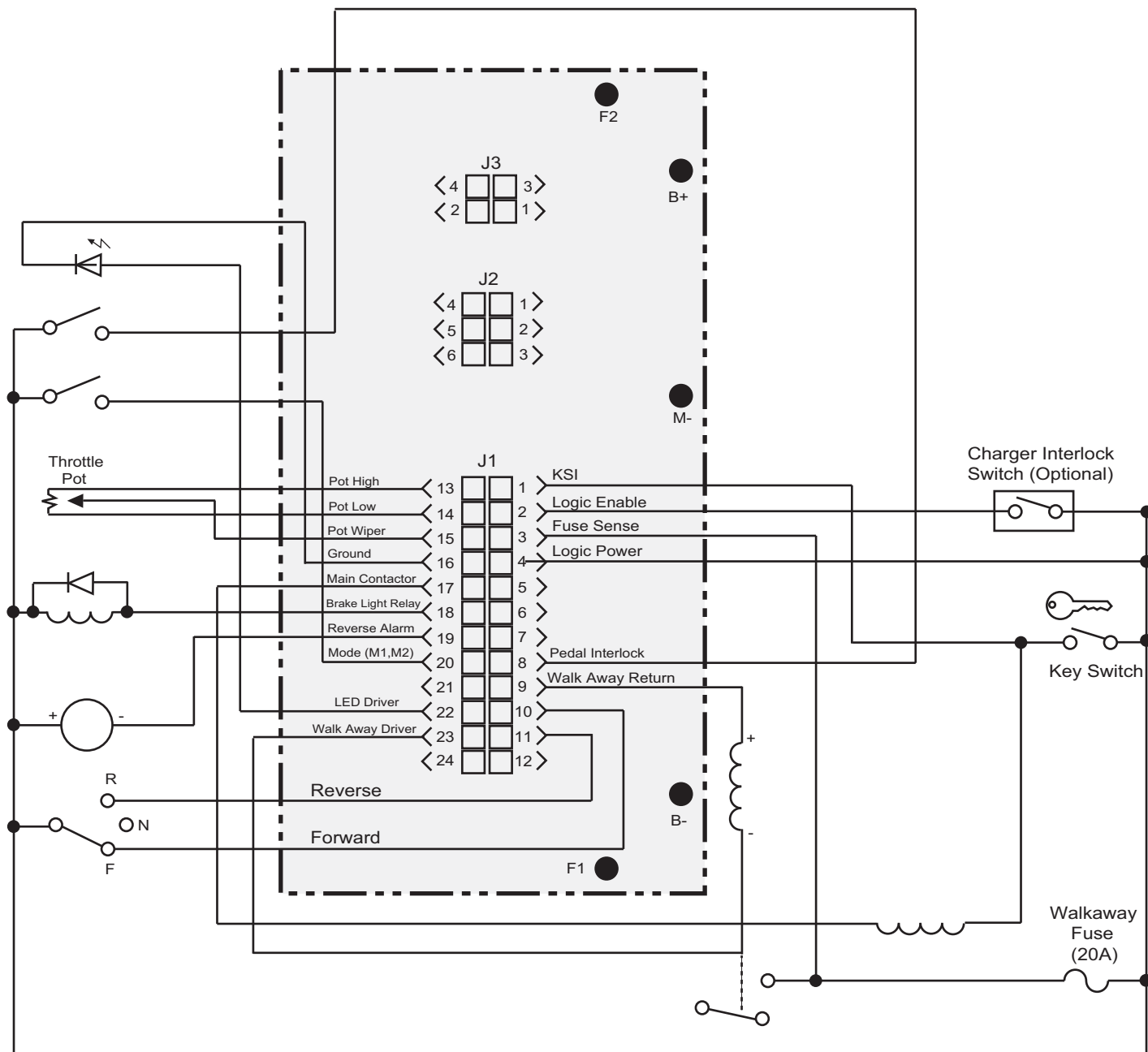


Fig. 10 J-1 Pin Connector Diagnostics

# ELECTRONIC SPEED CONTROL

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

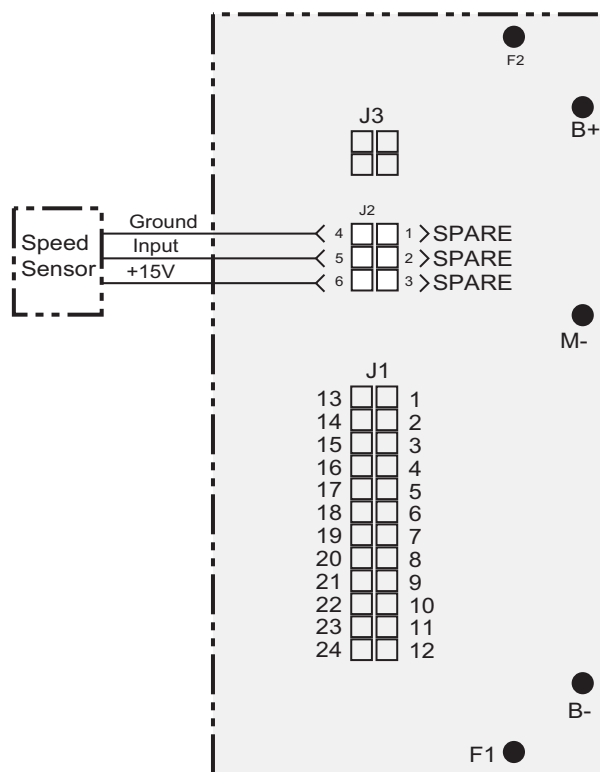
**Make certain all pin connections are firmly seated.**

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

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

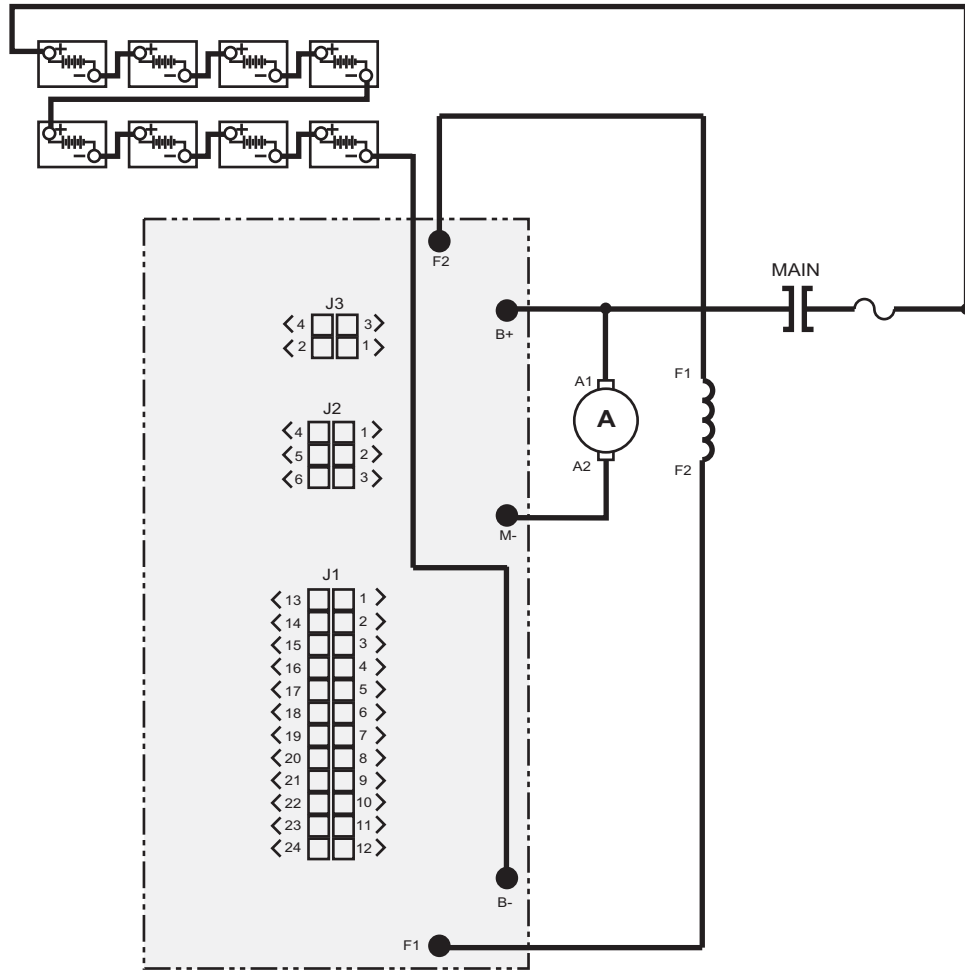
Armature will need to be rotated for this test. Jack vehicle up on the passenger side and rotate the rear wheel by hand

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

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

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

## INDUCTIVE THROTTLE SENSOR (ITS) TESTING AND REPLACEMENT

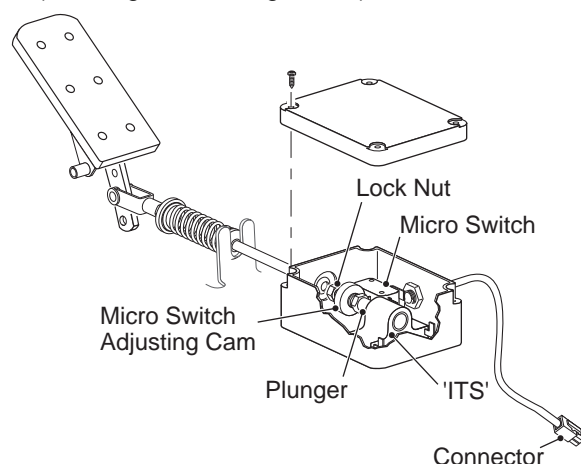
### Tool List

### Qty.

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-14).



**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-16). 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 over-tighten 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.

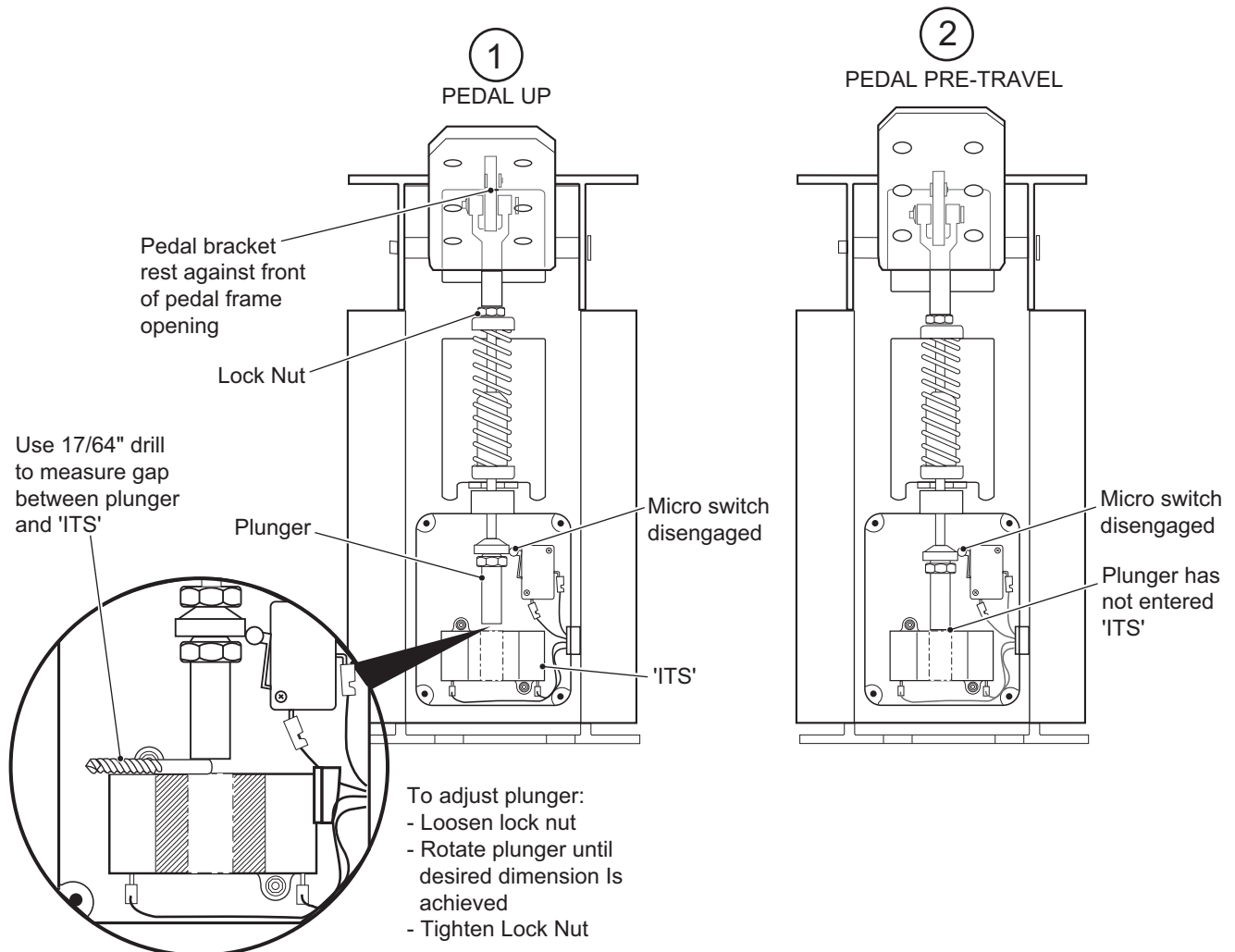
With the accelerator pedal in the full up position, insert a 7/32" drill bit between the plunger and the face of the ITS. The drill bit should be used to verify and adjust the distance between the face of the ITS and the face of the plunger (Ref. Fig. 15 on Page F-15). **If the plunger needs adjustment**, 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.

# ELECTRONIC SPEED CONTROL

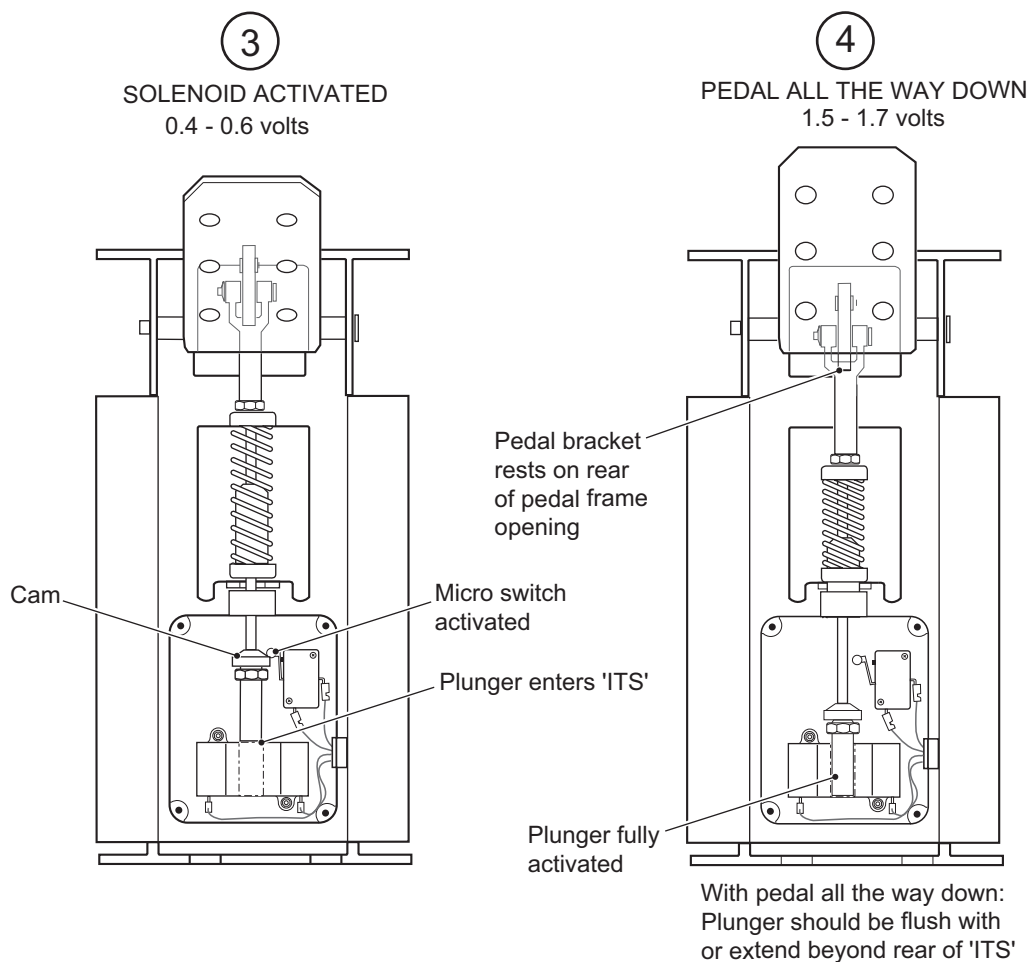
Read all of Section B and this section before attempting any procedure. Pay particular attention to all Notices, Cautions, Dangers and Warnings.



**Fig. 15 ITS Adjustment (Sheet 1 of 2)**

# ELECTRONIC SPEED CONTROL

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



**Fig. 16 ITS Adjustment (Sheet 2 of 2)**



# ELECTRONIC SPEED CONTROL

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

## CONTROLLER REPLACEMENT

Tool List	Qty.
Socket, 10mm .....	1
Socket, 7/16" .....	1
Socket, 13mm .....	1
Ratchet .....	1
Extension, 6" .....	1
Insulated Wrench, 9/16" .....	1
Shop Towel .....	1
Torque Wrench, in. lbs. ....	1
Torque Wrench, 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.

### NOTICE

Note the location of the wiring on the controller before removing wiring from controller. (Ref. Fig. 17 on Page F-18)

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.
Socket, 3/8" .....	1
Socket, 7/16" .....	1
Socket, 1/2" .....	1
Ratchet .....	1
Extension, 6" .....	1
Insulated Wrench, 9/16" .....	1
Shop Towel .....	1
Torque Wrench, 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.

### NOTICE

Note the location of the wiring on the solenoid before removing wiring from solenoid (Ref. Fig. 17 on Page F-18)

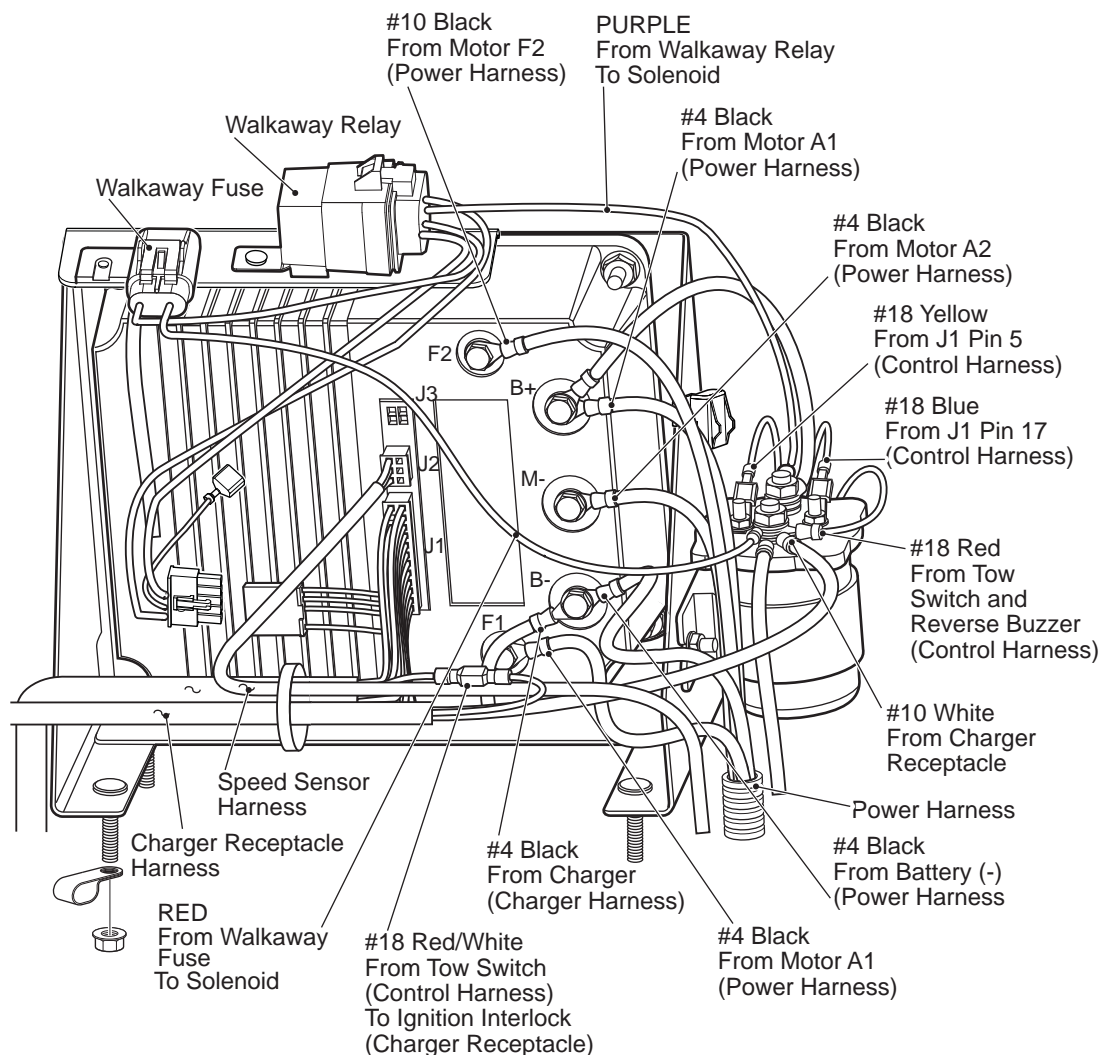
Remove the solenoid mounting bolts and remove the solenoid.

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

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



**Fig. 17 Controller Wiring**

## ELECTRONIC SPEED CONTROL

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

NOTES:

This image shows a full page of blank graph paper. The grid consists of small, equal-sized squares formed by thin gray lines. There are 20 columns and 20 rows of squares, creating a total area of 400 square units. The grid is perfectly aligned and covers the entire page without any margins or additional markings.

# ELECTRONIC SPEED CONTROL

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

NOTES:

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# MOTOR

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

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

## 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.

Insulated Wrench, 9/16" .....	1
Chalk or Paint pen .....	1
Socket, 7/16" .....	1
Ratchet .....	1
Internal Snap Ring Pliers.....	1

Using an insulated wrench, disconnect the negative (-) battery cable from the battery (Ref. Fig. 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).



### 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.

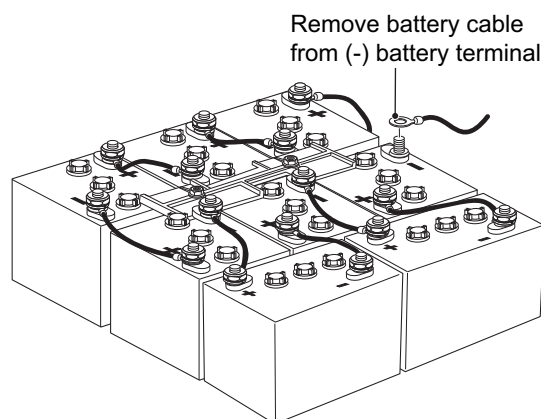


Fig. 1 Disconnecting Battery Cable

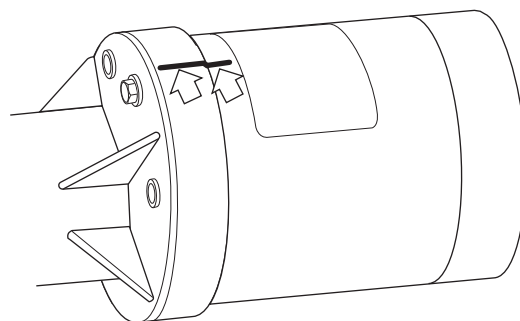


Fig. 2 Marking Axle and Motor

### Motor Disassembly

#### Tool List

#### Qty.

Straight Blade Screwdriver .....	1
Ratchet .....	1
Socket.....	1
Plastic Faced Hammer .....	1

Remove bearing cap (1) (Ref. Fig. 3 on Page 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.

# MOTOR

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

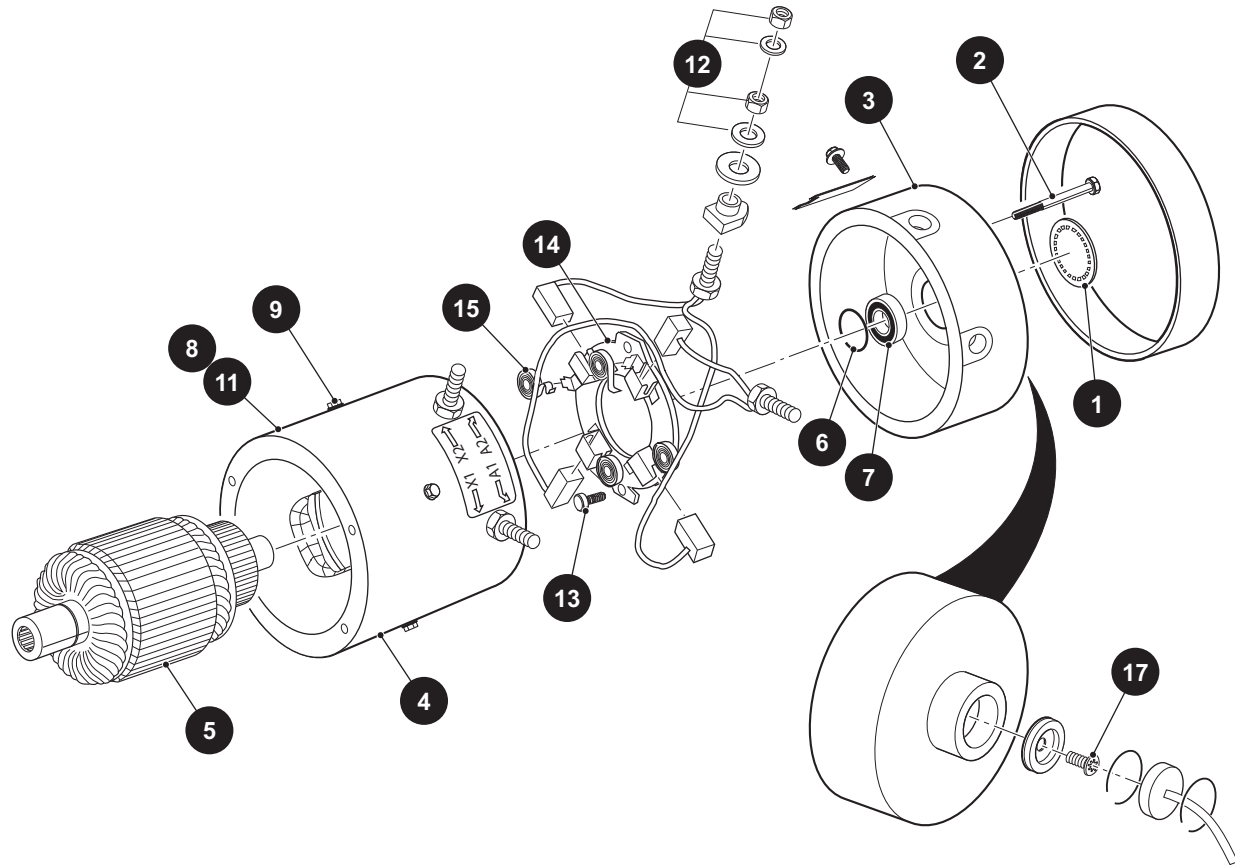


Fig. 3 Motor Components

## Bearing Replacement

### Tool List

	Qty.
Heat Gun or Lamp .....	1
Arbor Press.....	1
Bearing Driver Set .....	1
Snap Ring Pliers.....	1

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-3).

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



## 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.



## 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.

## NOTICE

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.



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



## 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.
Wrench, 1/2" .....	1
Ratchet .....	1
Socket, 1/2" .....	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.
Wrench, 1/2" .....	1
Ratchet .....	1
Socket, 5/16" .....	1

Brushes should be measured as shown and replaced when the minimum dimension of 0.62" (16 mm) is reached (Ref. Fig. 4).

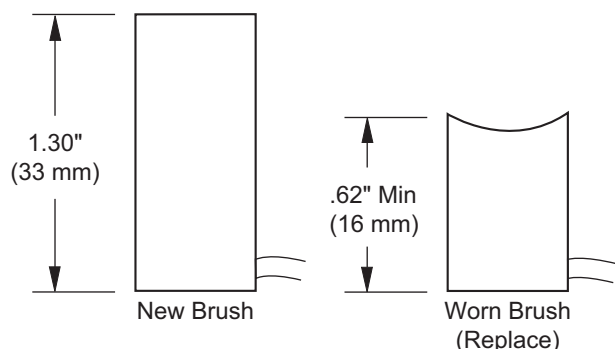


Fig. 4 Brush Wear

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

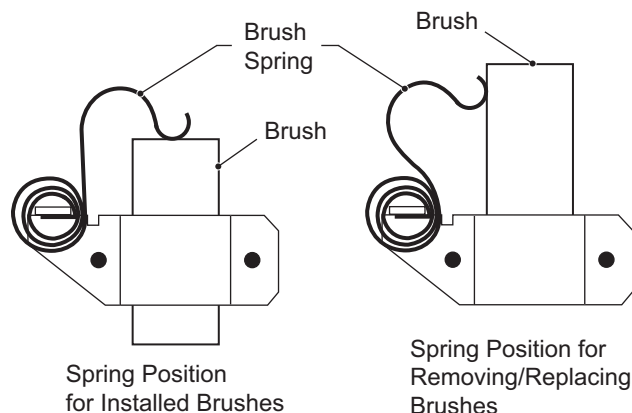


Fig. 5 Securing Brushes

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.
Socket, 3/8" .....	1
Torque Wrench, in. lbs. ....	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. 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

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

## 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.

Socket, 7/16" ..... 1  
Torque Wrench, in. lbs. .... 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). Tighten the nuts to 66 in. lbs. (7 Nm) torque.

### 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. 6 48V Motor Wiring**

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 Notices, Cautions, Warnings and Dangers.**

NOTES:

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# MOTOR

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

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## BATTERIES AND CHARGING

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

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# BATTERIES AND CHARGING

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

## SAFETY

### NOTICE

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

### ! WARNING

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.
Insulated Wrench, 9/16" .....	1
Battery Carrier .....	1
Hydrometer .....	1
Battery Maintenance Kit P/N 25587G01 .....	1
Battery Protective Spray .....	1

# BATTERIES AND CHARGING

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

## At Each Charging Cycle

### ! WARNING

To reduce the possibility of fire, never attach a battery charger to a vehicle that is to be unattended beyond the normal charging cycle. Overcharging 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).

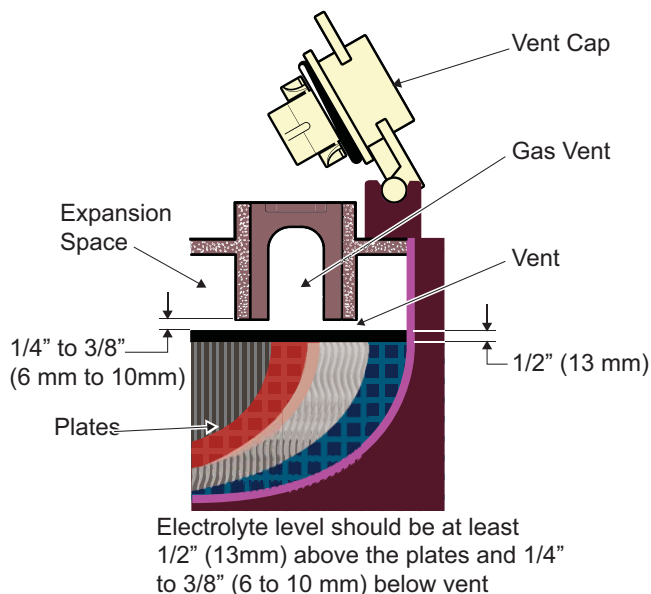


Fig. 1 Correct Electrolyte Level

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).

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.

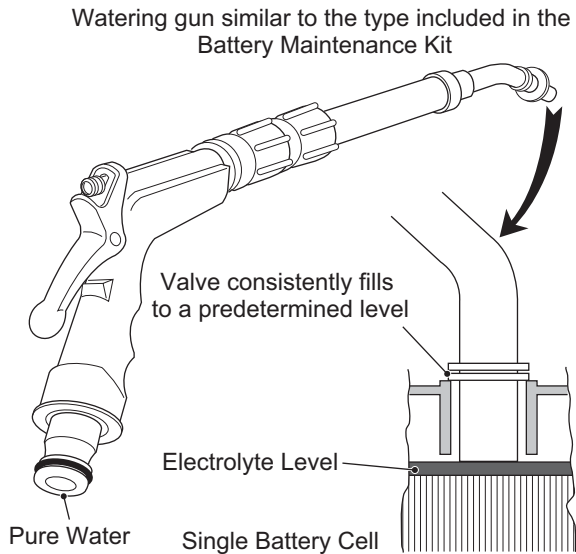
Automatic watering devices such as the one included in the Battery Maintenance Kit (P/N 25587G01) can be used with an approved water source (Ref. Fig. 3 on Page H-3). These watering devices are **fast and accu-**



# BATTERIES AND CHARGING

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

**rate** to use and maintain the correct electrolyte level within the battery cells.



**Fig. 3 Automatic Watering Gun**

## NOTICE

The watering device should only be used if the electrolyte level is less than 1/2" (13 mm) 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).

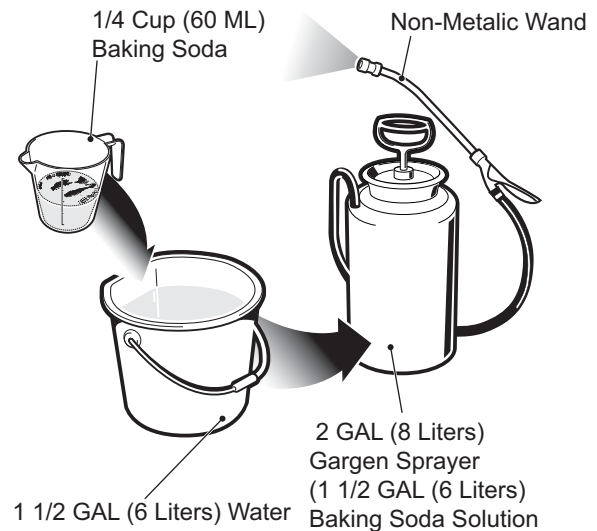
When cleaning the outside of the batteries and terminals, do not use a water hose without first spraying with a solution of sodium bicarbonate (baking soda) and water to neutralize any acid deposits.

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 bicarbonate (baking soda) and water. This solution is best applied with a garden type sprayer equipped with a **non metallic spray wand**. The solution should consist of 1/4 cup (60 ml) of sodium bicarbonate (baking soda) mixed with 1 1/2 gallons (6 liters) of clear water (Ref. Fig. 4). 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 25587G01).

Cleaning should take place once a month or more often under extreme conditions.

### Battery Replacement

## CAUTION

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

# BATTERIES AND CHARGING

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

*If a power wire (battery, motor or controller) is disconnected for any reason on the TCT 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 corrosion 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.

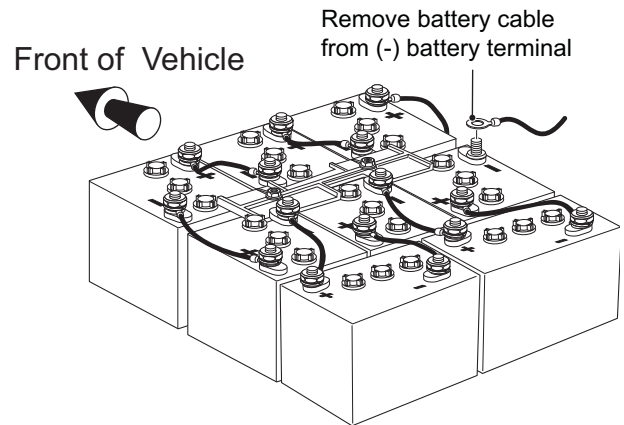
The batteries should be placed into the battery racks and the battery hold downs tightened to 45 - 55 in. lbs. (5 - 6 Nm) torque, to prevent movement but not tight enough to cause distortion of the battery cases.

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.

## ! WARNING

*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). Ensure that all battery terminals are installed with crimp up. Tighten the battery post hardware to 90 - 100 in. lbs. (6 - 8 Nm) torque. Do not over-torque the terminal stud nut, this will cause a "mushroom" effect on the battery post which will prevent the terminal nut from being properly tightened. Protect the battery terminals and battery wire terminals with a commercially available protective coating



**Fig. 5 Battery Connections**

## Prolonged Storage

### ! CAUTION

*Battery charger, 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 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 bat-

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

tery case to prevent self discharge. The batteries should be tested or recharged at thirty day minimum intervals

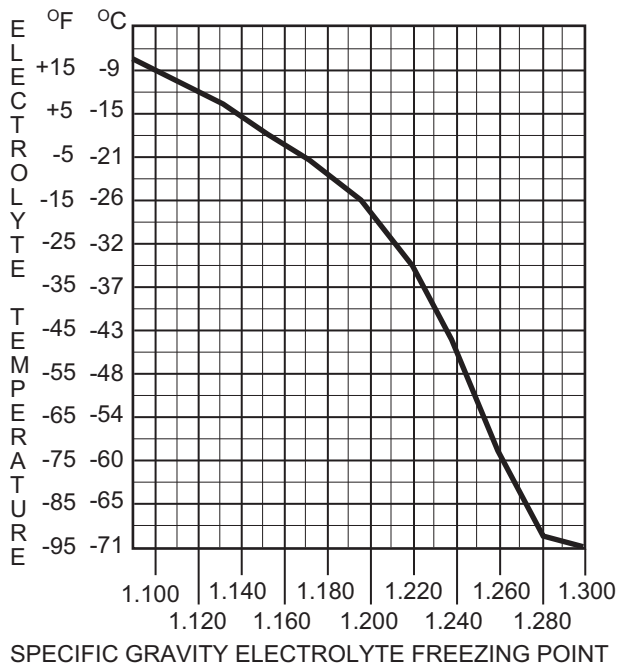


Fig. 6 Freezing Point of Electrolyte

## 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.

## NOTICE

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 manufacturers 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

# BATTERIES AND CHARGING

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

replaced with a good battery of the same brand, type and approximate age.

## Hydrometer

A hydrometer (P/N 50900G1) is used to test the state of charge of a battery cell (Ref. Fig. 7). 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.

## ! WARNING

*To prevent 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.*

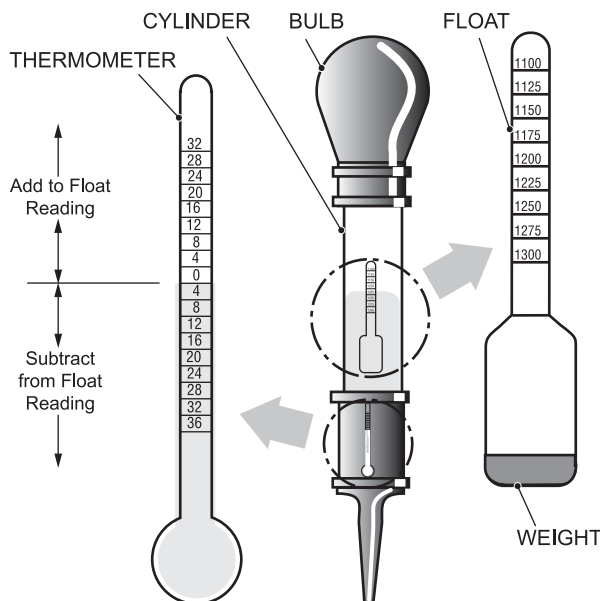


Fig. 7 Hydrometer

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.

## NOTICE

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

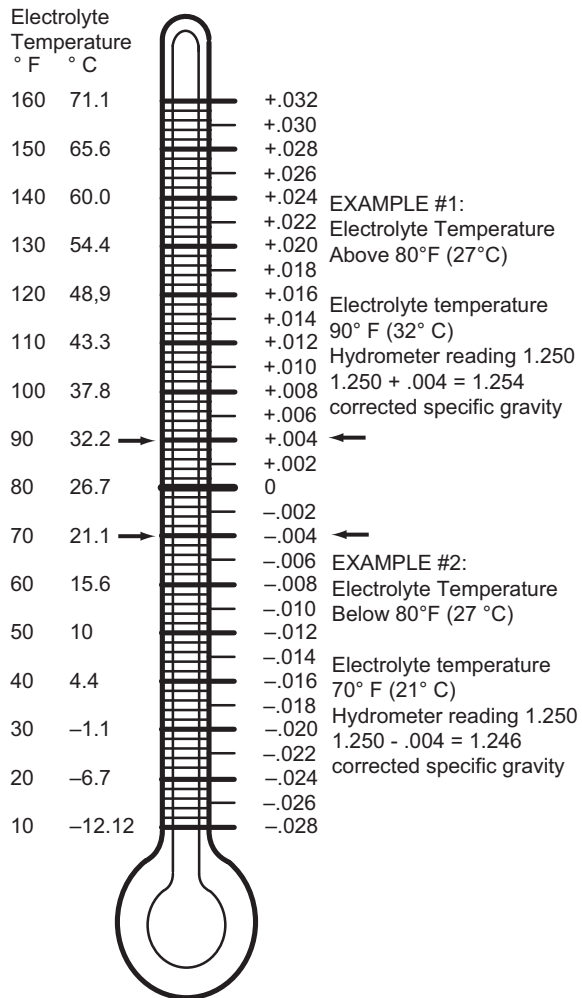
1. Draw electrolyte into the hydrometer several times to permit the thermometer to adjust to the electrolyte temperature and note the reading. Examine the color of the electrolyte. A brown or gray coloration indicates a problem with the battery and is a sign that the battery is nearing the end of its 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

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

and replaced with a good battery of the same brand, type and approximate age.



**Fig. 8 Hydrometer Temperature Correction**

# BATTERIES AND CHARGING

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

## NOTES:

This image shows a full page of blank graph paper. The grid consists of thin, light gray horizontal and vertical lines that intersect to form small squares across the entire surface. There are no margins, text, or other markings on the paper.

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## ELECTRICAL SYSTEM

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

## Notes:

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

## DIGITAL VOLT OHM METER

A typical DVOM (digital volt ohm meter) is shown (Ref. Fig. 1 on Page J-1). A recommended model is available through the Service Parts Department as P/N 27481G01. 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.

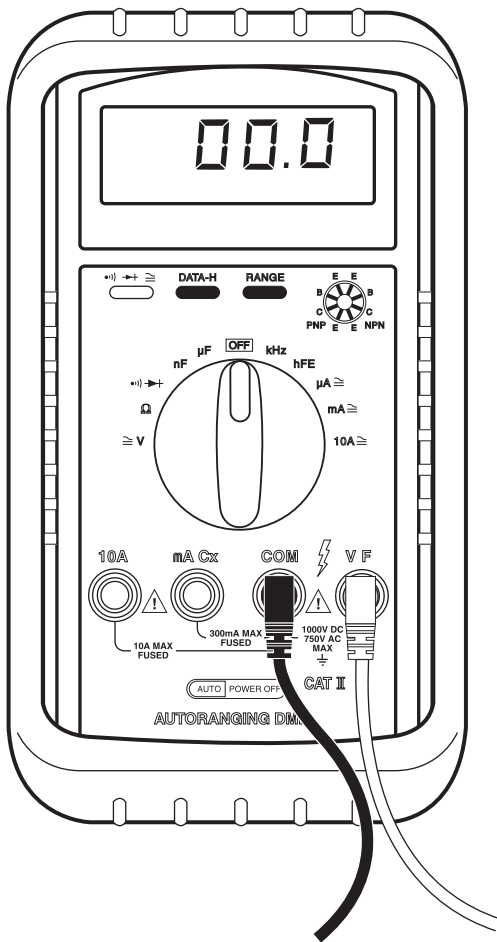


Fig. 1 DVOM

## 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 voltage or a signal from its origination point to its destination (Ref. Fig. 2 on Page J-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.

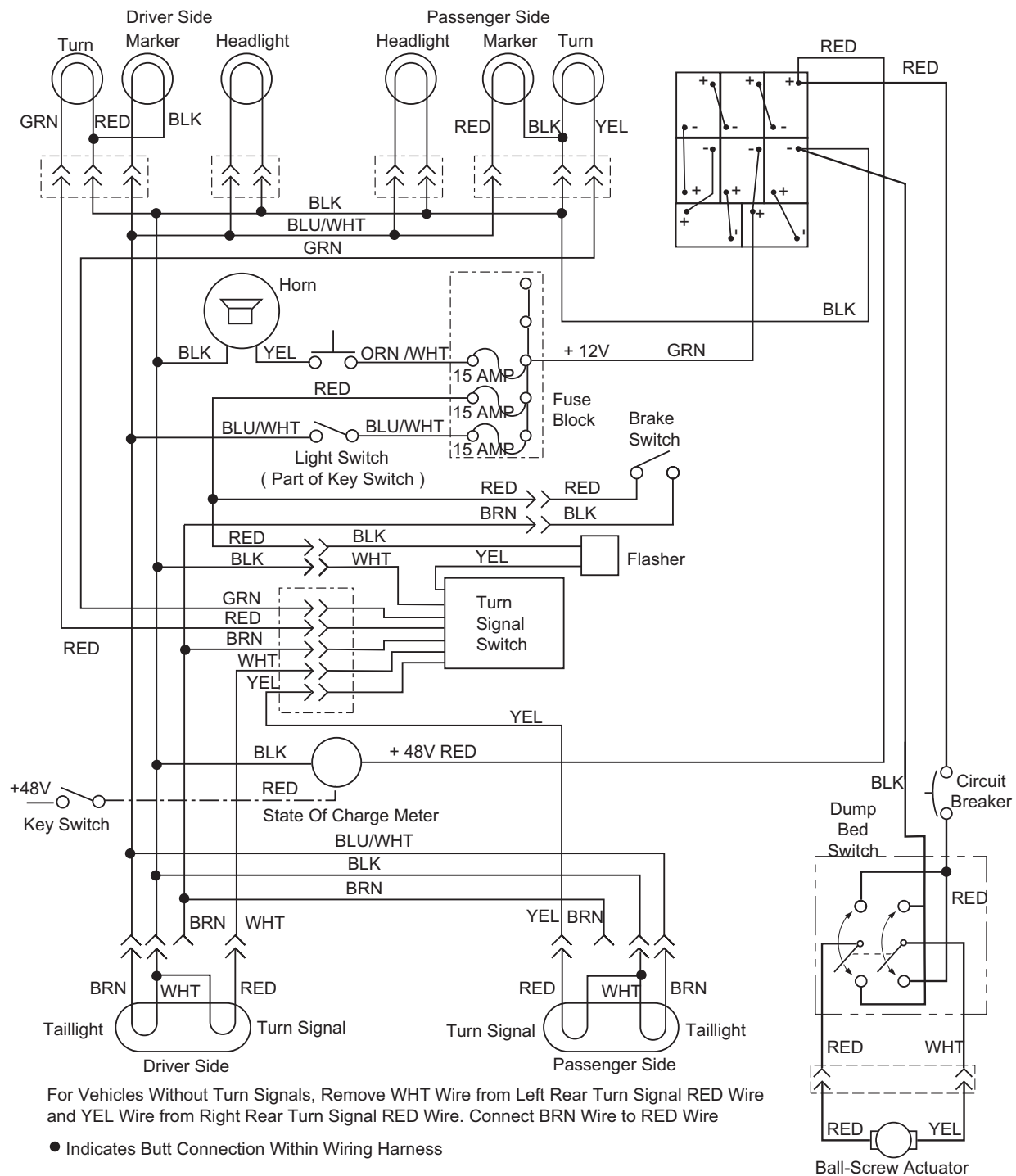
If power is not present but the other headlight functions, a wiring problem is indicated between the two headlights.

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 to 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 Notices, Cautions, Warnings and Dangers.



**Fig. 2 Accessory Wiring Diagram**

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

POWER SUPPLY

Tool List	Qty.
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.**

NOTICE

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 48 VDC) by setting DVOM to 50 VDC range and place the red probe (+) on the battery post with the green wire attached. Place the black probe (-) on the most negative battery post with the blue wire attached. A reading of 47 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 47 volts indicates poor battery condition and the vehicle should be recharged before proceeding with the test.

NOTICE

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 Converter Supply

Firmly attach the black probe (-) to the most negative battery post with the blue wire attached and the red probe (+) to the green terminal at the fuse block. A reading of 13.5 +/- 0.5 voltage indicates that the power wire is in good condition.

NOTICE

The green wire supplies power to the entire fuse block.

4. Check Fuse

Place the red probe (+) to each wire terminal connected to the other side of the fuse from the green wire while keeping the black probe (-) on the most negative battery post. 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 J-2) and (Ref. Fig. 3 on page J-3) 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

*bulbs with bare fingers. Use a clean, dry tissue or paper towel to handle the glass portion of the bulb.*

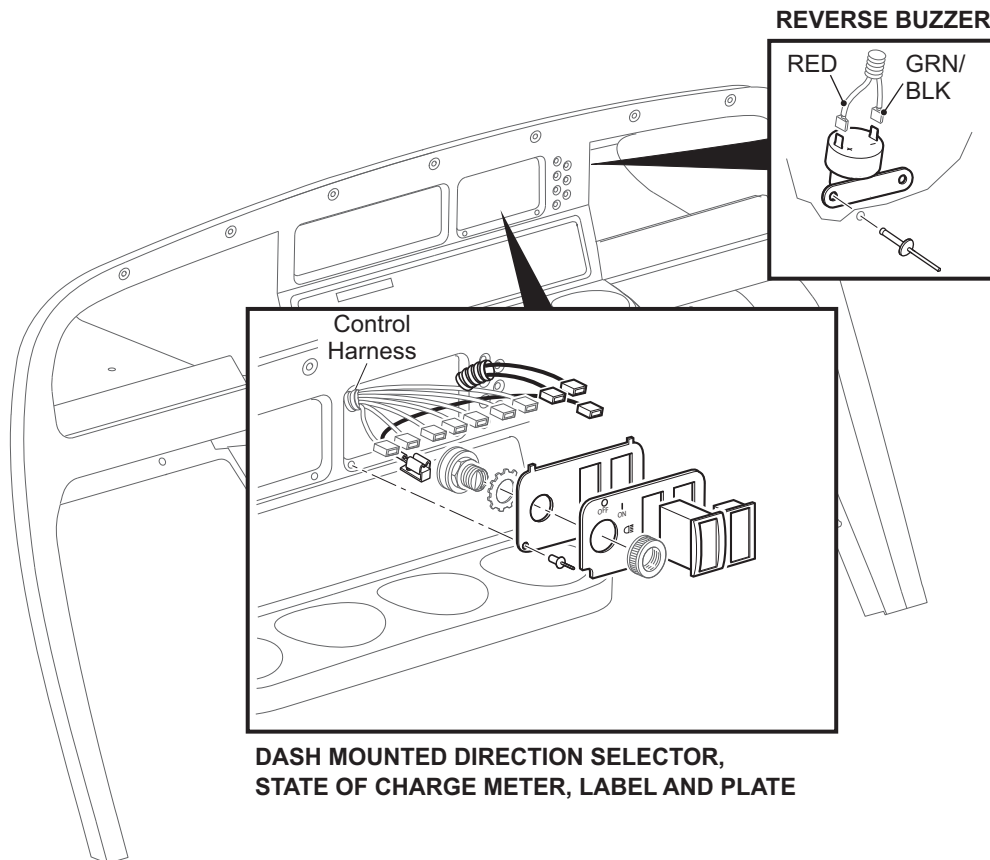
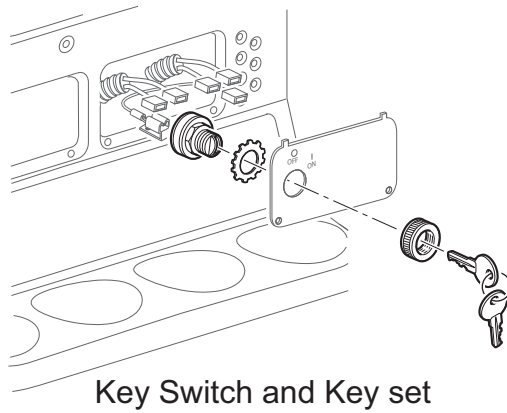
Always hold bulbs with a clean, dry tissue or paper towel. Natural oils from fingers will cause halogen bulbs to fail prematurely.

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.

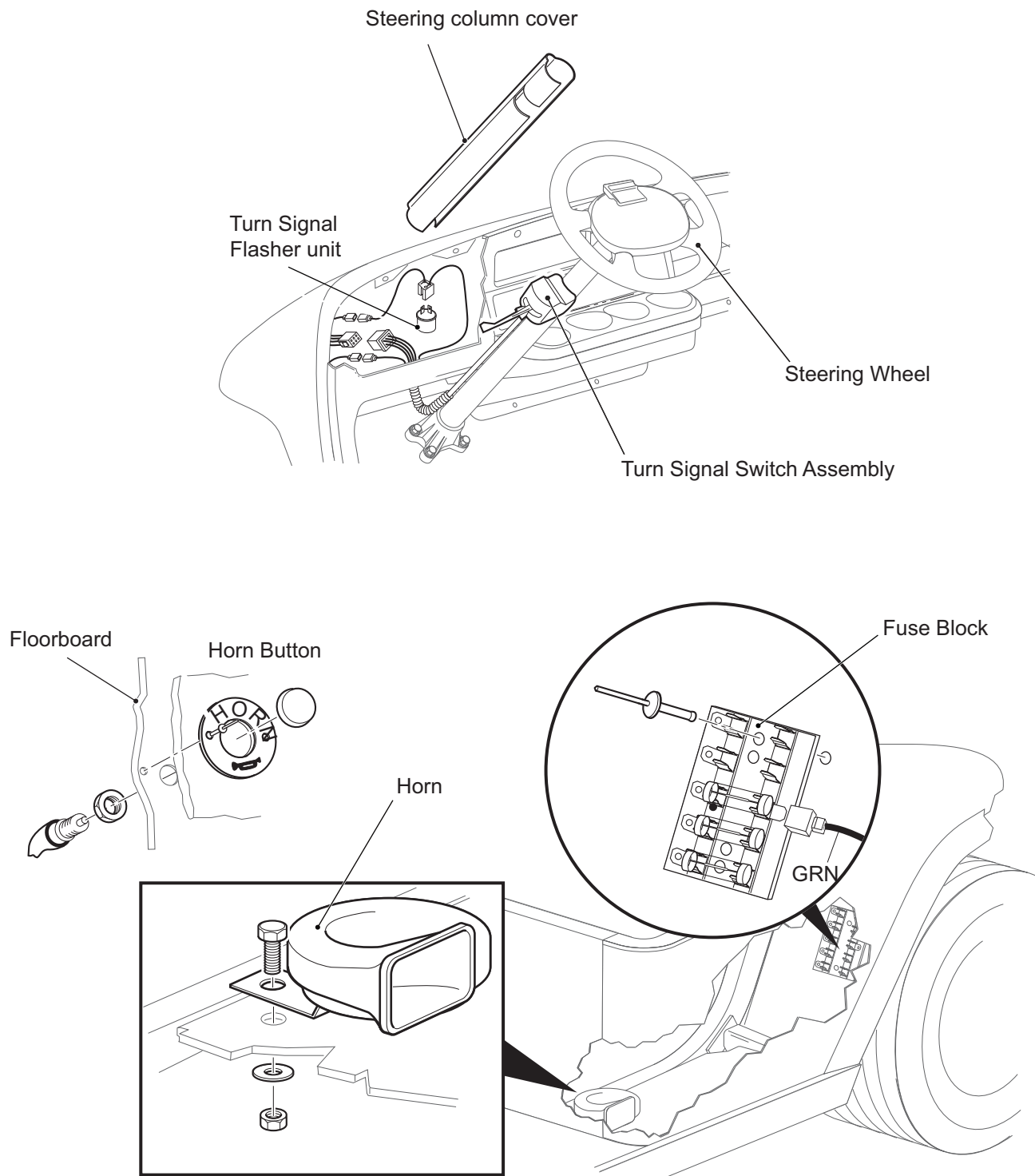
# ELECTRICAL SYSTEM

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



**Fig. 3 Ignition Switch, Direction Selector and State of Charge Meter**

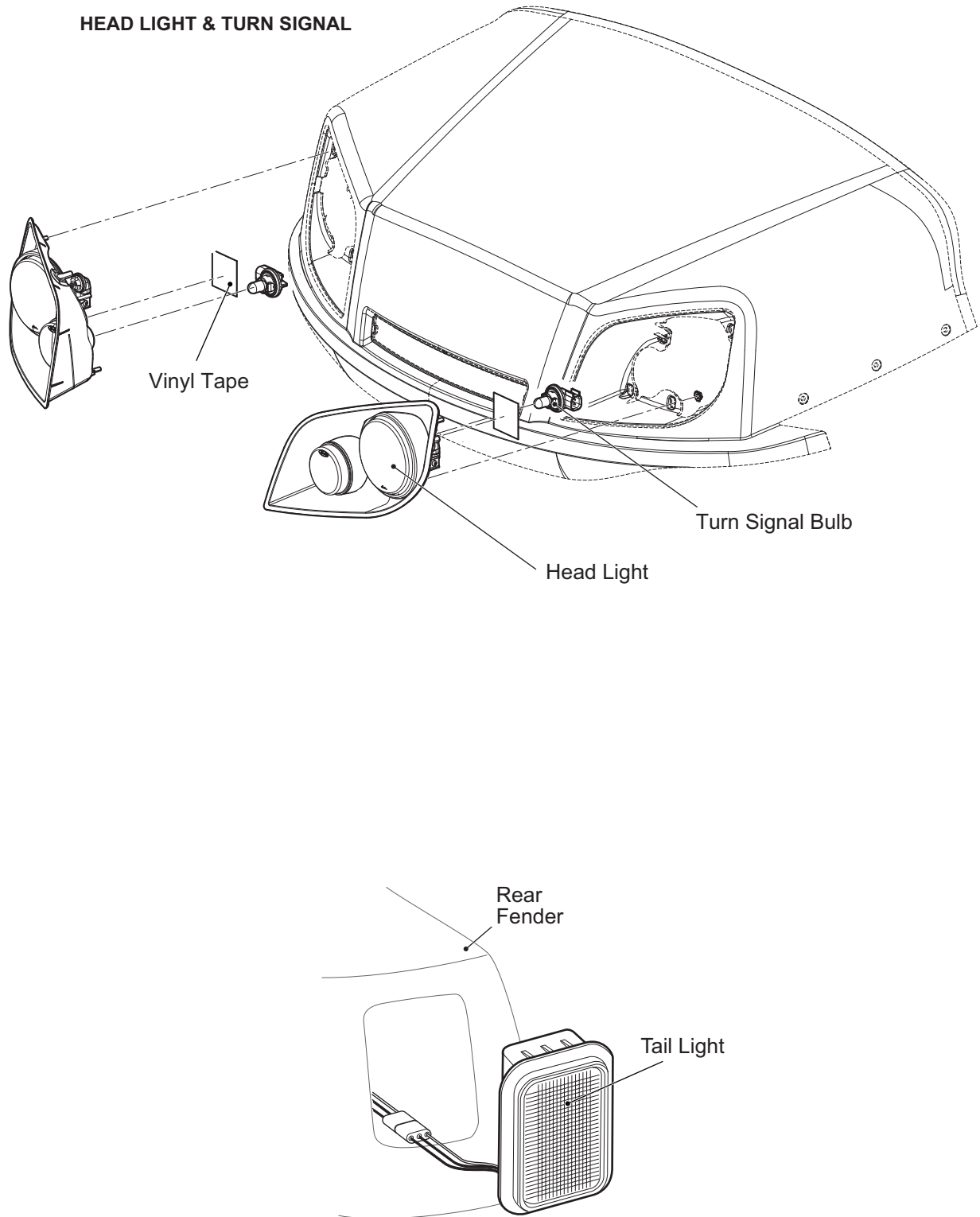
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**Fig. 4 Horn, Fuse Block and Turn Signal**

# ELECTRICAL SYSTEM

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



**Fig. 5 Head Light and Tail Light**

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

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# ELECTRICAL SYSTEM

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

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

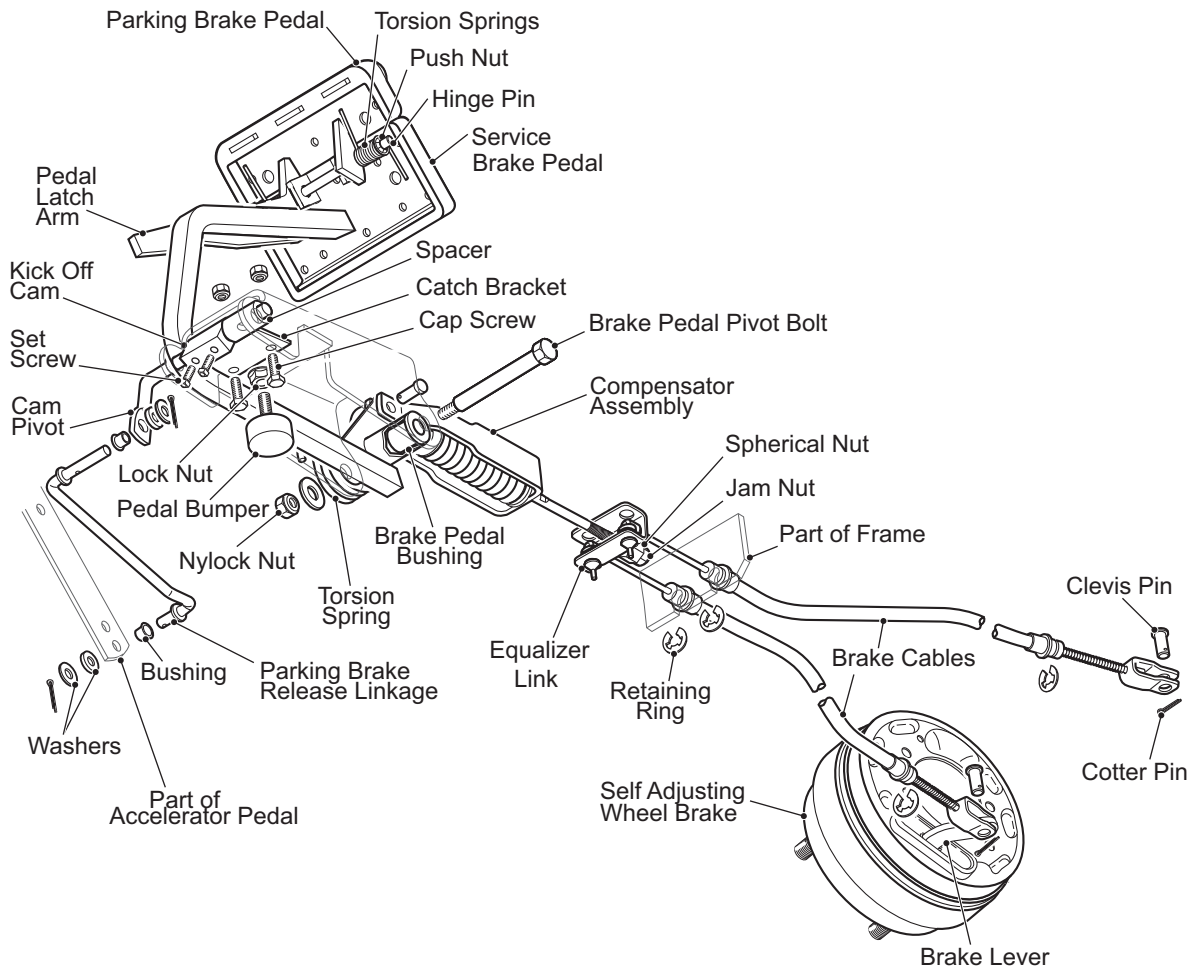


Fig. 1 Mechanical Brake System

## 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).

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 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.

# MECHANICAL BRAKES

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

## 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

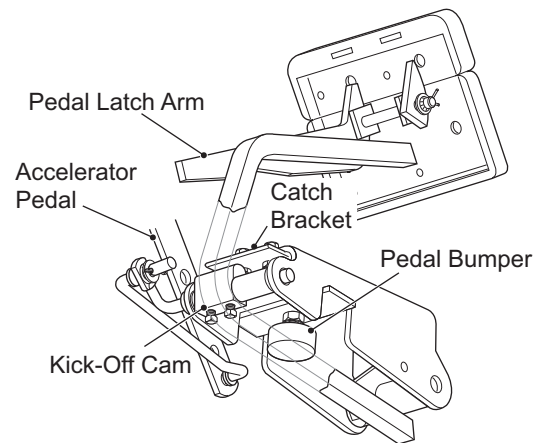
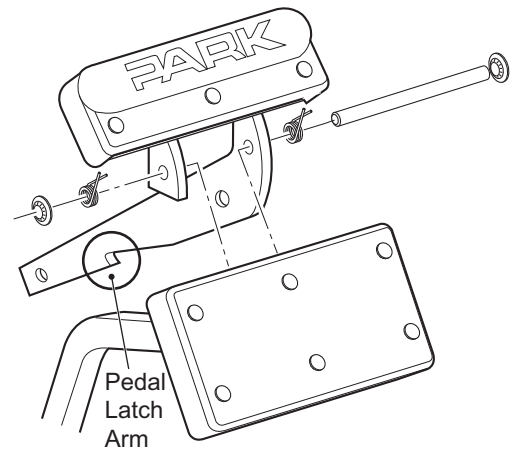
Never manually adjust the brakes at the star wheel. Doing so will cause permanent damage to the adjuster assembly and result in a gradual loss of brakes.

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. The brake adjuster is activated by movement of the lever attached to the brake cable.

## 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. 2).

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 bracket. The service brake pedal is held in the applied (down) position by the catch bracket.



**Fig. 2 Parking Brake and Kick-Off Mechanism**

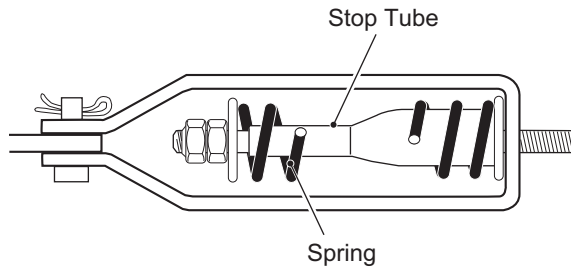
The latch arm is held in position by the tension in the brake linkage. The Parking Brake can be released by two methods:

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.

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

## 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. 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. 3 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.

# MECHANICAL BRAKES

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

## TROUBLESHOOTING FLOWCHART

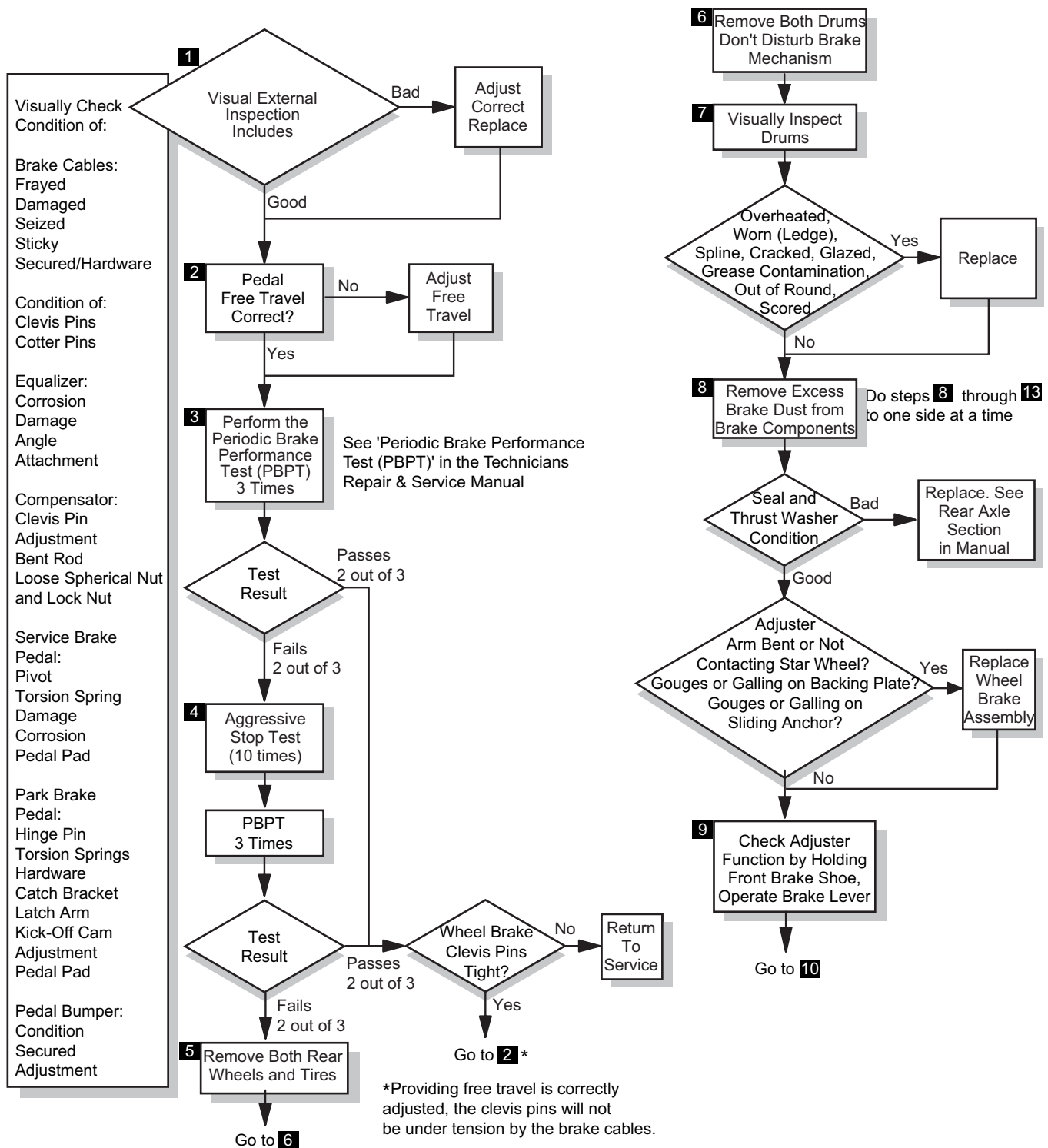


Fig. 4 Troubleshooting Flowchart

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

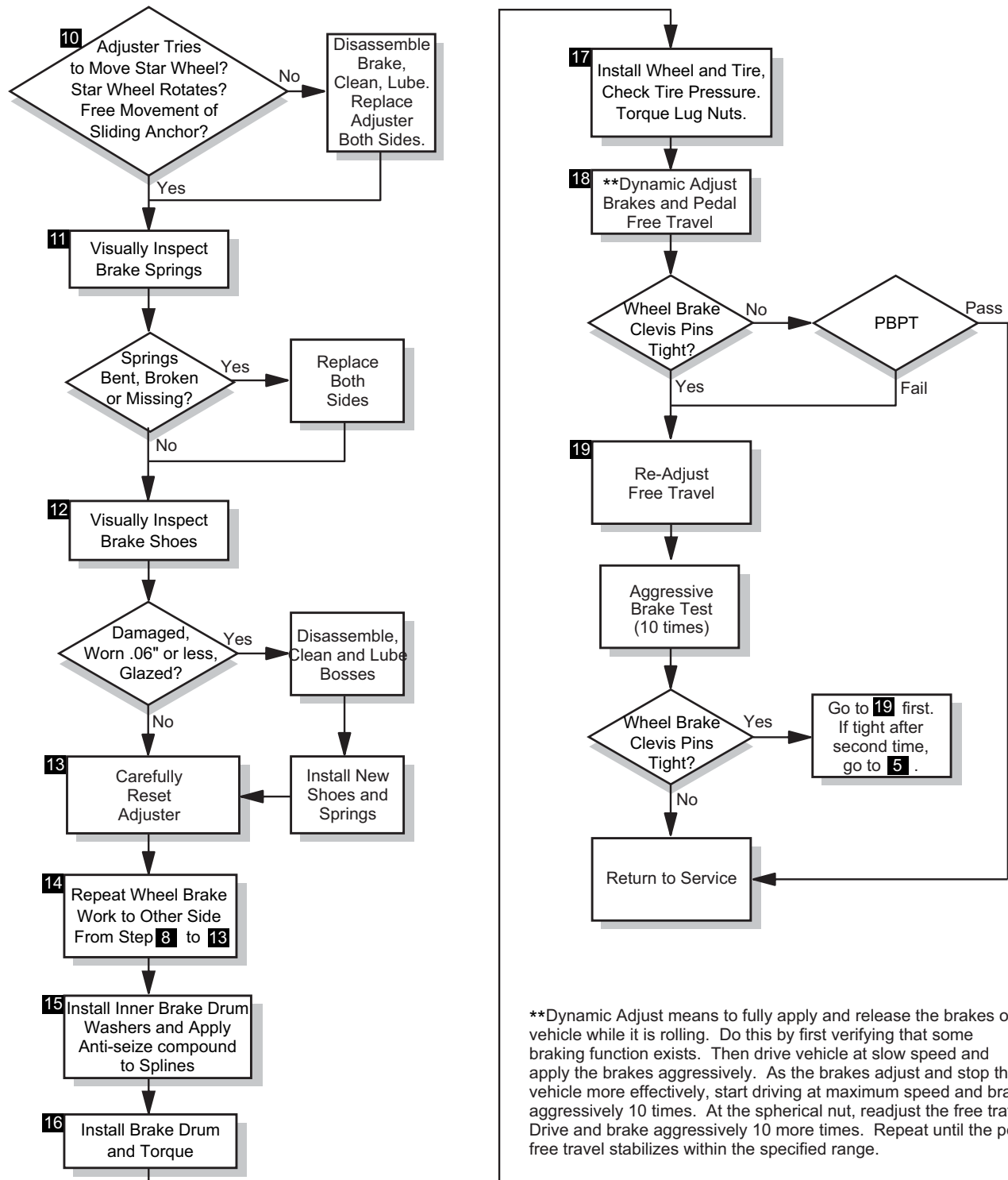


Fig. 5 Troubleshooting Flowchart (Continued)

# MECHANICAL BRAKES

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

## TROUBLESHOOTING TABLE

Test (PBPT), and Aggressive Stop Test is performed (Ref. Fig. 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**



# MECHANICAL BRAKES

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

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 (Continued)**

# MECHANICAL BRAKES

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

## 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 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-5). 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. See "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). Replace or adjust the pedal bumper if required. See "Pedal Bumper Adjustment" on page K-21.

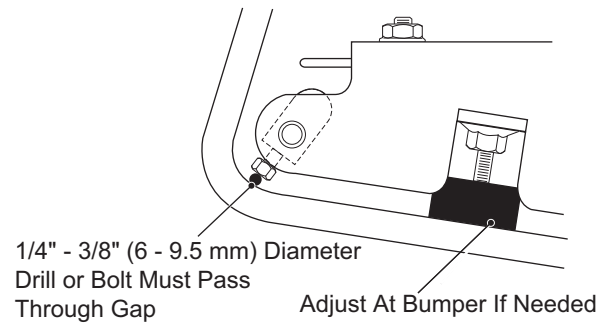


Fig. 7 Brake Pedal Bumper Inspection

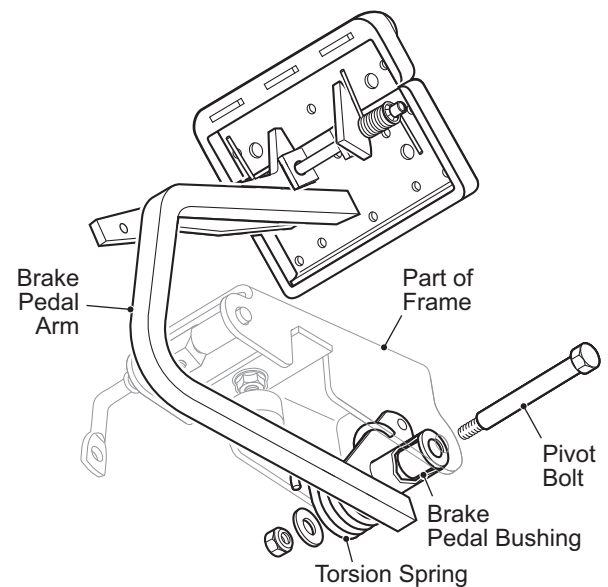


Fig. 8 Brake Pedal Inspection

#### 2. Check brake pedal return.

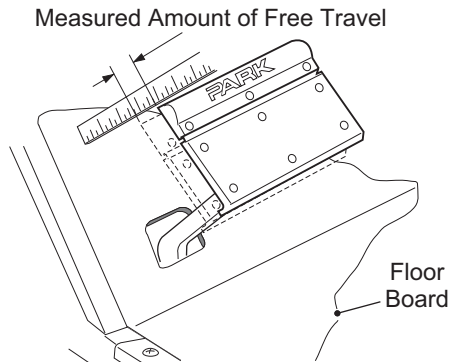
Apply the brake pedal and release. Check that the brake pedal arm rests against the pedal bumper when released. Check that the torsion spring is hooked around both the pedal and the frame and is in good condition. If the pedal does not return fully or is sluggish, the brake pedal bushings and pivot bolt should be inspected (Ref. Fig. 8). Replace pedal, spring, bushings and bolt as required. See "Brake Pedal Removal and Installation" on page K-20.

#### 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

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

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.



**Fig. 9 Check for Excessive Free Travel**

## NOTICE

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' 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

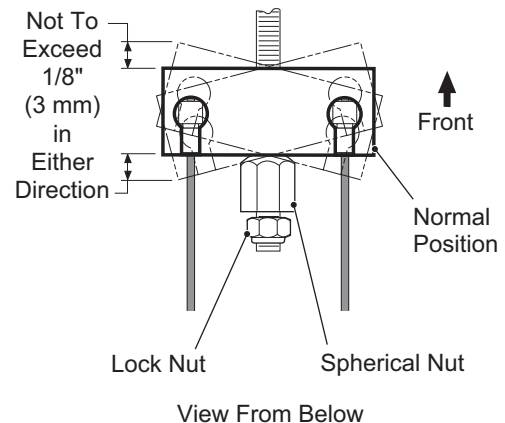
brake lever. They must be loose when the brake pedal has been released (Ref. Fig. 19 on Page K-15). If the clevis pins are not loose, but brake pedal free travel is correctly adjusted and the brake cables move freely, the problem is likely in the wheel brake.

### 6. Inspect the brake cable equalizer linkage.

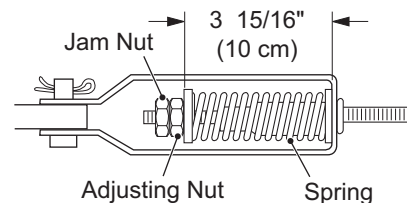
Inspect for signs of corrosion, damage, wear or excessive misalignment (Ref. Fig. 10 on Page K-9). Replace if corrosion, damage, or wear is found.

### 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.



NOTE: This dimension is factory pre-set with the parking brake disengaged and is not to be changed.



**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).

# MECHANICAL BRAKES

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

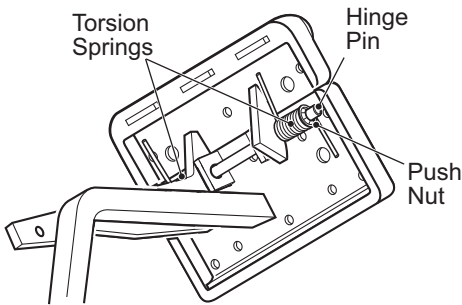


Fig. 11 Parking Brake Pedal Hinge Inspection

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.

## ⚠ WARNING

*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).

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). 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.

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.

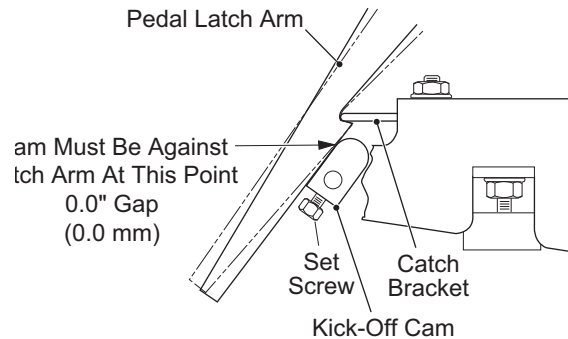


Fig. 12 Kick-Off Cam Inspection

## Periodic Brake Performance Test (PBPT)

### ⚠ 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.*

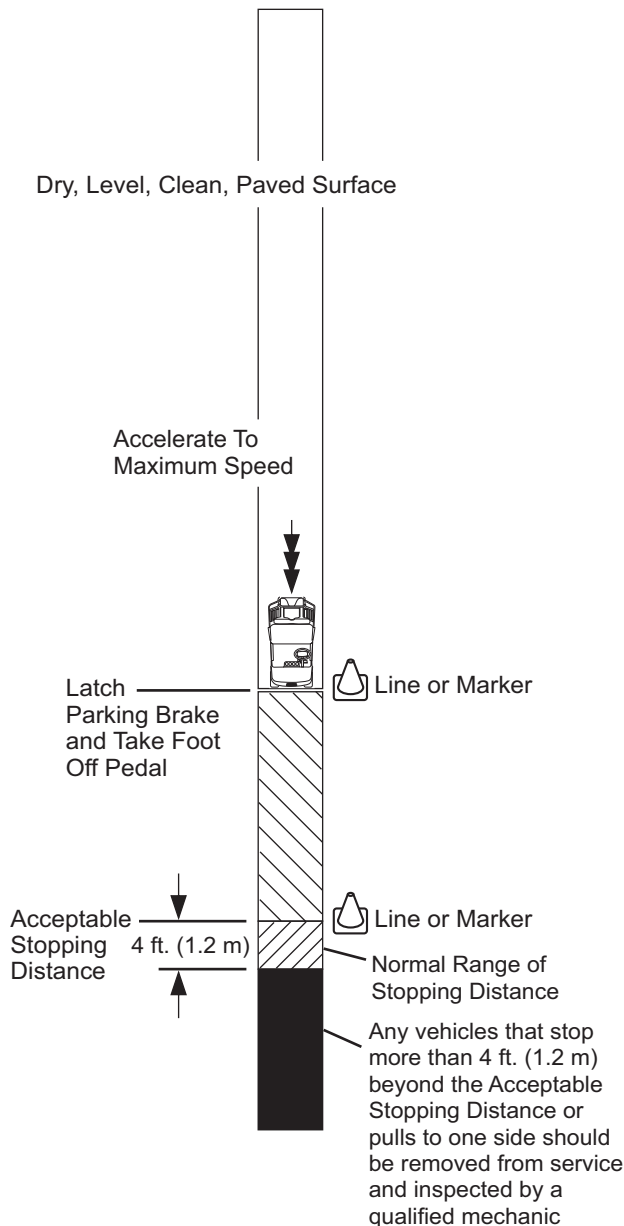
The Periodic Brake Performance Test (PBPT) should be performed regularly (see Periodic Service Schedule in the GENERAL INFORMATION AND ROUTINE MAINTENANCE section of this manual) as an evaluation of braking system performance. It is useful as a method of identifying subtle loss of performance over time 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.

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



**Fig. 13 Periodic Brake Performance Test**

## NOTICE

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). 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 stopping location or mea-

sure 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) 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.



# MECHANICAL BRAKES

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

## NOTICE

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.

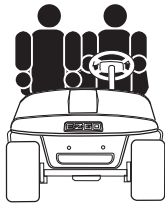


Fig. 14 Equally Loaded Vehicle

## 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).

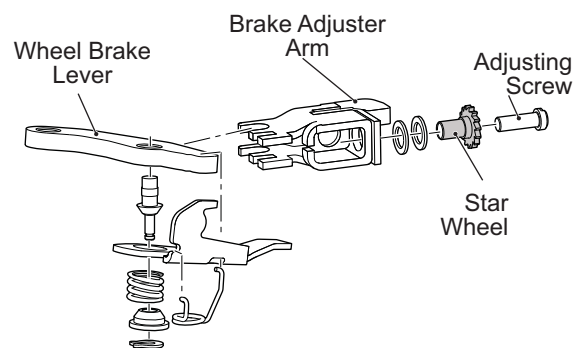


Fig. 15 Adjuster Mechanism

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).

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

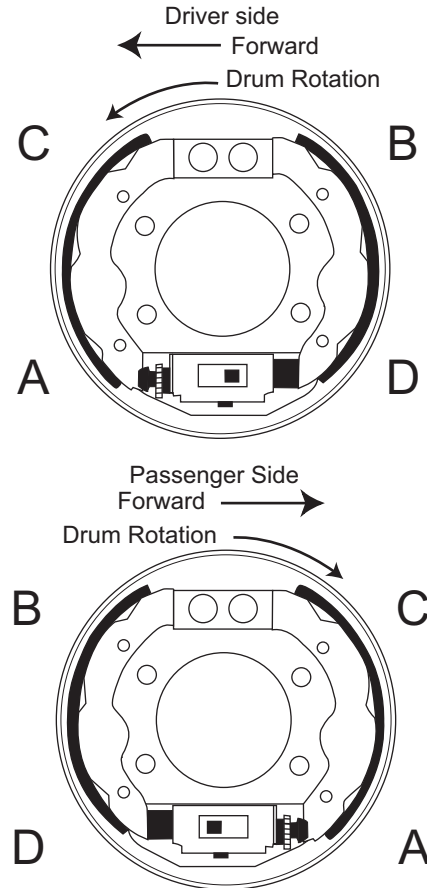
7. Check the condition and operation of the moving anchor assembly (Ref. Fig. 22 on Page K-16). Operate the brake lever to check for free motion. The adjuster assembly and brake lever should move smoothly from front to back on the backing plate. If the moving anchor assembly is damaged or binds against the backing plate, replace both of the wheel brake assemblies.

## WARNING

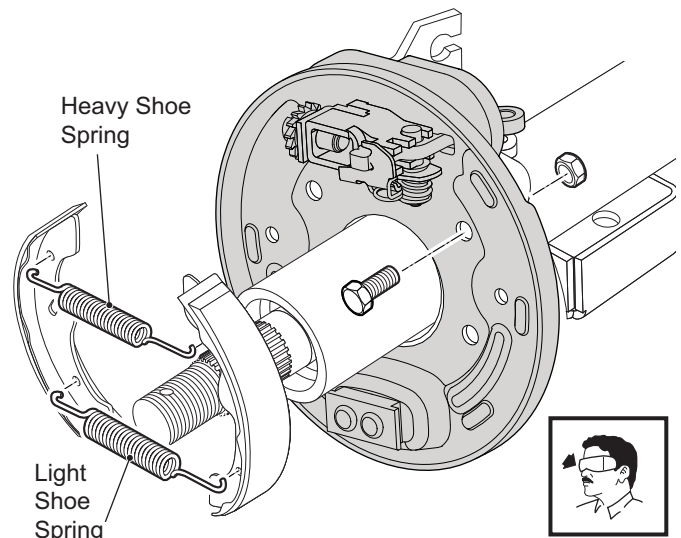
*A backing plate assembly that shows any indication of galling or gouging is not repairable and must be replaced with a new wheel brake assembly. Always replace wheel brake assemblies in pairs.*

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.
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. 14 on Page K-12). 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.
10. Inspect the brake shoe springs.  
Be sure that they are not broken or damaged and are correctly installed. The springs must be inserted with the light spring at the bottom. The long hook is installed down through the rear brake shoe. The heavier top spring is installed with the spring hooks facing up. The heavy top spring is installed with both spring hooks installed down through the brake shoes (Ref. Fig. 17). Repeat procedure at the opposite wheel brake.
11. 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 14 This includes all linkage and wheel brake components.

The pattern of normal brake shoe wear is shown in quadrant 'A', 'B', 'C' & 'D' with quadrant 'A' showing the most wear. Quadrant 'B' will show the second most wear.



**Fig. 16 Brake Shoe Wear**



**Fig. 17 Orientation of Brake Shoe Springs**

# MECHANICAL BRAKES

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

## MAINTENANCE AND REPAIRS

### Tool List

	Qty.
Hydraulic Floor Jack .....	1
Scale .....	1
Jack Stands .....	4
Wheel Chocks .....	4
Socket, 1/2" .....	1
Socket, 3/4" .....	1
Socket, 11/16" .....	1
Socket, 15/16" .....	1
Socket, 1 1/8" .....	1
Socket, 1/4" .....	1
Torque Wrench, ft. lbs. ....	1
Torque Wrench, in. lbs. ....	1
Extension, 6", .....	1
Ratchet .....	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 15947G1) .....	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

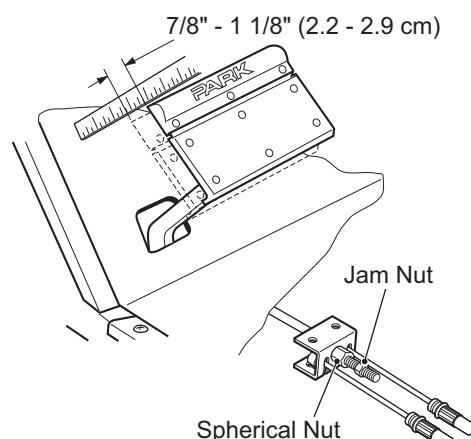
essential to proper brake function. Too much pedal free travel will limit braking capability. Too little pedal free travel may cause the brakes to drag (not fully released). Either condition can prevent the brakes from adjusting properly.



## 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). 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 for 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.

At the spherical nut, adjust the free travel as noted above.

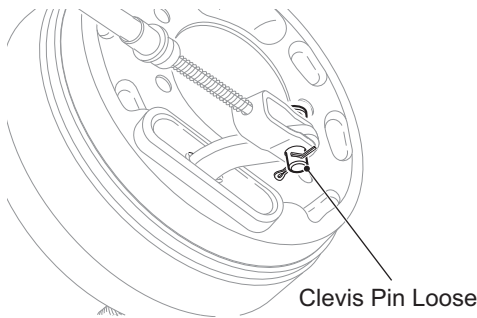
Drive again and brake aggressively 10 times.



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

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). 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.

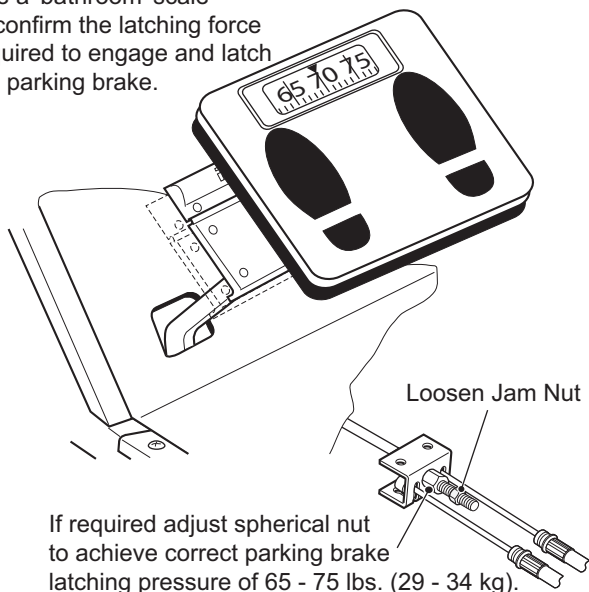


**Fig. 19 Check Clevis Pins**

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).

Perform the Periodic Brake Performance Test as described and return the vehicle to service if brake performance is satisfactory.

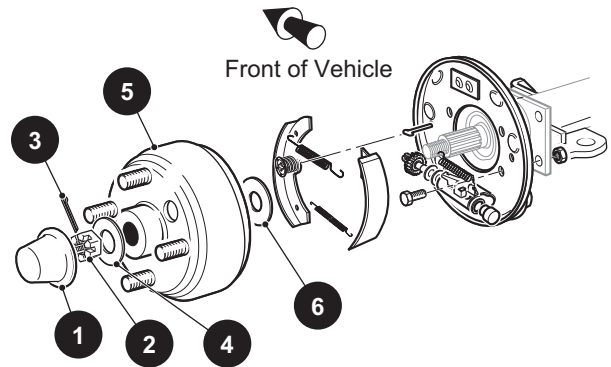
Use a 'bathroom' scale to confirm the latching force required to engage and latch the parking brake.



**Fig. 20 Checking Parking Brake Latching Pressure**

## 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).



**Fig. 21 Brake Assembly**

Remove the cotter pin (3) and castellated nut as shown.

### NOTICE

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 15947G1).

### 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.

# MECHANICAL BRAKES

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

## NOTICE

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 Removal" 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 surfaces with Multi Purpose Grease (MPG) lubricant (Ref. Fig. 22).

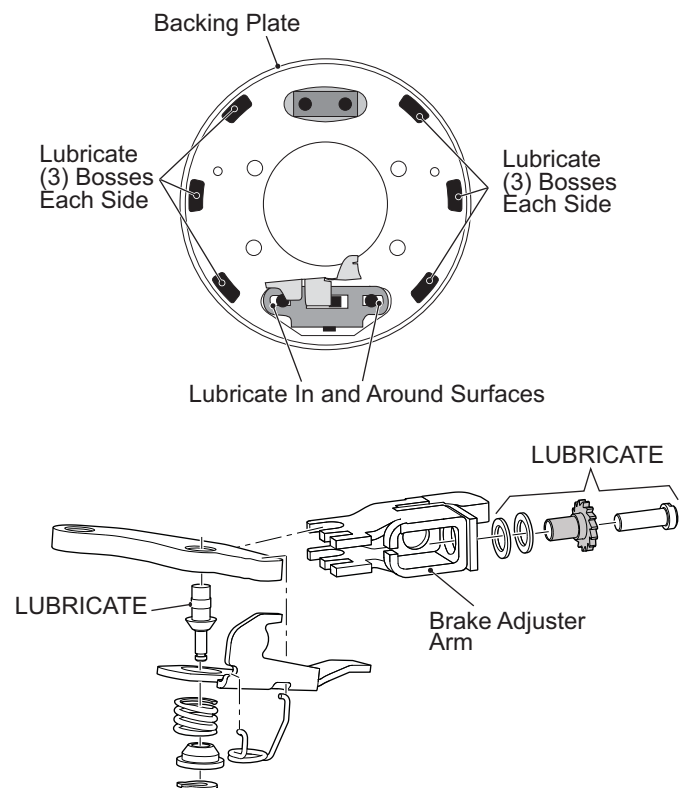


Fig. 22 Wheel Brake Lubrication Points

Install the actuator components, adjuster components and brake shoes. See "Brake Shoe Installation" on page K-18. If the brake shoes and drum are not to be replaced, sand the friction surfaces lightly with emery cloth to remove any foreign material.

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



## CAUTION

Be sure that the adjusting screw is screwed into the star wheel nut until only 1 - 2 threads are exposed. If the brake shoes are replaced, replace the brake springs and the adjuster components.

Replace the springs one side at a time, using the other side as a guide.

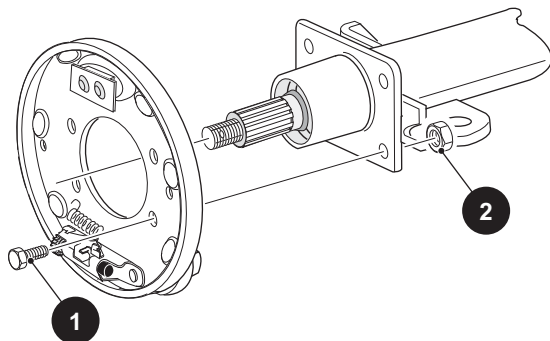
Install brake drum as described in 'Brake Drum Removal and Installation'.

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).



**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 Removal

## NOTICE

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.

Using a pair of pliers, compress the brake shoe retainer springs (1) at the open end of the spring. While holding the tension pin (2) with a second set of pliers, turn the retainer spring 1/4 turn to align the slot in the spring retainer with the flats in the tension pin. Remove the brake shoe retainer springs.

Grasp the brake shoes (3) in the center and tilt them outwards and away from the back mounting plate. This will release the tension in the brake springs(4). Remove the brake springs and remove the brake shoes (Ref. Fig. 26 on Page K-19).

Inspect brake shoes. If a brake shoe has less than 0.40 lining material thickness AT ANY POINT on either shoe then both shoes MUST be replaced.

Check for free lateral (front and back) movement of the adjusting mechanism and for free movement of the 'star' wheel. Remove the boot on the brake lever. Clean any accumulated brake dust from the backing plate and adjuster mechanism using a brush or air hose.

If the brake is being removed for an axle bearing and seal replacement, the four bolts and nuts securing the brake assembly the brake assembly to the rear axle must be removed. When reinstalling the brake mounting bolts, tighten to 23 - 35 ft.lbs torque.

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).

# MECHANICAL BRAKES

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

## Brake Shoe Installation

The brake shoe end is pointed and engages the back-side of the adjuster. There is a 17L stamped into brake shoe (Ref. Fig. 24).



**Fig. 24 Brake Shoe '17L'**

The brake shoe end is squared off and engages the screw end of the adjuster. The brake shoe is stamped with '17T' into the shoe (Ref. Fig. 25 ).

Install the brake shoes using the reverse order of disassembly and secure with the brake shoe retainer springs and brake shoe return springs.

Clean the axle shaft to remove grease, dirt and all foreign matter.



**Fig. 25 Brake Shoe '17T'**

Insert a straight blade screwdriver between the adjusting lever and the adjusting mechanism. Rotate the star wheel counter clockwise until the shoes have retracted sufficiently to permit the brake drum to be installed. install washer (5), brake drum (6), washer (8) castellated nut (9), and tighten the axle nut to 80 - 90 ft. lbs. (108 - 122 Nm) torque. Continue to tighten until a new cotter pin (10) can be installed through the castellated nut and the hole in the axle. Maximum torque 140 ft. lbs. (190 Nm).

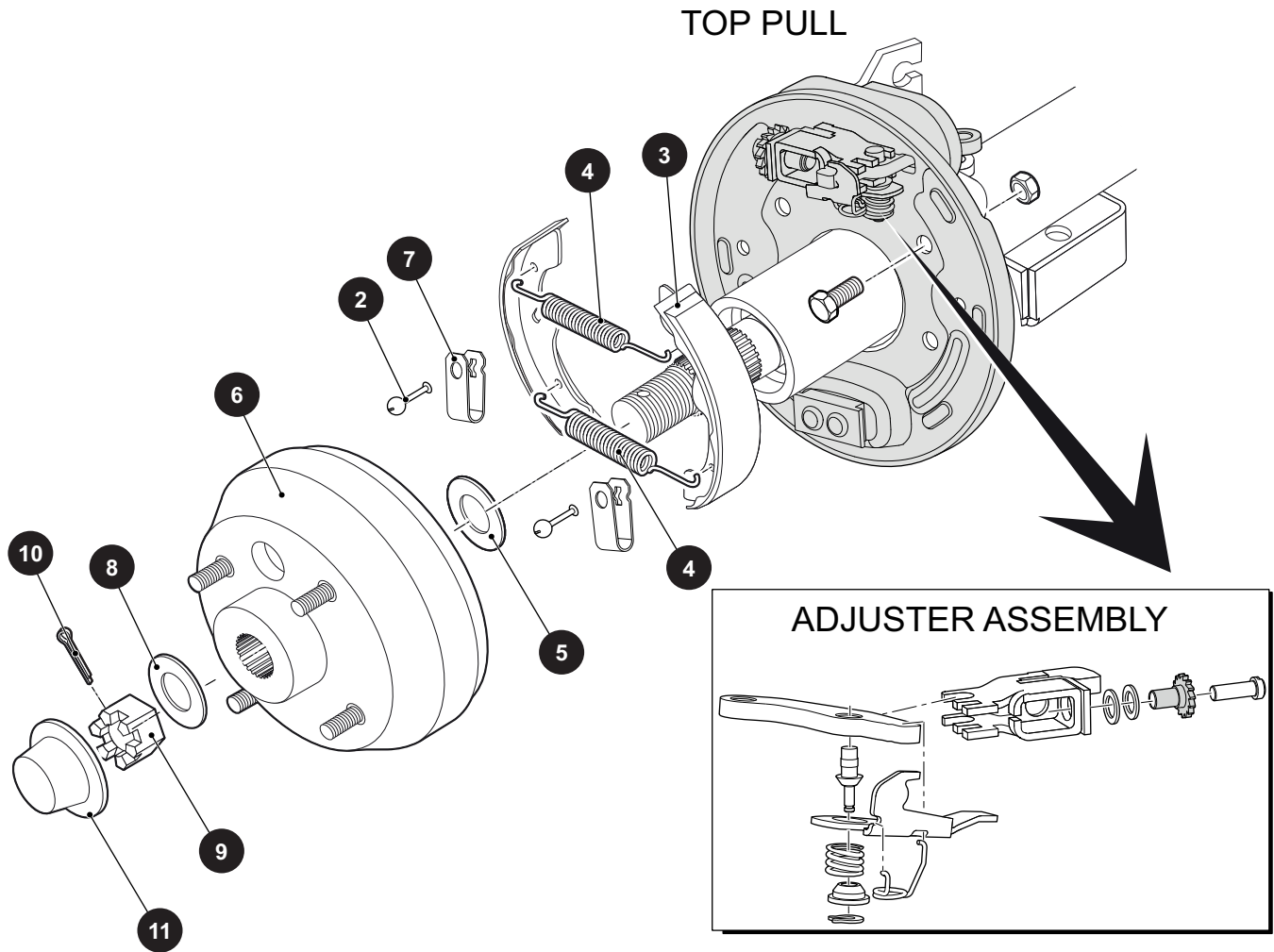
Install the brake drum. See "Brake Drum Removal and Installation" on page K-15.

Repeat on other side of vehicle.

Adjust the brake pedal free travel. See "Adjusting Brake Pedal Free Travel" on page K-14.



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



**Fig. 26 Brake Shoes & Springs**

## Brake Cable and Equalizer Assembly Removal and Installation

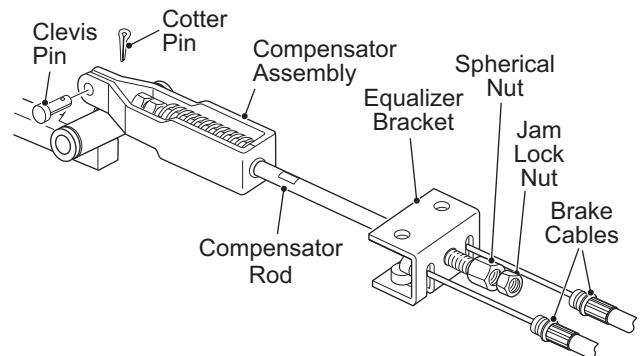
### NOTICE

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. 27). Inspect the hardware and replace if needed. Remove the brake cable and equalizer assembly and discard.

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.



**Fig. 27 Brake Cable, Equalizer and Compensator**

Adjust the brake pedal free travel. See "Adjusting Brake Pedal Free Travel" on page K-14.

# MECHANICAL BRAKES

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

## 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-19).

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 inserting 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. 28). 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.

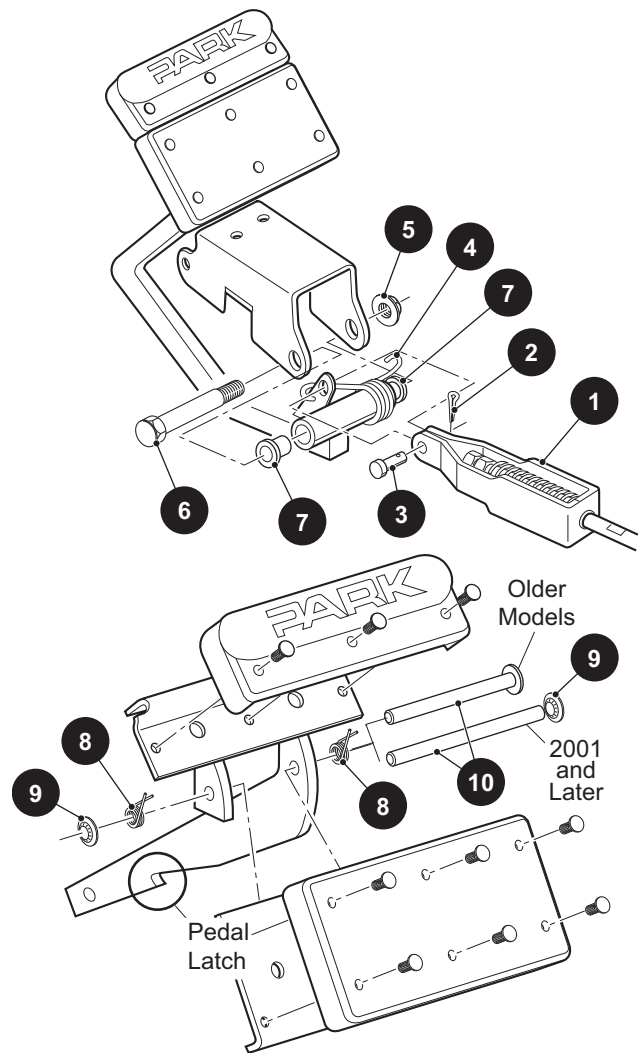


Fig. 28 Brake Pedal Removal and Installation

## Parking Brake Catch Bracket Removal and Installation

Remove the driver side front wheel to gain access to the brake pedal release mechanism.

### WARNING

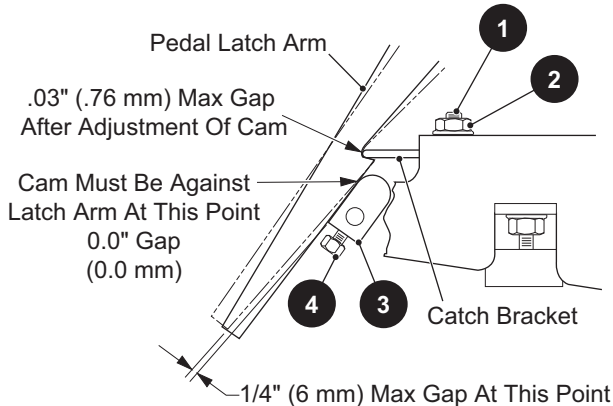
To prevent serious injury death resulting from the use of worn parking brake components, to not attempt to re-new worn components. The catch bracket is a hardened part. Do not grind or file it as doing so will cause the part to lose its hardness characteristics. A new part must be used.

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

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. 29 ).

If required, adjust the kick-off cam (3). See "Parking Brake Kick-Off Cam Removal, Replacement and Installation." on page K-22.

Install wheel. See WHEELS AND TIRES section.



**Fig. 29 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. 28 on Page K-20) and remove the parking brake pedal. Some models may use two push nuts on the pin.

## ! 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).

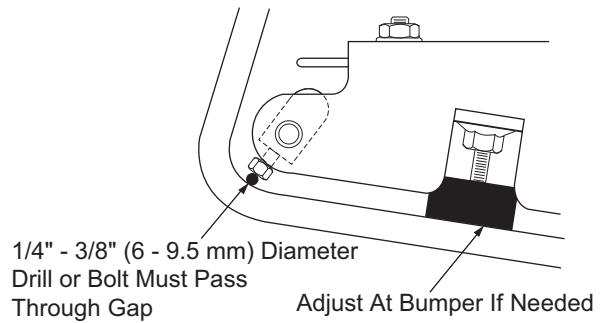
If required, adjust the kick-off cam (3). See "Parking Brake Kick-Off Cam Removal, Replacement and Installation." on page K-22.

## Pedal Bumper Adjustment

Loosen the bumper lock nut and adjust the bumper by rotating it (Ref. Fig. 30 on Page K-21). 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. 30 Pedal Bumper Adjustment**

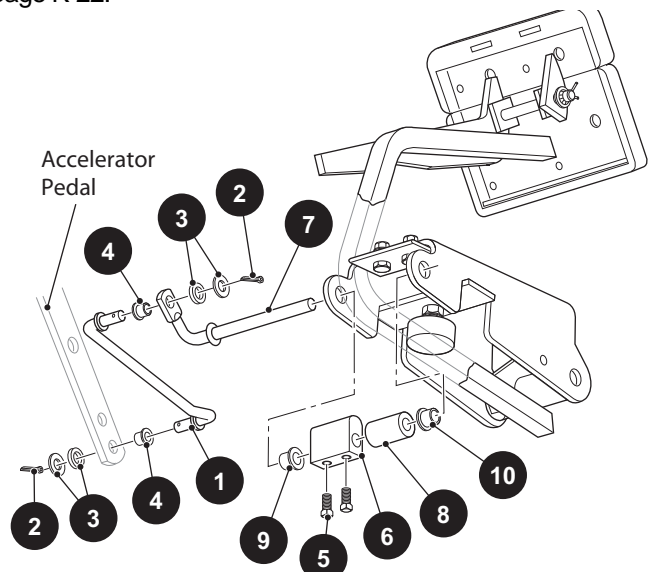
## Parking Brake Release Linkage Removal and Replacement

Remove the cotter pin (2), washers (3) and bushings (4) from linkage rod (1). Remove the linkage rod (Ref. Fig. 31).

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-22.



**Fig. 31 Parking Brake Release Linkage and Kick-Off Cam Removal and Installation.**

# MECHANICAL BRAKES

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

## **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. 31 on Page K-21).

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.



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

NOTES:

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# MECHANICAL BRAKES

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

NOTES:

This image shows a full page of blank graph paper. The grid consists of thin, light gray horizontal and vertical lines that intersect to form small squares across the entire surface. There are no margins, text, or other markings on the paper.

## TABLE OF CONTENTS FOR SECTION 'L'

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Fig. 1 Charger Installation .....	L - 1

# BATTERY CHARGER

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

## Notes:

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

## CHARGER DESCRIPTION

The Powerwise QE 48V charger is automatic and is designed specifically for charging electric vehicle batteries.

When the charger is plugged into a vehicle's charger receptacle it will automatically turn on and the charger's LED will start flashing GREEN to indicate the battery is charging.

When the LED is GREEN continuously the batteries are fully charged.

## PORTABLE CHARGER INSTALLATION

### WARNING

*Use charger only on 48 volt battery systems. Other usage may cause personal injury and damage. Lead acid batteries may generate explosive hydrogen gas during normal operation. Keep sparks, flames, and smoking materials away from batteries. Provide adequate ventilation during charging. Never charge a frozen battery. Study all battery manufacturers' specific precautions such as recommended rates of charge and removing or not removing cell caps while charging.*

### DANGER

***Risk of electric shock. Connect charger power cord to an outlet that has been properly installed and grounded in accordance with all local codes and ordinances. A grounded outlet is required to reduce risk of electric shock – do not use ground adapters or modify plug. Do not touch uninsulated portion of output connector or uninsulated battery terminal. Disconnect the DC supply before making or breaking the connections to the battery while charging. Do not open or disassemble charger. Do not operate charger if the AC***

***supply cord is damaged or if the charger has received a sharp blow, been dropped, or otherwise damaged in any way – refer all repair work to qualified personnel. Not for use by children.***

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. For optimum performance and shortest charge times, place the charger in an area with adequate ventilation. The charger should also be placed in an area that will be relatively free of dirt, mud, or dust since accumulations within the fins of the charger will reduce their heat-dissipating qualities. Optimal cooling also occurs when the charger is placed on a horizontal surface with the fins vertical. More airflow from below the charger will help cool the fins, so placement above open areas or areas with cut-outs for airflow is desirable. If the charger is operated in an outdoor location, rain and sun protection must be provided. As the charger may get hot during operation, the charger must be placed such that risk of contact by people is reduced. Wall mount or shelf mount using #10-M5 screws. The charger's status display must be visible to the user.

Provide Protection From Elements



 NEMA 15 - 5R Grounded AC Receptacle  
110 - 120 VAC. Dedicated 15 AMP Circuit

Locations outside the US and Canada: Reference appropriate local electrical code and charger manufacturer recommendations for AC power requirements

Ref Pci 15

**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. The charger will automatically start a few seconds after the plug is in place. The charger will automatically stop when the 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 Notices, Cautions, Warnings and Dangers

## NOTICE

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.

## WARNING

*An ungrounded electrical device may become a physical hazard that could result in an electrical shock or electrocution.*

## UNDERSTANDING THE CHARGER

When the charger is plugged into the vehicle's charger receptacle, the charger will automatically turn on and the charger's LED will start flashing GREEN to indicate the batteries are charging.

Once a minimum battery voltage of 2 volts per cell (Vpc) is reached, the charger's output current will change from a full current charge to the trickle rated charging current. The length of charge time will vary by how depleted the batteries are, the input AC voltage, and/or charger ambient temperatures. The charger's LED will give a SHORT flash if the charge is less than 80% and a LONG flash if the charge is greater than 80%. If the charger's LED is a steady GREEN the batteries are fully charged and the charger may be unplugged, although not necessary. The charger may be left plugged in for long periods of time to maintain the batteries charge level.

If a fault occurred anytime during the charging, the charger's LED will quickly flash RED. The specific fault is indicated by the number of RED flashes that occur, there will be a pause and then the flashes will repeat again. There are several possible conditions that will generate errors. Some errors will require human intervention to first resolve the problem and then reset the charger by unplugging the DC cord from the vehicle.

If the AC voltage is interrupted and restored, the charger will turn back on automatically.

## LED DISPLAY INFORMATION

### LED Operation Codes:

SHORT GREEN FLASH = less than 80% charged

LONG GREEN FLASH = more than 80% charged

SOLID GREEN = 100% charged

RED FLASH = fault code

### LED Fault Code:

RED FLASH: Light turns on briefly, but does not flash after that - check for valid AC voltage.

ONE RED FLASH: One flash, a pause and then again one flash and a pause - Charge Enable Fault: poor contact in the DC connector or dirty contacts or Battery Temperature Fault: battery temperature is greater than 122° F (50° C) or less than 14° F (-10° C).

TWO RED FLASHES: Two flashes, a pause and then again two flashes and a pause - Battery Voltage Fault: Battery pack is less than 36.0 Volts or more than 67.2 Volts. Battery pack is too discharged or over charged for the charger to work.

THREE RED FLASHES: Three flashes, a pause and then again three flashes and a pause - Battery Charge Time-out: Charge time exceeded. This may indicate a problem with the battery pack or that the charger output current was severely reduced due to high ambient temperatures.

FOUR RED FLASHES: Four flashes, a pause and then again four flashes and a pause - Battery Fault: Charge time exceeded. This indicates a problem with the battery pack voltage not reaching the required nominal level within the maximum time allowed.

SIX RED FLASHES: Six flashes, a pause and then again six flashes and a pause - Charger Fault: An internal fault has been detected. If this fault is displayed again after unplugging the charger's DC power cord and plugging it back in, the charger must be taken to a qualified service center.

## MAINTENANCE INSTRUCTIONS

1. For flooded lead-acid batteries, regularly check the water levels of each battery cell after charging and add distilled water as required to the level specified by the battery manufacturer. Follow the safety instructions recommended by the battery manufacturer.
2. Make sure the charger connections to the battery terminals are tight and clean. Check for any deformations or cracks in the plastic parts. Check the charger harness for chaffing and rubbing. Inspect all wiring for fraying, loose terminals, chaffing, corrosion or deterioration of the insulation.
3. Keep the cooling fins free of dirt and debris, do not expose the charger to oil, dirt, mud or to direct heavy water spray when cleaning equipment.
4. Inspect the plug of the battery charger and the vehicle receptacle housing for dirt or debris. Clean the DC connector monthly or more often if needed.

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

## Notes:

This image shows a full page of blank graph paper. The grid consists of thin, light gray horizontal and vertical lines that intersect to form small squares across the entire surface. There are no margins, text, or other markings on the paper.

## BATTERY CHARGER

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

## Notes:

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## LIST OF ILLUSTRATIONS

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## REAR SUSPENSION

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

NOTES:

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

## REAR SUSPENSION

### NOTICE

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
Wheel Chocks .....	4
Jack Stands .....	4
Floor Jack .....	1
Wrench, 1/2" .....	1
Wrench, 9/16" .....	1
Wrench, 3/4" .....	1
Socket, 1/2" .....	1
Socket, 9/16" .....	1
Socket, 9/16", Deepwell .....	1
Extension, 3" .....	1
Ratchet .....	1
Torque Wrench, ft. lbs. ....	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 P-2). In addition the rear axle is secured to the rear of the engine by means of a casting that is bolted to the engine and mounted to the rear axle with 'U' bolts. This section is confined to the removal and replacement of the springs and shock absorbers. Rear axle shaft removal is covered in REAR AXLE section.

### Shock Absorber Removal

Raise the rear of the vehicle in accordance with the instructions provided in Section 'B' 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 ).

Compress the shock absorber (1) and remove the top shock absorber Vinyl cap (5) and nut (4).

Remove the shock absorber.

### Shock Absorber Installation

Shock absorber installation is in the reverse order of disassembly except that the shock absorber nuts (4,5) must be tightened until the shock absorber bushings (4) expand to the diameter of the shock absorber washer (2).

### Rear Spring 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.*

### NOTICE

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 (4) (Ref. Fig.1)

Place a floor jack under the center section of the rear axle (24) 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 (7) and the hardware (8,10) can be removed.

Remove the rear spring shackle assembly (13) and the front spring mounting hardware (10).

Remove the spring (6).

### Rear Spring Installation

Spring installation is in the reverse order of disassembly.

### NOTICE

When installing the rear spring shackles, be sure that the cupped side of the shackle plate faces the spring.

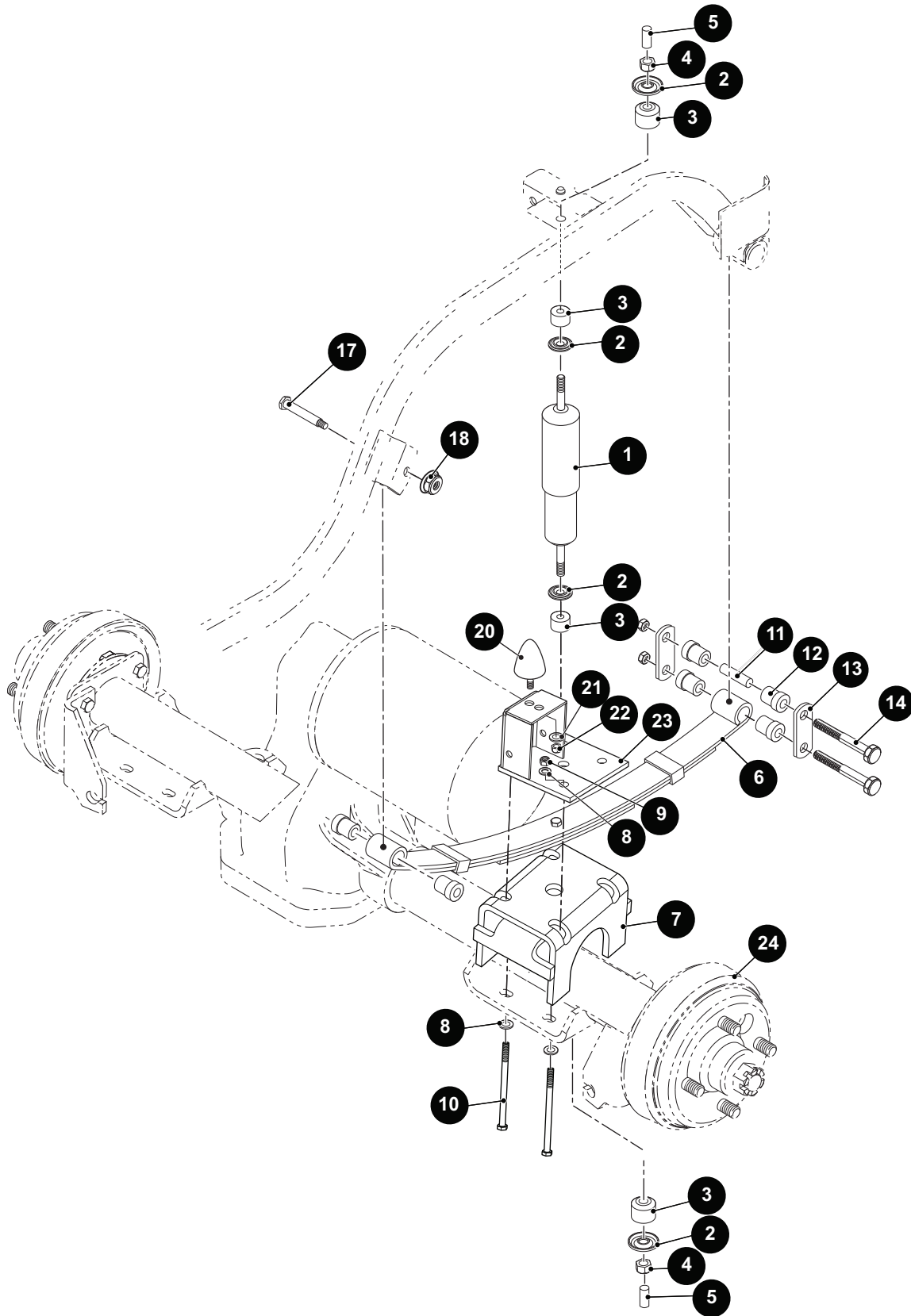
The shock absorber nuts (4) must be tightened until the shock absorber bushings (3) expand to the diameter of the shock absorber washer (2) (Ref ).

Tighten the front spring hardware (17) to 21 - 25 ft. lbs. (28 - 34 Nm) torque.

Tighten all other hardware to 18 - 22 ft. lbs. (24 - 30 Nm) torque.

# REAR SUSPENSION

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



**Fig. 1 Rear Suspension**

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

## REAR AXLE REMOVAL

Tool List	Qty
Lug Wrench, 3/4" .....	1
Impact Wrench .....	1
Impact Socket, 3/4" .....	1
Torque Wrench, ft. lbs. ....	1
Socket, 3/4" .....	1
Ratchet .....	1
Thread Locking Sealant .....	A/R
Wrench, 12mm .....	1
Wheel Chocks .....	4
Jack Stands .....	4
Floor Jack .....	1
Wrench, 1/2" .....	1
Wrench, 9/16" .....	1
Wrench, 3/4" .....	1
Socket, 1/2" .....	1
Socket, 9/16" .....	1
Socket, 9/16", Deepwell .....	1
Extension, 3" .....	1
Ratchet .....	1
Torque Wrench, ft. lbs. ....	1

the governor and remove the cable. See SPEED CONTROL section. Remove the linkage rod off of the governor.

Remove the shock absorbers (see removal elsewhere in this section).

Remove the clevis pin from both brake cables where they attach to the wheel brake levers. Remove the brake cable from the brakes. Remove the retaining rings at either end of the outer brake cable and move cables out of the way of the axle.

Place a floor jack under the center section of the rear axle 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 and the hardware can be removed from the spring. Raise the back of the vehicle and take the springs loose at the rear shackle.

Slide rear axle out of vehicle.

### Rear Axle Installation

Rear axle installation is in the reverse order of removal.

Pay particular attention to placement of axle in the engine frame support. See 'Engine Installation' in the ENGINE section.

## 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' of this manual and support the rear of the vehicle on the outer ends of the rear bumper.

Remove the tires. See WHEELS AND TIRES section.

Remove the muffler. See ENGINE section. Remove the triangular bracket supporting the differential to the engine frame.

Remove the 'U' bolts holding axle to engine frame.

Remove the drive belt and driven clutch (see CLUTCHES section).

Remove the F/R shifter bracket nut and loosen the cable nuts, then remove the cable and bracket from the differential.

Remove the accelerator cable from the accelerator bracket and take off the push nut holding the cable on

## REAR SUSPENSION

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

## NOTES:

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## REAR AXLE

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

## Notes:

[illegible]



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

## REAR AXLE REMOVAL

### WARNING

*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.

### NOTICE

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). Install new cotter pins.

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. 1 Motor Wiring - 48 Volt

## 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 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.*

### NOTICE

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.

### WARNING

*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

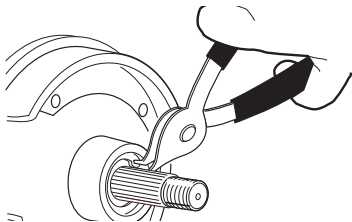
Read all of Section B and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.

## AXLE SHAFT REMOVAL AND DISASSEMBLY

Tool List	Qty.
Arbor press .....	1
Bearing separator .....	1
Needle nose pliers .....	1
Internal snap ring pliers .....	1
Slide hammer, P/N 18753G1 .....	1

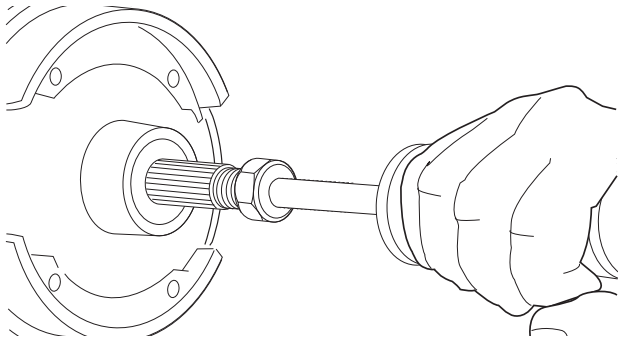
For brake drum removal, see BRAKE section.

Remove the outer snap ring from the axle tube(Ref. Fig. 2).



**Fig. 2 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. 3).

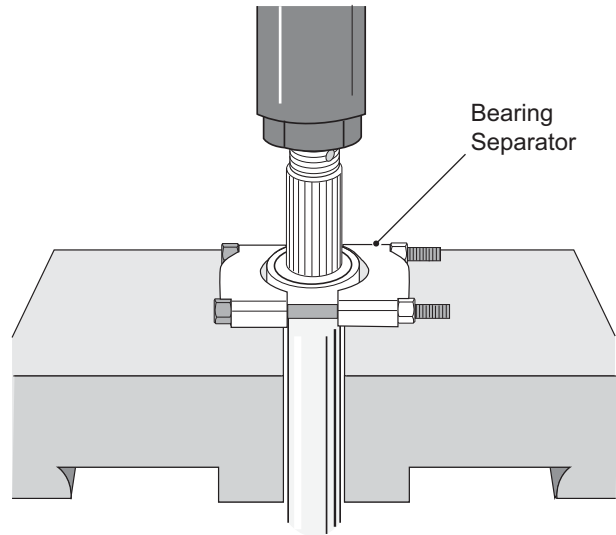


**Fig. 3 Removing/Installing Axle Shaft**

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. 4).

## AXLE SHAFT SEAL REMOVAL AND REPLACEMENT

Tools List	Qty.
Internal snap ring pliers.....	1
Seal puller .....	1
Seal installer, P/N 18739G1 .....	1
Ball peen hammer .....	1



**Fig. 4 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. 5 on Page N-3).

Use a puller to remove the seal (Ref. Fig. 6 on Page N-3).

To install the seal, use the special seal installer to drive the seal into its correct position (Ref. Fig. 7 on Page N-3).

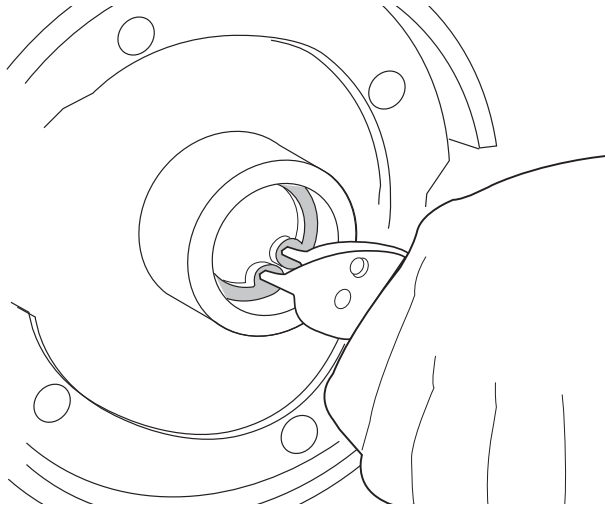


### CAUTION

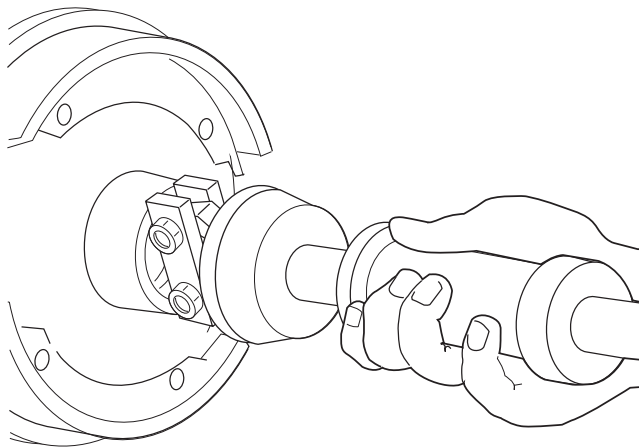
To prevent seal damage, lightly coat the axle shaft with bearing grease and support the shaft during installation.

Install the inner snap ring (Ref. Fig. 5 on Page N-3).

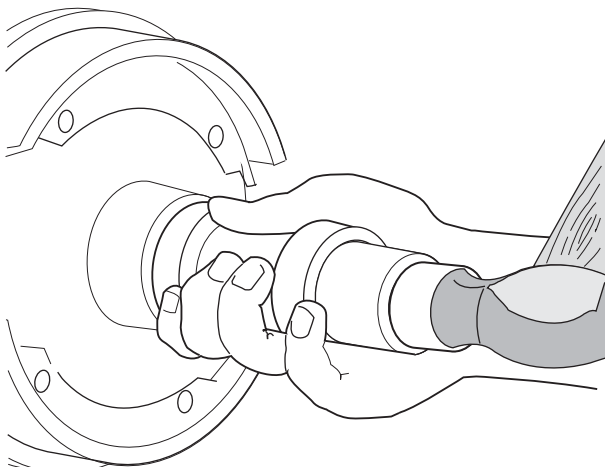
Read all of Section B and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.



**Fig. 5 Removing/Installing Inner Snap Ring**



**Fig. 6 Removing Seal**



**Fig. 7 Installing Seal**

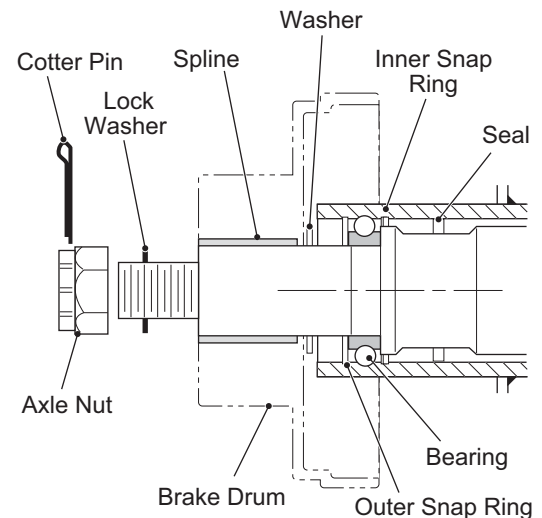
## AXLE SHAFT REPLACEMENT

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. 8)

## NOTICE

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. 8 Cut Away of Outer Bearing and Break Drum**

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

Notes:

This image shows a full page of blank graph paper. The grid consists of thin, light gray horizontal and vertical lines that intersect to form small squares across the entire surface. There are no margins, text, or other markings on the paper.

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Rear Support Installation .....	P - 1
Front Strut .....	P - 1
Sun Top .....	P - 1
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## LIST OF ILLUSTRATIONS

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Fig. 2 Split Windshield .....	P - 3
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## WEATHER PROTECTION

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

## Notes:

This image shows a full page of blank graph paper. The background is a very light gray color. Overlaid on this background is a precise grid of thin, medium-gray lines. These lines intersect at right angles to form a continuous pattern of small, identical squares across the entire surface of the page. There are no margins, text, or other markings present.

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

## SUN TOP AND WINDSHIELD

### WARNING

*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

### WARNING

*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 trailer.*

*Remove windshield before trailer.*  
*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 trailer the vehicle.

## SUN TOP

### Tool List

### Qty.

Plastic Faced Mallet.....	1
Wrench, 1/2" .....	2
Wrench, 9/16" .....	2
Hex Wrench, 7/32" .....	1
Straight Blade Screwdriver.....	1

### Rear Support Installation

1. At driver side of vehicle, align the holes in the rear strut (5) with the holes in the seat back support bracket, being sure that the open end of the strut faces the front of the vehicle as shown (See Detail C).
2. Insert bolt (11) through the seat back support bracket. Place nylon washer (8) between seat back support bracket and rear strut.
3. Secure with washer (10) and lock nut (11) at outer

side of rear strut as shown. Finger tighten hardware to allow for adjustment.

4. Repeat procedure with rear strut at passenger side of vehicle.

### Front Struts

1. Remove and discard the four bolts from the front cowl (See Detail A).
2. At the upper hole (both sides of vehicle), install the front strut (3) with bolt (18) on the outside of strut, and a spacer between the front cowl and strut. Finger tighten hardware to allow for adjustment.
3. At the lower hole, secure the strut with bolt (18) and lock nut (1) on the outside of strut between the front cowl and strut as shown. Finger tighten hardware to allow for adjustment.

### Sun Top

1. Place sun top (17) onto struts (See Detail D).
2. At front of vehicle, secure sun top loosely with bolts (18), washers (15) and lock nuts (16). Finger tighten hardware to allow for adjustment.
3. Tighten all hardware to 13 - 15 ft. lbs. (18 - 20 Nm) torque. (See Detail D)

# WEATHER PROTECTION

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

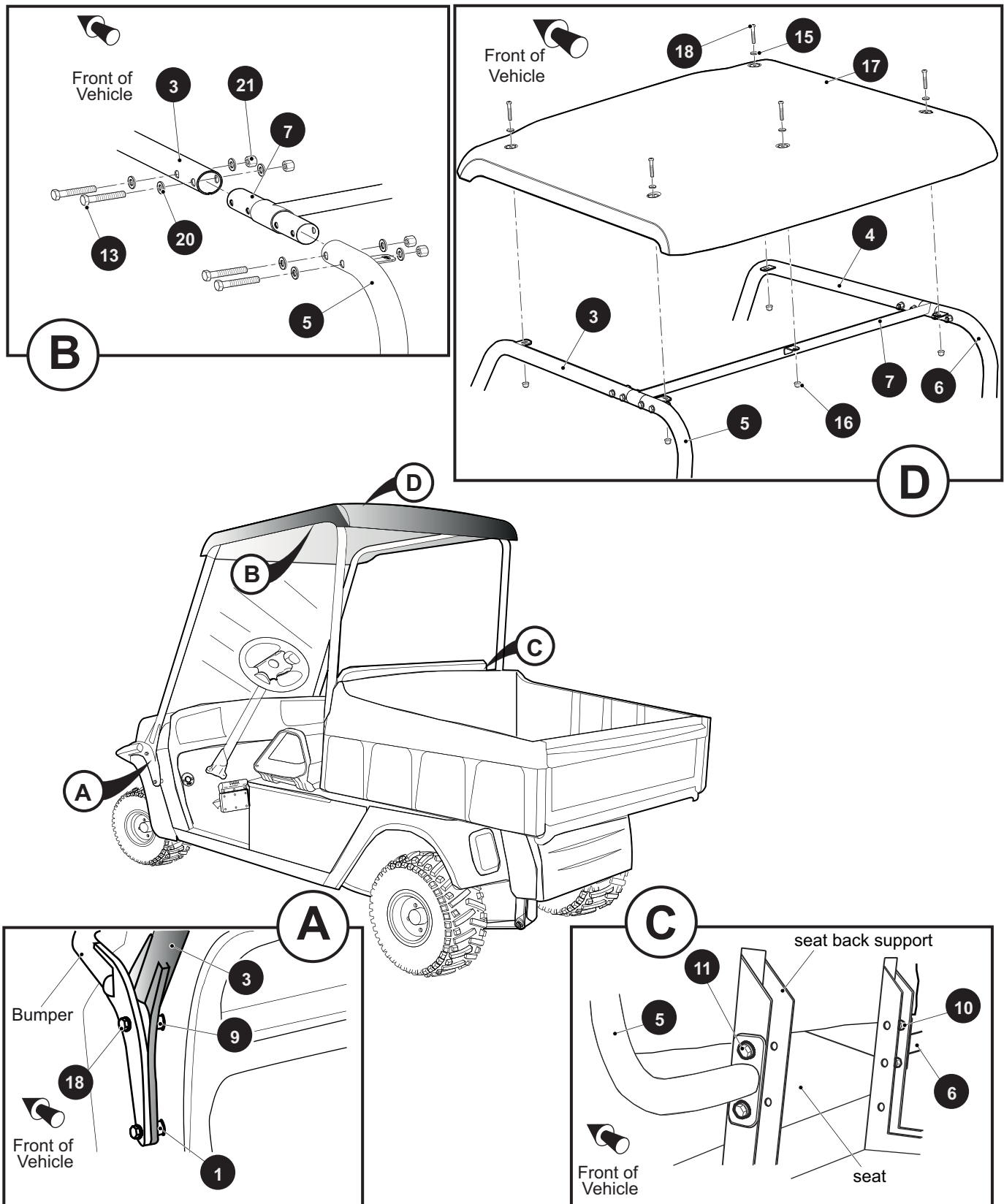


Fig. 1 Sun Top



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

## SPLIT WINDSHIELD

### Tool List

	Qty.
Plastic faced mallet .....	1
Wrench, 7/16" .....	1
Phillips screwdriver .....	1

Remove protective covering from the windshield (2) (Ref. Fig. 2).

Install sash (3) on each side of the lower section of windshield. Using a plastic faced mallet, gently tap sash to ensure windshield seats properly (See Detail A).

Insert bolt (4) through washer (5), rubber grommet (6) and existing hole in front strut. Secure with washer (5) and lock nut (7) (See Detail B). **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 (See Details B and C). Repeat for opposite side of windshield.

Position top grips (8) as shown (See Detail D) at top hole on each side of front strut. Secure with top grip fasteners (9).

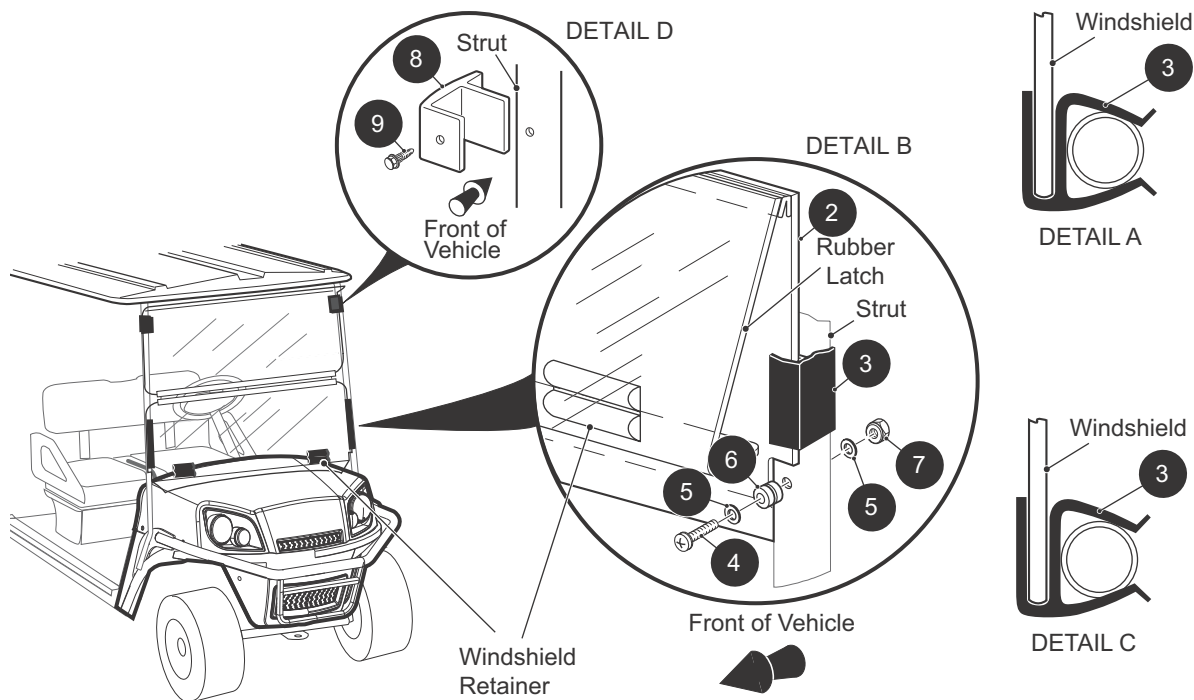


Fig. 2 Split Windshield

### NOTICE

It may be necessary on early production sun tops to drill a 9/32" hole in front face of both sides of front strut approximately 7" down from top of strut.

Swing the top section of windshield up and secure by hooking the top grip on each side of strut around the windshield.

To secure windshield when lowered, press edge of windshield firmly into windshield retainers (See Detail B).



### CAUTION

Take care not to warp windshield when raising and lowering the top section of windshield.

# WEATHER PROTECTION

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

## FULL WINDSHIELD

### Tool List

	Qty.
Plastic faced mallet.....	1
Wrench, 7/16" .....	1
Phillips screwdriver .....	1
Remove protective covering from the windshield (2) (Ref. Fig. 3).	

Install sash (3) on each side of the windshield. Using a plastic faced mallet, gently tap sash to ensure windshield seats properly (See Detail A).

Insert screw (4) through washer (5), rubber grommet (6) and existing hole in front strut. Secure with washer (5) and lock nut (7) (See Detail B). **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 (See Details B and C). Repeat for opposite side of windshield.

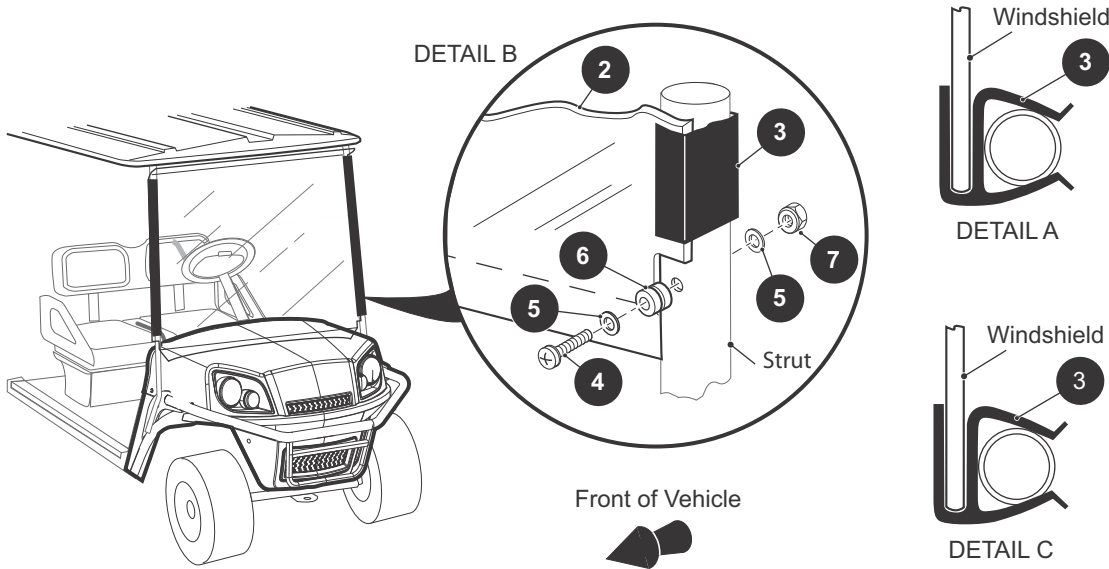


Fig. 3 Full Windshield

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

## Notes:

This image shows a full page of blank graph paper. The background is a very light gray, and it is covered by a precise grid of thin, darker gray lines. The grid consists of small, equal-sized squares that extend across the entire area of the page, leaving no margins or other markings.

## WEATHER PROTECTION

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## Notes:

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Basic Electrical Troubleshooting for Accessories .....	Q - 2
<b>SUSPENSION AND STEERING</b> .....	<b>Q - 3</b>

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

NOTES:

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

## ELECTRICAL SYSTEM

Condition	Possible Cause	Correction
VEHICLE WILL NOT MOVE  Refer to Section F (Electronic Speed Control)	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
	Ignition interlock switch has failed	Replace reed switch (portable) Replace relay (on-board charger)
VEHICLE SPEED ERRATIC	Faulty ESC system	Test and replace components as indicated by test procedure
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
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

# TROUBLESHOOTING

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

## **Basic Electrical Power System Troubleshooting**

To diagnose electrical problems in the electrical power system, refer to 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.



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

## 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)
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

## TROUBLESHOOTING

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

## Notes:

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## LIGHTNING PROTECTION AND GROUNDING

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

## Notes:

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# LIGHTNING PROTECTION AND GROUNDING

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

GS-726-006	REVISION: A	TITLE:  General Specification: Lightning Protection and Grounding
EFFECTIVE: 10/19/92	SUPERCEDES: Rev -, ECN 027194	

## 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 Notices, Cautions, Warnings and Dangers.

GS-726-006	REVISION: A	TITLE:  General Specification: Lightning Protection and Grounding
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## 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 man-made 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.

## 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 pene-

# LIGHTNING PROTECTION AND GROUNDING

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trating 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 Notices, Cautions, Warnings and Dangers.*

## Notes:

[illegible]



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## GENERAL SPECIFICATIONS

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

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# GENERAL SPECIFICATIONS

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A Textron Company

**MODEL: TERRAIN 1000**  
**TYPE: ELECTRIC POWERED TRUCK**  
**MODEL YEAR: 2012**  
**Part No: 618858**



## PRODUCT SPECIFICATION

### CONFIGURATION HIGHLIGHTS

**Precision Drive System™ (PDS):** Factory programmable to application

- Solid State continuously variable separately excited speed controller
- Dash mounted direction selector switch (Forward-Neutral-Reverse)
- Anti-roll back, walkaway braking and alarm
- Anti-stall motor protection
- Regenerative 'Pedal Down' and/or 'Pedal Up' braking
- Full torque, reduced speed reverse
- Inductive throttle sensor
- Diagnostic indicator
- Factory selectable performance options

**Battery Charger:** 48 VDC PowerWise™, 120/230 VAC 50/60 Hz. Underwriters Laboratories (U.L.) Listed, (C.S.A. Certified)

**Motor:** 48 Volt DC shunt wound, brazed armature, solid copper windings. Non vented 2.5 hp (1.9 kW) @ 2700 rpm (1 hour)

**Drive Train:** Direct motor shaft connected to transaxle pinion shaft

**Electrical System:** 48 Volt DC, eight, 6 volt deep cycle storage batteries batteries (115 minute minimum, 225 amp-hour @ 20 hr. discharge rate)

**Transaxle:** Differential with helical gears

**Brakes:** Dual rear wheel mechanical self-adjusting drum brakes. Automatic single point park brake release with self-compensating system

**Cargo Bed:** Roto-molded cross-linked polyethylene. Lifts for access to powertrain. Removable hinged multi-position tailgate requires no latch mechanism

## PRODUCT OVERVIEW

### Dimensions

Overall Length	111.5 in (283.0 cm)
Overall Width	49.5 in (126.0 cm)
Overall Height (No Canopy)	49.5 in (126.0 cm) (Top of steering wheel)
Overall Height (With Canopy)	78.5 in (199.0 cm)
Wheel Base	77.0 in (196.0 cm)
Front Wheel Track	38.0 in (97.0 cm)
Rear Wheel Track	38.5 in (98.0 cm)
Gnd Clearance @ Differential	6.0 in (15.0 cm)
Cargo Box Width (inside)	44.0 in (112.0 cm)
Cargo Box Length (inside)	36.0 in (91.0 cm)
Cargo Box Depth (inside)	10.5 in (27.0 cm)
Cargo Box Capacity	9.6 cu ft (0.27 m <sup>3</sup> )
Cargo Box Material	Roto-molded polyethylene

### Vehicle Power

Power Source	48 Volts DC
Motor Type	Shunt Wound
Horsepower (kW)	2.5 hp (1.9 kW) @ 2700 rpm
Electrical System	48 Volt
Batteries (Qty, Type)	Eight, 6 Volt Deep Cycle
Key or Pedal Start	Pedal Start
Speed Controller	48VDC PowerWise™ w/10.0 ft (3.0 m)
Battery Charger	DC Cord
Drive Train	400 Amp Precision Drive System (PDS)
Transaxle	Motor Shaft Direct Drive
Gear Selection	Differential with helical gears
Rear Axle Ratio	Dash Mounted Forward-Neutral-Reverse 14.7:1

### Performance

Seating Capacity	2 Persons
Dry Weight	820.0 lb (375.0 kg) (Without Batteries)
Curb Weight	1310.0 lb (595.0 kg)
Bed load capacity	550.0 lb (250.0 kg)
Vehicle load capacity	1000.0 lb (450.0 kg)
Outside Clearance Circle	22.0 ft (6.7 m)
Intersecting Aisle Clearance	N/A
Speed (Level Ground)	16.0 mph ± 0.5 mph (26.0 kph ± 0.8 kph)
Towing Capacity	600.0 lb (270.0 kg) max load

### Steering & Suspension

Steering	Self-compensating rack and pinion
Front Suspension	Leaf springs with hydraulic shock absorbers
Rear Suspension	Leaf springs with hydraulic shock absorbers
Service Brake	Rear wheel mechanical self-adjusting drum
Parking Brake	Self-compensating, single point engagement
Front Tires	Stryker 22.0 x 9.0 -10.0 Uni-directional
Rear Tires	Stryker 22.0 x 9.0 -10.0 Uni-directional

### Body & Chassis

Frame	Welded steel with DuraShield™ powder coat
Front Body & Finish	Injection molded TPO
Standard Color	Hunter Green

### Noise & Vibration

Noise	Sound pressure; continued A-weighted equal to or less than 70 db(A)
Vibration, WBV	Highest RMS value of weighted acceleration is 0.98 m/s <sup>2</sup>
Vibration, HAV	Highest RMS value of weighted acceleration is less than 2.5 m/s <sup>2</sup>
	The uncertainty of measurement is 0.39 m/s <sup>2</sup>

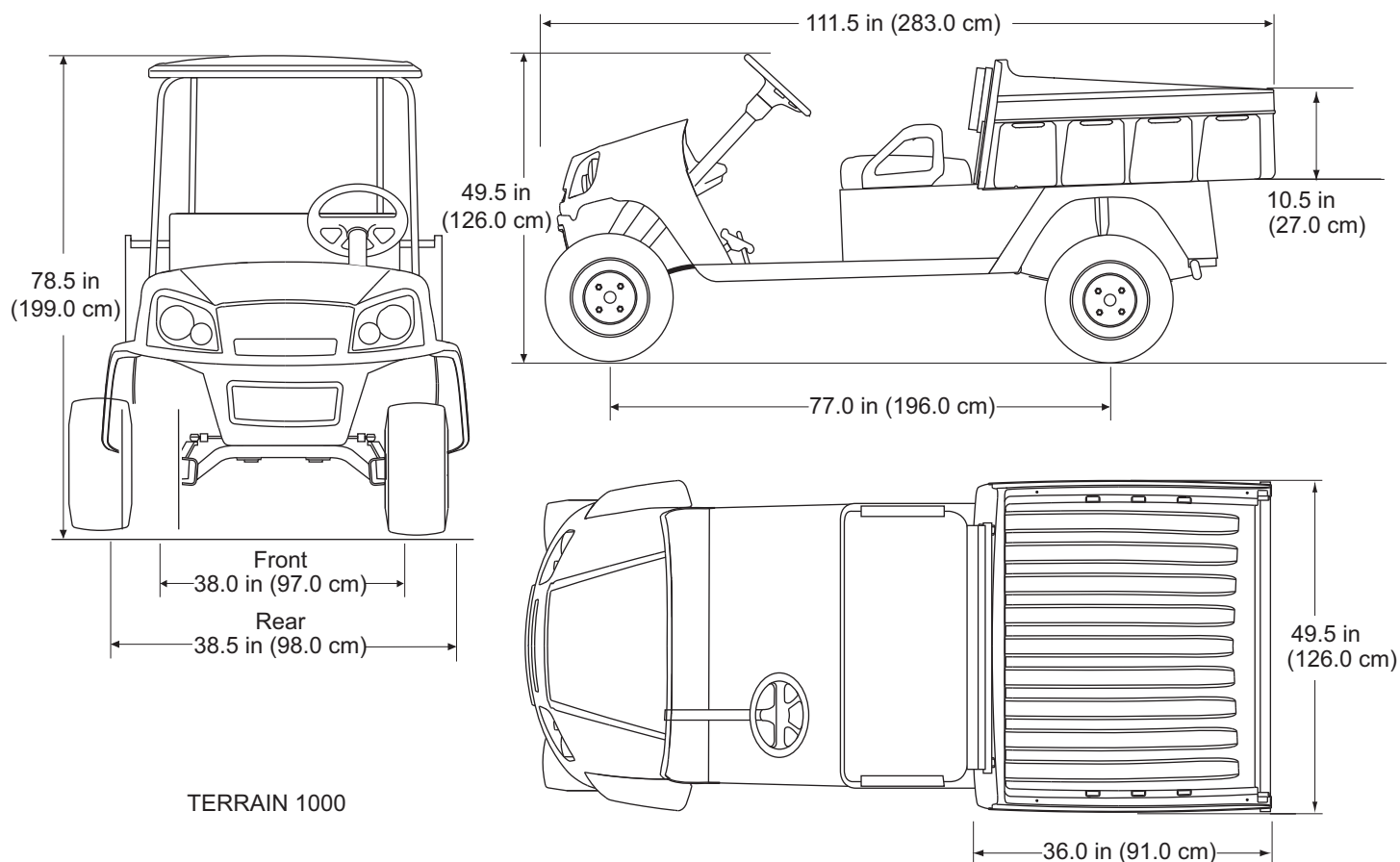
*Some items shown may be optional equipment*

Specifications are subject to change without notice

\* Field installed accessories may require installation charges

# GENERAL SPECIFICATIONS

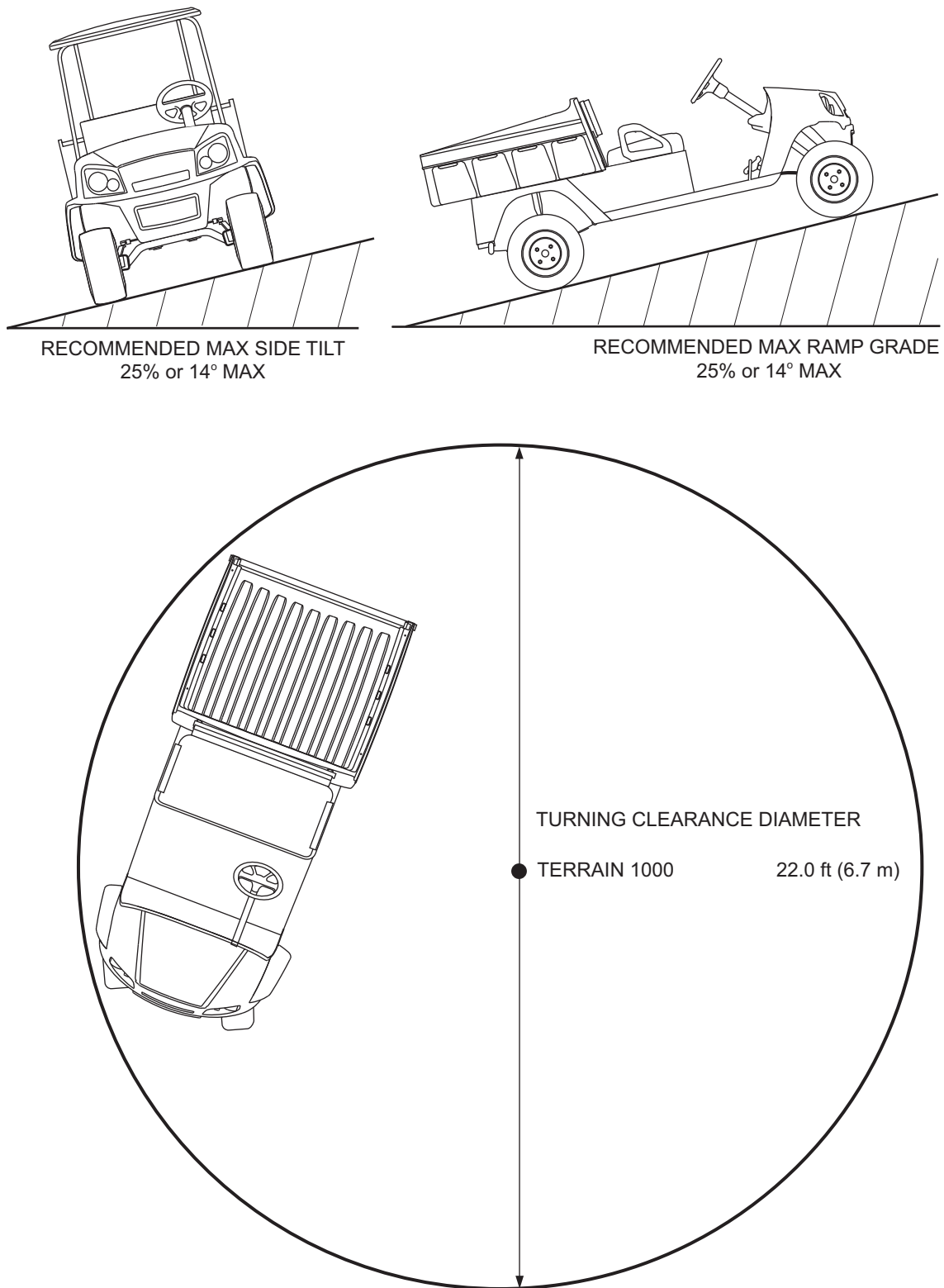
*Read all of Section B and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.*



**Fig. 1 Vehicle Dimensions**

# GENERAL SPECIFICATIONS

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



**Fig. 2 Vehicle Dimensions, Incline Specifications and Turning Clearance Diameter**

## GENERAL SPECIFICATIONS

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

## Notes:

This image shows a full page of blank graph paper. The grid consists of thin, light gray horizontal and vertical lines that intersect to form small squares across the entire surface. There are no margins, text, or other markings on the paper.





A Textron Company

**E-Z-GO Division of Textron Inc.,**  
1451 Marvin Griffin Road, Augusta, Georgia 30906 - 3852 USA

**TO CONTACT US...**

North America:

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