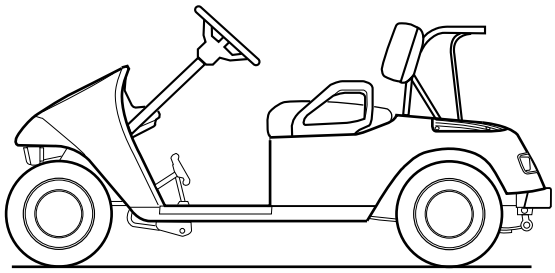
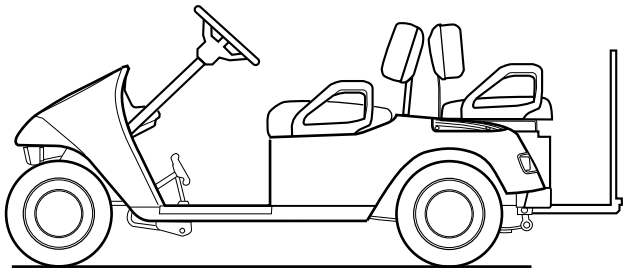
A Textron Company

REPAIR AND SERVICE MANUAL

TXT 48V

ELECTRIC POWERED GOLF CAR





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ISSUED JANUARY 2010

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SAFETY

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

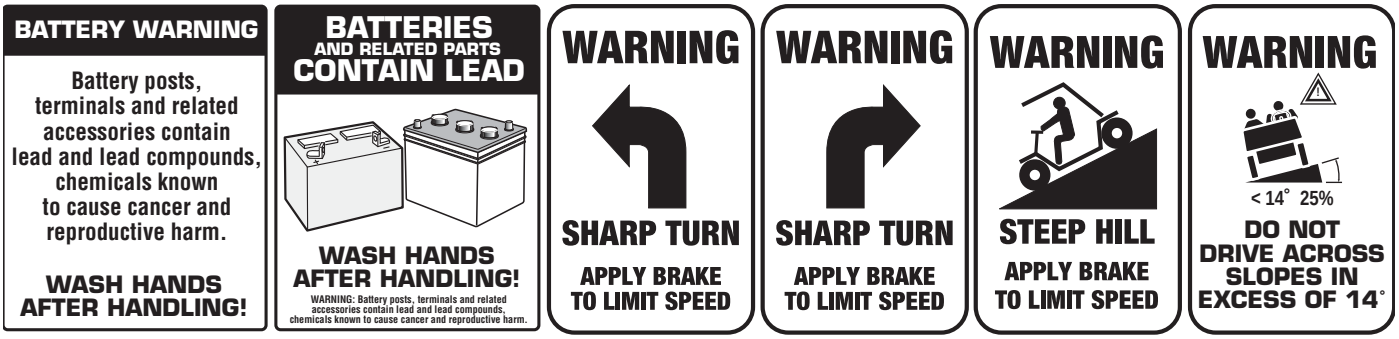
Read and understand all labels located on the vehicle. Always replace any damaged or missing labels.

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.

Use extra caution when towing the vehicle(s). Do not tow a single vehicle at speeds in excess of 12 mph (19 kph). Do not tow more than three vehicles at a time. Do not exceed 5 mph (8 kph) while towing multiple vehicles. Towing the vehicle at above the recommended speed may result in personal injury and/or damage to the vehicle and other property. Vehicles equipped with the AC Drive motor must be towed with the Run-Tow switch, located under the passenger seat, in the 'Tow' position.

If the vehicle is to be used in a commercial environment, signs similar to the ones illustrated should be used to warn of situations that could result in an unsafe condition



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.

NOTICES, CAUTIONS AND WARNINGS

NOTICE

Address practices not related to personal injury.

⚠ 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

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

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

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TECHNICIAN'S REPAIR AND SERVICE MANUAL

ELECTRIC POWERED PERSONAL VEHICLE GOLF CARS

TXT 48V FLEET

TXT 48V FREEDOM

Starting Model Year 2010

E-Z-GO Division of TEXTRON, Inc. 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.

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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:
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E-Z-GO DIVISION OF TEXTRON, INC., 1451 MARVIN GRIFFIN ROAD, AUGUSTA, GEORGIA USA 30906-3852

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GENERAL INFORMATION

To obtain a copy of the limited warranty applicable to the vehicle, call or write a local distributor, authorized Branch or the Warranty Department with vehicle serial number and manufacturer code.

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

Overfilling battery may void the warranty.

BATTERY PROLONGED STORAGE

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

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

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

Disconnect the controller from the battery set by selecting the 'TOW/MAINTENANCE' position on the RUN-TOW/MAINTENANCE SWITCH located under the passenger seat.

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

Refer to the 'Prolonged Storage' section within the BATTERIES AND CHARGING section of this manual.

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SAFETY INFORMATION

Read all of manual to become thoroughly familiar with this vehicle. Pay particular attention to all Notices, Cautions, Dangers and Warnings

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

GENERAL

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

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

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

E-Z-GO Division of Textron 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.

E-Z-GO Division of Textron is not liable for errors in this manual or for incidental or consequential damages that result from the use of the material in this manual.

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

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

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

Refer to GENERAL SPECIFICATIONS for vehicle seating capacity.

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

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

GENERAL OPERATION

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

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

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

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SAFETY INFORMATION

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

Always reduce speed to compensate for poor terrain or conditions.

Always apply service brake to control speed on steep grades.

Always maintain adequate distance between vehicles.

Always reduce speed in wet areas.

Always use extreme caution when approaching sharp or blind turns.

Always use extreme caution when driving over loose terrain.

Always use extreme caution in areas where pedestrians are present.

MAINTENANCE

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

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

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

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

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

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

Always use recommended tools.

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

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

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

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

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

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

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

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

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SAFETY INFORMATION

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

VENTILATION

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

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

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

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

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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.

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Read all of this manual to become thoroughly familiar with this vehicle. Pay particular attention to all Notices, Cautions, Dangers and Warnings.

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).

Vehicle batteries must be fully charged before initial use.

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Read all of this manual to become thoroughly familiar with this vehicle. Pay particular attention to all Notices, Cautions, Dangers and Warnings.

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

ROUTINE MAINTENANCE

NOTICE

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

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

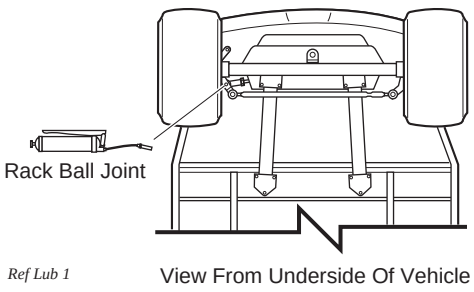

Fig. 2 Lubrication Point

⚠ CAUTION

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

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

REAR AXLE

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

BRAKES

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

⚠ WARNING

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

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

TIRES

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

LIGHT BULB REPLACEMENT

Refer to ELECTRICAL SYSTEM for information regarding light bulb replacement.

VEHICLE CLEANING AND CARE

⚠ CAUTION

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

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

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

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

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

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

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

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

Corrosive materials used as fertilizers or for dust control can collect on the underbody of the vehicle. These materials will accelerate corrosion of underbody parts. It is recommended that the underbody be flushed 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 28140-G** and 28432-G**).
- Multi-purpose Battery Protectant formulated to form a long-term, flexible, non-tacky, dry coating that will not crack, peel or flake over a wide temperature range (P/N 75500-G01).
- White Lithium Grease designed to provide lubrication protection in areas where staining or discoloring is a problem, or in areas of extreme temperature ranges (P/N 75502-G01).
- Penetrant/Lubricant, a 4-in-1 product that penetrates the most stubborn of frozen parts, lubricates leaving a light lubricating film, prevents corrosion by adhering to wet or dry surfaces and displaces moisture, sealing against future moisture return (P/N 75503-G01).
- Multi-purpose Cleaner and Degreaser that contains natural, environmentally safe solvents (P/N 75504-G01).
- Multi-purpose Hand Cleaner is an industrial strength cleaner containing no harsh solvents, yet gently lifts grease off hands. May be used with or without water (P/N 75505-G01).
- Battery Cleaner that promotes easy, non-violent neutralization of battery acids and battery acid crystals. The resulting sodium salts are water soluble and easily washed away (P/N 75506-G01).
- Battery Maintenance Kit for complete battery cleaning and watering, with battery maintenance instructions (P/N 25587-G01).
- Biodegradable Cleaner that cleans the toughest dirt and heavy soils by breaking down grease to be easily wiped or rinsed away (P/N 75507-G01).
- Multi-purpose Value Pack sampler package including 4 ounce (118 ml) aerosol cans of Battery Protector, Penetrant/Lubricant, White Lithium Grease, and Carburetor and Choke Cleaner (P/N 75508-G01).
- Plexus plastic cleaner and polish removes minor scratches from windshield (P/N 28433-G**).

SUN TOP AND WINDSHIELD

⚠ WARNING

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

The windshield does not provide 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.

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Read all of this manual to become thoroughly familiar with this vehicle. Pay particular attention to all Notices, Cautions, Dangers and Warnings.

HARDWARE

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

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

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

TORQUE SPECIFICATIONS

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)			

Ref Tsp 1

Fig. 3 Torque Specifications

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Read all of this manual to become thoroughly familiar with this vehicle. Pay particular attention to all Notices, Cautions, Dangers and Warnings.

PERIODIC SERVICE SCHEDULE

✓ Check ♦Clean, Adjust, etc. ▲ Replace

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

DAILY	
	BEFORE USE: ✓ Check service brake general operation ✓ Check park brake function ✓ Check warning device function in reverse ✓ Check tire condition ✓ Check overall vehicle condition
BATTERIES	♦ Recharge to full charge state after each day's use
CHARGER / RECEPTACLE	✓ Inspect connector system at each charge
WEEKLY	
TIRES	✓ Examine for cuts, excessive wear and pressure (See GENERAL SPECIFICATIONS)
WHEELS	✓ Check for bent rims, loose or missing lug nuts
MONTHLY - 20 HOURS (includes items listed in previous table & the following)	
BATTERIES	♦ Clean battery & terminals ✓ Check charge condition and all connections
WIRING	✓ Check all wiring for loose connections and broken/missing insulation
SERVICE BRAKE	✓ Conduct brake performance test
BRAKE FLUID (IF EQUIPPED)	✓ Check for leakage
ACCELERATOR	✓ Check for smooth movement
CHARGER / RECEPTACLE	♦ Clean connections, keep receptacles free of dirt and foreign matter
DIRECTION SELECTOR	✓ Check attachment, adjust as required
STEERING ASSEMBLY	✓ Check for abnormal play, tightness of all hardware
TIE ROD/LINKAGES	✓ Check for excessive play, bent components or loose connections
REAR AXLE	✓ Check for leakage, add SAE 30 oil as required
QUARTERLY - 50 HOURS (includes items listed in previous tables & the following)	
FRONT AXLE	✓ Check for damage to axle and loose or missing hardware
FRONT SHOCK ABSORBERS	✓ Check for oil leakage and loose fasteners
FRONT SPRINGS	✓ Check for loose hardware, cracks at attachments
FRONT WHEEL ALIGNMENT	✓ Check for unusual tire wear, align if required

Fig. 4 Periodic Service Schedule

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Read all of this manual to become thoroughly familiar with this vehicle. Pay particular attention to all Notices, Cautions, Dangers and Warnings.

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

Fig. 4 Periodic Service Schedule

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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.

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NOTICES, CAUTIONS, WARNINGS AND DANGERS

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

NOTICE

A NOTE indicates a condition that should be observed.

⚠ CAUTION

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

⚠ WARNING

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

⚠ 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 become caught in the moving parts of the powertrain.

Use care not to contact hot objects.

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

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

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

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

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

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

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

Additional Warnings

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

⚠ 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 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.

⚠ CAUTION

Overfilling batteries may result in electrolyte being

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expelled from the battery during the charge cycle. Expelled electrolyte may cause damage to the vehicle and storage facility.

BATTERY REMOVAL & INSTALLATION

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

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 TCT 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 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.

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

Using an insulated wrench, remove the negative (-) cable first, the positive (+) cable and then all other cables from the vehicle batteries. Remove the battery hold down by removing the hardware and lifting the retainer from the batteries.

Remove the batteries using a commercial battery carrier.

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

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

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

⚠ WARNING

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

Use care to connect battery cables as shown in the following illustration (Ref. Fig. 1). **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 95 - 105 in. lbs. (11 - 12 Nm). Protect the battery terminals and battery cable terminals with a commercially available protective coating.

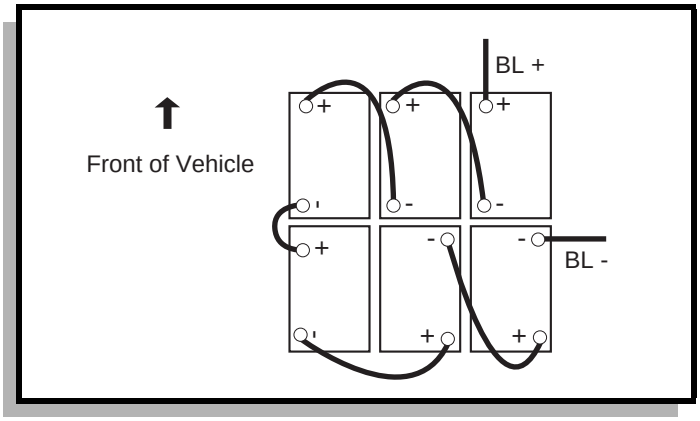

Fig. 1 Battery Connections

LIFTING THE VEHICLE

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

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Some servicing operations may require the vehicle be raised.

⚠ WARNING

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

⚠ 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 (Ref. Fig. 2). Center jack under the rear frame crossmember. Raise vehicle and locate a jack stand under outer ends of rear axle.

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

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

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

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

Lower the vehicle by reversing the lifting sequence.

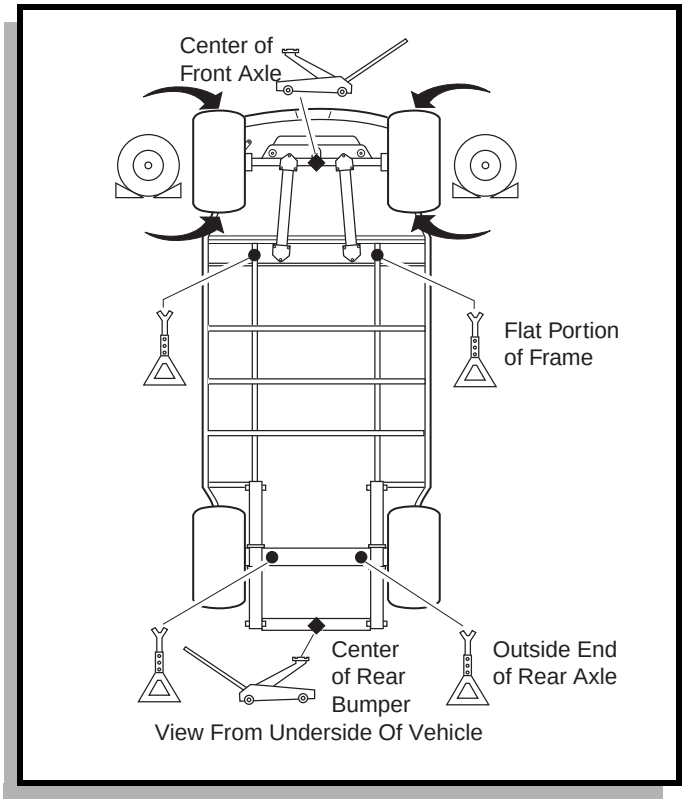

Fig. 2 Lifting the Vehicle

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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 could generate sparks or repairs that require welding or cutting.

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

In general, body component replacement can be accomplished with a minimum of specialized tools. Most body components are held in place with conventional removable hardware (nuts, bolts, washers and screws). Some components are mounted with 'pop' rivets which require that the rivet head be removed in order to push out the shank of the rivet. The rivet head is easily removed by drilling into the head with a **sharp** drill bit that is **slightly** larger than the shank of the rivet (Ref. Fig. 1 on Page C-1). Care must be exercised when drilling to prevent the drill from being forced through the plastic body 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.

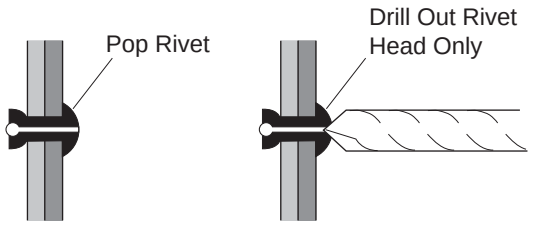

Fig. 1 Drill Out Metal Rivet

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.

Instrument Panel Replacement

Tool List	**Qty. Reqd.**
Electric/air drill	1
Drill bit, 7/32"	1
Wrench, 5/16"	1
Phillips screwdriver	1
Rivet gun	1

NOTICE

The instrument panel may be removed without removing the cowl or may be removed as part of the cowl.

When installing a replacement instrument panel, a new console safety label (4) **MUST** be ordered and placed on the new instrument panel. When ordering a replacement instrument panel, provide vehicle serial number to the Service Parts Representative who will provide the correct part number for the safety label.

⚠ WARNING

To prevent the possibility of injury due to lack of vehicle information, the correct safety label must be on the instrument panel at all times.

Using an insulated wrench, disconnect the battery cable at the negative (-) battery terminal.

Pull the front of the floor mat (5) up to expose the rivets (6) that secure the instrument panel to the floor. Drill out the rivets attaching the bottom of the instrument panel to the floor and across the top of the instrument panel attaching it to the cowl (7).

Remove the four screws (8) located within the instrument panel pockets**.**

The instrument panel (1) may now be pulled away from the cowl.

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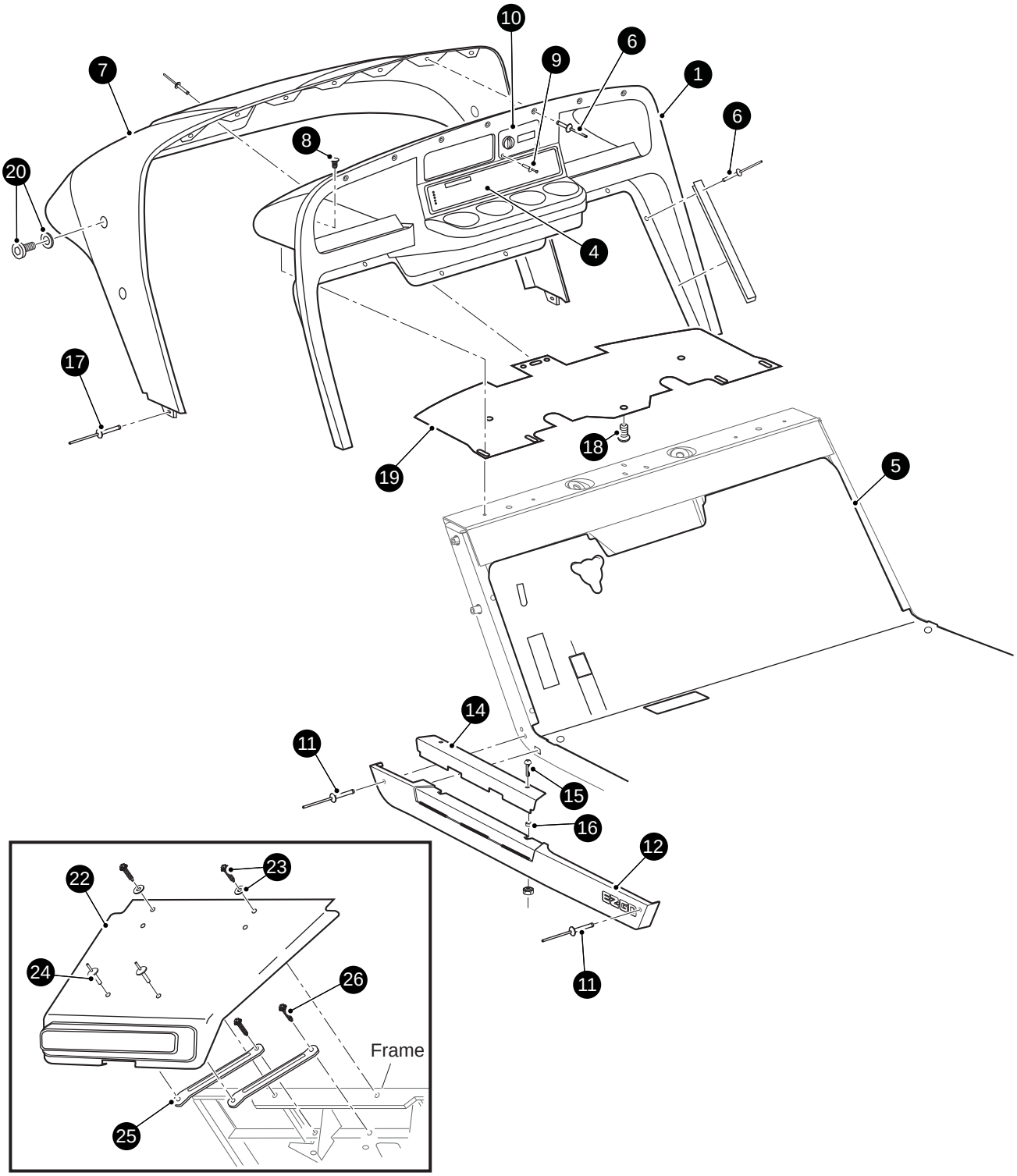

Fig. 2 Body Components (Front)

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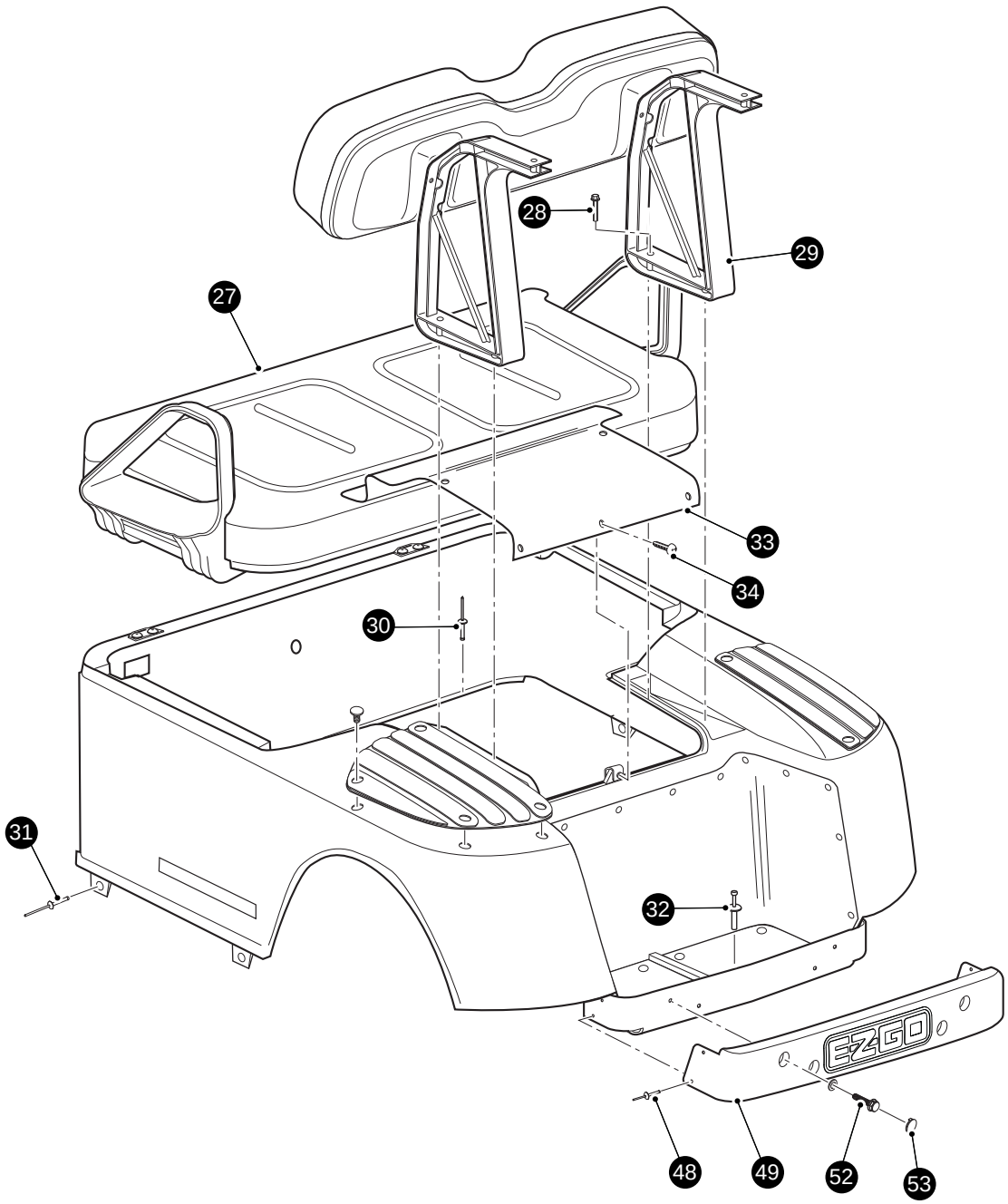

Fig. 3 Body Components (Rear)

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Remove the drive rivets (9) securing the ignition switch plate (10) to the instrument panel. Rotate the ignition switch plate and push it through the instrument panel opening, freeing the panel for removal.

Reassembly is the reverse order of disassembly and will require new rivets.

Cowl Replacement

Tool List	Qty. Reqd.
Electric/air drill	1
Drill bit, 7/32"	1
Wrench, 5/16"	1
Phillips screwdriver	1
Rivet gun	1
Duct tape	1
Allen key, 3/16"	1

Drill out the rivets (6) across the top of instrument panel (1) attaching it to the cowl (7) (Ref. Fig. 2 on Page C-2).

Remove the rivet (11) at the front and back of each rocker panel (12).

Remove the rocker panel sill plates (14) by removing the hardware (15) securing them to the frame. As the sill plate is removed, be sure to catch the three spacers (16) under each sill plate for reuse when sill plates are reinstalled.

Drill out the rivets (17) securing the sides of the cowl to the frame.

From underneath the cowl, remove the ratchet fastener (18) attaching the center of the splash panel (19) to the frame cross member.

Remove the four screws (8) located within the instrument panel pockets.

Remove the bolts and washers (20) from the sides of the cowl and lift the cowl assembly from the vehicle.

Reassembly is the reverse order of disassembly and will require new rivets. The bolts and washers (20) reinstalled into the cowl should be tightened to 8 - 12 ft. lbs torque.

Front Shield Replacement

Tool List	Qty. Reqd.
Wrench, 7/16"	1
Pry bar	1

The front shield (22) need not to be removed to replace any other body components (Ref. Fig. 2 on Page C-2).

If the front shield is damaged, remove hardware (23) securing the front shield to the frame.

Remove the two rivets (24) securing the front shield to the brackets (25).

If a bracket is damaged, remove screw (26) securing it to the frame after removing the front shield.

Install replacement shield in reverse order of disassembly.

Rocker Panel Replacement

Tool List	Qty. Reqd.
Phillips screwdriver	1
Wrench, 7/16"	1
Electric/Air drill	1
Drill bit, 7/32"	1
Rivet gun	1

Remove the rocker panel sill plates (14) by removing the hardware (15) securing them to the frame (Ref. Fig. 2 on Page C-2). As the sill plate is removed, be sure to catch the three spacers (16) under each sill plate for reuse when sill plates are reinstalled.

To remove the rocker panel, remove the rivets (11) at the front anad rear of the rocker panel (12). Unsnap the rocker panel 12) from the vehicle frame.

Replace rocker panel in reverse order of disassembly.

Align the replacement sill plate with spacers in place and install hardware.

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Body Replacement

Tool List	Qty. Reqd.
Electric/air drill	1
Drill bit, 7/32"	1
Socket, 3/8"	1
Socket, 7/16"	1
Socket, 9/16", deepwell, 3/8" drive	1
Ratchet, 3/8" drive	1
Wrench, 3/8"	1
Wrench, 7/16"	1
Wrench, 9/16"	1
Rivet gun	1
Phillips screwdriver	1
Pry bar	1

NOTICE

Prior to removing the rear body, the foot rest or cargo bed, as applicable, must be removed. See the applicable paragraphs for instructions for replacement of those items.

Remove the rocker panels as described above.

Remove seat from body (27) (Ref. Fig. 3 on Page C-3).

⚠ WARNING

To prevent possible injury or death from battery explosion, batteries should always be removed before any servicing that could generate sparks or repairs that require welding or cutting.

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

Remove hardware (28) attaching seat back supports (29) to body.

At the front of the rear body, remove the rivets (30) securing the rear body to the frame and floorboard area. Drill out the heads of the large head rivets (31) that secure the bottom of the body panel to the side of the vehicle.

Remove the rivets (32) that secure the floor of the bag-well area to the frame underneath.

Remove the body.

If the trunk lid (33) is to be reused, remove the hardware (34) securing the trunk lid to the body panel. Remove the trunk lid.

Installation of rear body is in the reverse order of disassembly using new rivets. Install the bolts (28) into the seat supports (29) and tighten to 21 - 25 ft. lbs.

Rear Bumper Replacement

Tool List	Qty. Reqd.
Electric/Air drill	1
Drill bit, 7/32"	1
Flat tip screwdriver	1
Allen wrench, 7/32"	1

For Golf Cars, drill out rivets (48) located at each end of the rear bumper (49) (Ref. Fig. 3 on Page C-3). Carefully remove the plugs (53) with a screwdriver. Remove the shoulder bolts (52) underneath the plugs. Remove the rear bumper.

To replace the bumper, place the rear bumper against the rear body panel and tighten the shoulder bolts (52) to 9 - 12 ft. lbs. torque (Ref. Fig. 3 on Page C-3). Replace the plugs. Using the existing holes in the frame as a guide, drill holes in the bumper from underneath the vehicle and install new rivets.

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WHEEL AND TIRE SERVICE

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

⚠ WARNING

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

Tire condition should be inspected 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.

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

Tire inflation should be determined by the condition of the terrain. See GENERAL SPECIFICATIONS section for recommended tire inflation pressure. For outdoor applications with major use on grassy areas, the following should be considered. On hard turf, it is desirable to have a **slightly** higher inflation pressure. On very soft turf, a lower pressure prevents tires from cutting into the turf. For vehicles being used on paved or hard surfaces, tire inflation pressure should be in the higher allowable range, but under no condition should inflation pressure be higher than recommended on tire sidewall. **All four tires** should have the same pressure for optimum handling characteristics. Be careful not to overinflate. Due to the low volume of these small tires, overinflation can occur in a matter of seconds. Be sure to install the valve dust cap after checking or inflating.

Tire Repair

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

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

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

⚠ WARNING

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

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

Wheel Installation

⚠ CAUTION

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

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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 in a 'cross sequence' pattern (Ref. Fig. 1 on Page D-2). Then, tighten lug nuts to 50 - 85 ft. lbs. (70 - 115 Nm) torque in 20 ft. lbs. (30 Nm) increments following the same 'cross sequence' pattern.

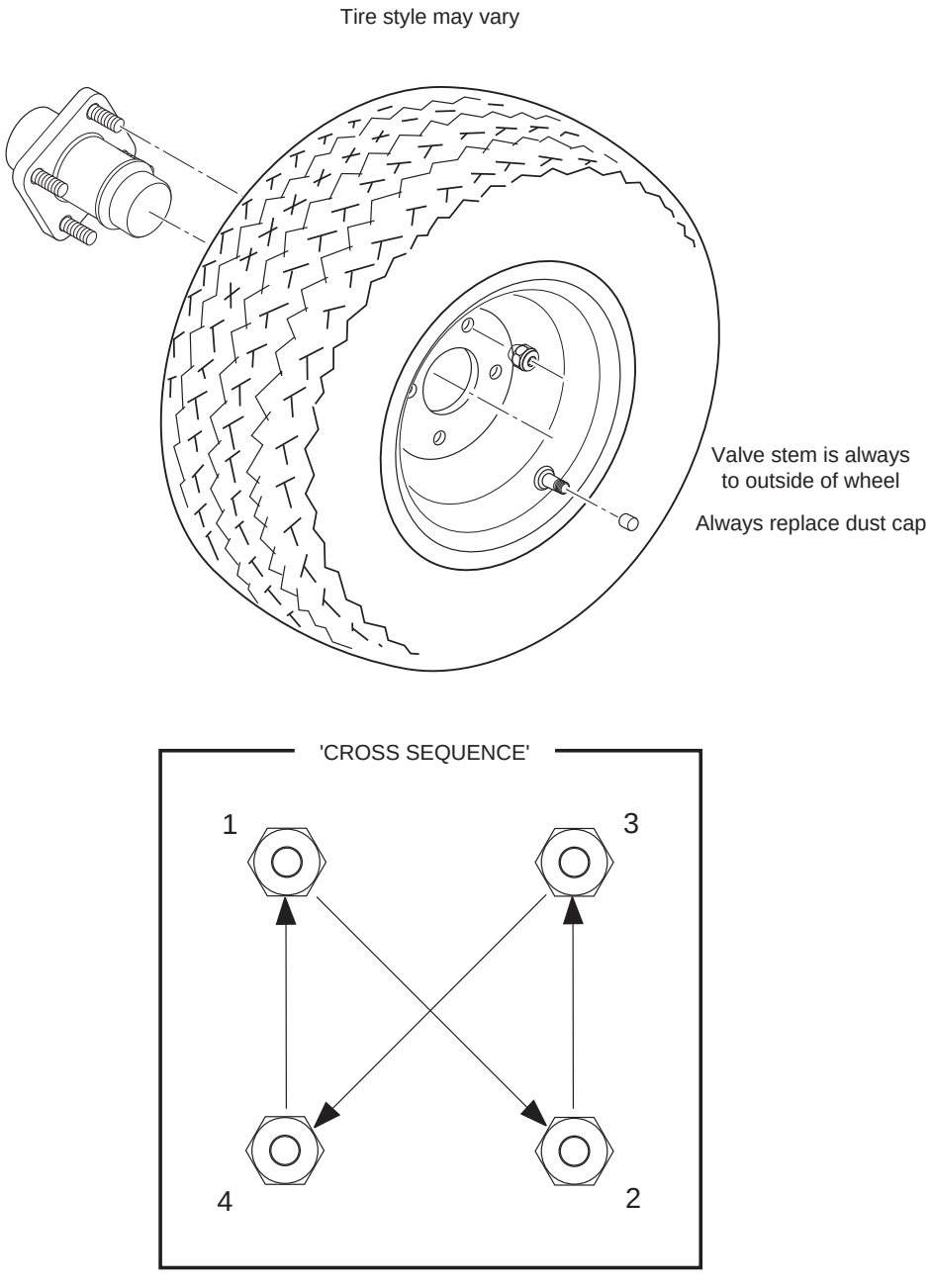

Fig. 1 Wheels and Tires

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TRUCOURSE TECHNOLOGY SYSTEM™

GENERAL

TruCourse Technology (TCT) system vehicles are operated in one of three modes or “performance options”. All options have standard features that control, protect and diagnose the vehicle. The options are defined as follows:

1. The Golf Coastal performance option: The motor’s speed is sensed and regulated to a maximum of 14.8 mph (23.8 kph) and minimum of 10.2 mph (16.4 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 regenerative braking. As the vehicle crests a hill and begins to descend, the speed will be smoothly regulated to 14.8 mph (23.8 kph). This option is enabled when there is a blank plug installed and by the handheld diagnostic tool.
2. The Golf Steep Hill performance option: This option includes all of the driving features of the Golf Coastal performance option with the motor’s speed sensed and regulated to 12.8 mph (20.6 kph) plus regenerative braking. Regenerative braking occurs when the throttle is released while the vehicle is moving. The motor will electrically resist the motion of the vehicle until the throttle is depressed again or the vehicle stops. This is the strongest of the three compression braking options. This option is enabled by the handheld diagnostic tool.
3. The Golf Mild Hill performance option: This option includes all of the driving features of the Steep Hill option with the motor’s speed sensed and regulated to 13.8 mph (22.2 kph), except that the regenerative braking feel is milder. This option is enabled by the handheld diagnotic tool.
4. The Freedom performance option: This option includes all of the driving features of the Golf Coastal option except that the flat ground and downhill compression braking speeds are 18.5 mph (29.7 kph) instead of 13.2 mph (21 kph). This option is enabled by the handheld diagnotic tool. THIS OPTION IS NOT OFFERED ON FLEET VEHICLES.

Handheld can be used anytime as long as the Run-Tow switch is not in the Tow position or when the battery charger is connected to the vehicle.

Performance options of the TCT 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 motor 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 mode by handheld only to ease troubleshooting

TRUCOURSE TECHNOLOGY (TCT) SYSTEM™ PERFORMANCE OPTIONS & DIAGNOSTICS

Performance Option	Top Speed	Regenerative Braking Strength	Anti-Stall Protection
Airport	0 - 6 mph (6 - 12.8 kph)	Coast	Yes
Golf Coastal	14.8 mph (23.8 kph)	Coast	Yes
Golf Steep Hills	12.8 mph (20.6 kph)	Heavy	Yes
Golf Mild Hills	13.8 mph (22.2 kph)	Mild	Yes
Freedom	18.5 mph (30 kph)	Coast	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 ensure that the Run-Tow/Maintenance switch is in the ‘RUN’ position.
2. Ensure that the charger is unplugged from the vehicle.
3. Locate the vehicle diagnostic port and remove the environmental cover.
4. Connect the handheld diagnostic tool and select the desired performance setting.
5. Disconnect the handheld diagnostic tool, replace the environmental cover and seat.

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At monthly intervals, test the TCT 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 TCT system is functioning. If vehicle speed continues to rise, apply the service brake to control speed and proceed with diagnostic check.

NOTICE

Charging the vehicle will also de-activate the diagnostic mode and the handheld diagnostic tool will not operate

The two-position 'Run-Tow/Maintenance' switch is located under the passenger side of the seat on the ESC environmental cover (Ref. Fig. 1 on Page E-2).

TRUCOURSE TECHNOLOGY (TCT) SYSTEM™

OPERATION

With the switch in 'TOW/MAINTENANCE' position:

- the controller is deactivated
- the electronic braking feature is deactivated which allows the vehicle to be towed or roll freely
- the warning beeper is deactivated
- With the switch in 'RUN' position:
- the controller is activated
- the electronic braking feature and warning beeper features are activated

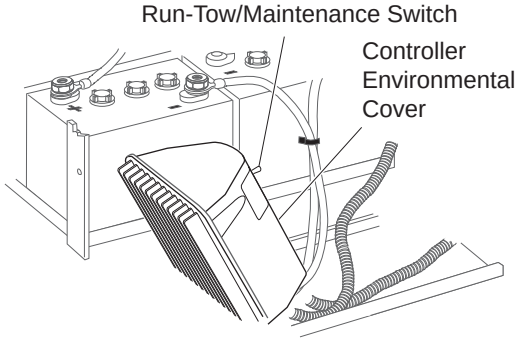

Fig. 1 Run-Tow/Maintenance Switch

NOTICE

TCT 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. The system functions in all key switch positions.

⚠ WARNING

The TCT 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.

the regenerative braking will limit the speed of the vehicle to the designed speed range.When the regenerative braking feature is activated by this sequence of events, the motor generates power which is returne d to the batteries. TCT 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 resist 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 TCT 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 deactivated allowing the vehicle to roll freely before damage can be done.

In Performance Mode option (See chart on page 1) features different degrees of regenerative breaking that takes place anytime that accelerator pedal is released. The Steep Hill option will rapidly slow the vehicle to a stop unless the accelerator pedal is depressed. The Mild

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Hill option will slow the vehicle to a stop at a slower rate unless the accelerator pedal is depressed.

The TCT has 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 TCT should be disconnected from the batteries by selecting the 'TOW/MAINTENANCE' position on the Run-Tow/Maintenance switch located under the passenger seat.

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

Pedal Box

The pedal box assembly is a modularized unit that contains the accelerator pedal, return spring and an enclosed box that contains the pedal position micro switch and a solid state Inductive Throttle Sensor (ITS) that is activated by a moving plunger attached to the accelerator pedal. To access the pedal box, remove the rocker panel, lift the floor mat, and remove the access cover from the floor (Ref. Fig. 3 on Page E-3). The ITS and plunger are accessed by removing the two screws and top cover from the enclosed pedal box.

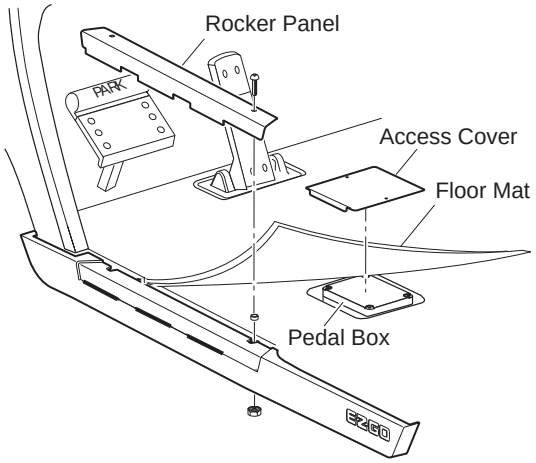

Fig. 2 Access to Pedal Box

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, motor speed sensor and many other units. The controller and solenoid are located under the seat on the passenger side of the vehicle (Ref. Fig. 3 on Page E-3).

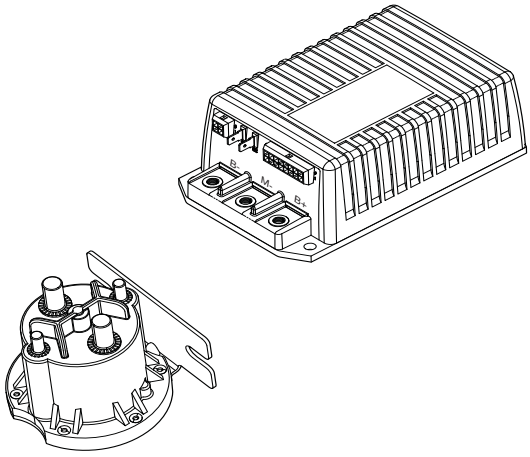

Fig. 3 Controller and Solenoid

The main wire harness, pedal box, and speed sensor are connected to the controller through a 16 pin plug (Ref. Fig. 8 on Page E-8). The pedal box is connected to the controller through a four pin plug on main wire harness. The speed sensor is connected to the controller through a three pin plug on main wire harness.

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.

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GENERAL TROUBLESHOOTING

Tool List	Qty. Required
Floor jack	1
Jack stands	2
Wheel chocks	4
Jumper wire (with alligator clips)	1
Digital Volt Ohm Meter	1
Socket, 3/8", 3/8" drive	1
Socket, 10mm	1
Ratchet, 3/8" drive	1
Torque wrench, in. lbs., 3/8" drive	1
Torque wrench, ft. lbs., 3/8" drive	1
Extension, 6", 3/8" drive	1
Insulated wrench, 9/16"	1
Wrench, 1/2"	1
Wrench, 7/16"	1
Phillips screwdriver, large	1
Phillips screwdriver, small	1
Shop towel	1
Allen wrench, .050"	1
Drill bit, 7/32"	1

Symptoms

Vehicle does not operate, operates poorly or intermittently.

Testing 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 eight 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.

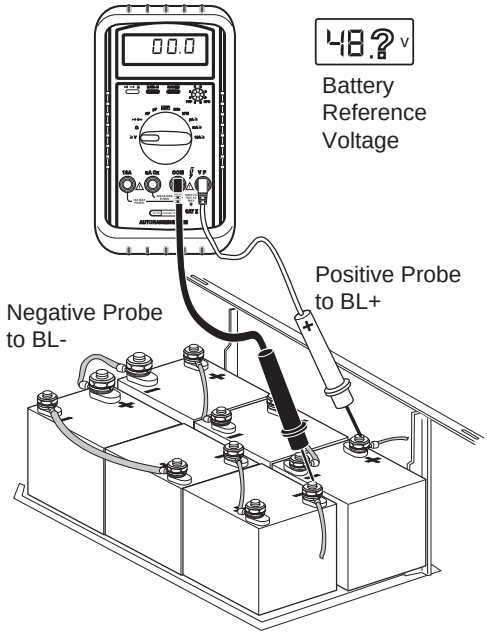

Fig. 4 Battery Reference Voltage

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 E-4). 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.

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 TCT model vehicles, the Run-Tow/Maintenance switch must be placed in the 'Tow/Maintenance' position.

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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.

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 KΩ 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 KΩ, the meter will indicate "0" when it detects continuity.

Testing a Switch for Continuity

Place one probe on one contact of the switch, place the second probe on the second terminal of the switch (Ref. Fig. 5 on Page E-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.

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 E-5). If the meter shows "0" or gives an audible indication, the solenoid terminals are "welded" closed and **the solenoid must be replaced.**

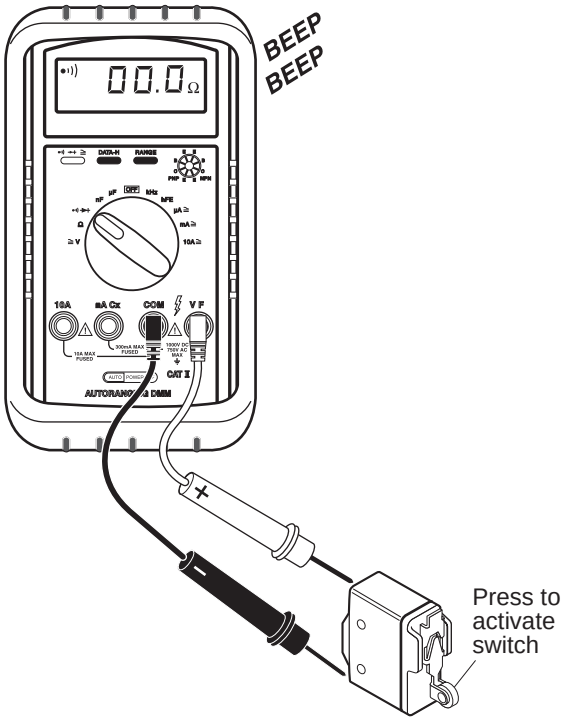

Fig. 5 Continuity Check of Switch

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.**

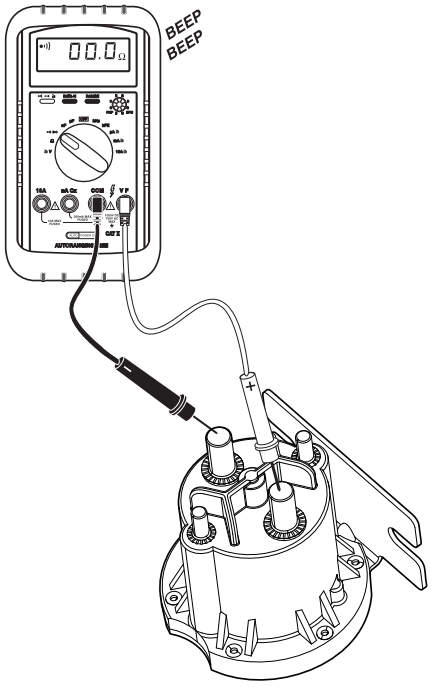

Fig. 6 Continuity Check of Solenoid

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TROUBLESHOOTING DIAGRAMS

The following diagrams will assist in servicing the vehicle. By utilizing the diagnostic mode Fault Codes, considerable time will be saved in determining the probable vehicle operating malfunction. The vehicle controller wiring diagram is included for your convenience in tracing the electrical wiring.

1206HB-5201 Controller Faults and Troubleshooting

1311 Display	Explanation	Tested When	Controller Response	Recover When	Possible Cause
HW FAILSAFE	Hardware Failsafe Error	Throttle applied to cause contactor to initially close	1,2,3	KSI cycled	1. Controller defective 2. Controller power cables mis-wired
FIELD MISSING	Motor Field Winding open	Contactor closed	2,8	Condition clears	1. Field Winding or its connection open
M- SHORTED	Armature PWM pulses not detected	Contactor Closed	1,2	Condition clears	1. Controller defective 2. Power cables shorted
CURRENT SENSE FAULT	Armature Current reading at invalid Zero Amps level Out-of-Range value	KSI OFF -> ON, Continuous	1,2,3	KSI OFF-> ON when condition cleared	1. Controller defective 2. Excessive Plug Current detected
MAIN DROPOUT 2	Contactor detected as opening during Regen	Contactor commanded to be closed	3,9	Throttle reapplied	1. Contactor opened 2. Contactor coil or wiring opened
MAIN DRIVER OFF	Main Driver FET detected as not turning ON	Throttle applied to cause Contactor to close	3,8	Condition clears	1. Controller defective
MOTOR STALL	High Armature Current when no Speed Pulses detected	Contactor closed	6	Speed Pulses appear	1. Motor is stalled 2. Defective speed sensor or wiring
MAIN DROPOUT 1	Contactor detected as opening during Drive	Contactor commanded to be closed	3,9	Throttle reapplied	1. Contactor opened 2. Contactor coil or wiring opened
MAIN COIL OPEN	Main Contactor coil detected as open	Continuous while KSI ON	3	Condition clears	1. Contactor coil or wiring open
MAIN DRIVER ON	Main Driver FET detected as ON when commanded to be OFF	Continuous while KSI ON and Contactor commanded to be open	4	Condition clears	1. Controller defective 2. Pin 12 short to ground
SPEED SENSOR FAULT	No speed pulses detected	Contactor closed	4	Condition clears	1.Defective or missing speed sensor 2. Open speed sensor wiring
MAIN WELDED	Main Contactor detected as stuck closed	Contactor commanded to be Open	4	Contactor commanded to Open and does Open	1. Welded Contactor
NEG IA 300	Very high Regen Current	Continuous	No Action	Throttle reapplied	1. High Regen Current
NEG IA 250	High Regen Current	Continuous	No Action	Throttle reapplied	2. High Regen Current
MAIN DRIVER OVERCURRENT	High Driver Current Detected	Continuous while Contactor is commanded to be closed	No Action	Throttle reapplied	1. Main Contactor coil or wiring shorted 2. Electrical Noise

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1311 Display	Explanation	Tested When	Controller Response	Recover When	Possible Cause
HPD (HIGH PEDAL DISABLE)	High Pedal Disable Controller powers up with Key, Direction and Throttle applied OR Throttle applied before Key and Direction switch applied	KSI ON, Forward or Reverse ON	8	Throttle < 25%	1. Incorrect sequence of Vehicle input controls 2. Defective Throttle device
THERMAL CUTBACK	Over/Under Temperature Cutback	Continuous	5	Condition clears	1. Temperature >85°C or < -25°C 2. Excessive load on vehicle 3. Improper mounting of controller 4. Operation in extreme environment
OVERVOLTAGE	Battery Voltage > OVERVOLTAGE MIN parameter	Continuous	7	Condition clears	1. Battery Voltage > Shutdown limit
LOW BATTERY VOLTAGE	Battery Voltage < LOW VOLTAGE MAX parameter	Continuous	5	Condition clears	1. Battery Voltage < Cutback Limit 2. Corroded Battery Terminal 3. Loose Battery or Controller terminal
THROTTLE FAULT	Throttle Input Fault	Continuous	8	Condition clears	1. Throttle wiring open or shorted 2. Defective Throttle device

Controller Fault Responses
1 - Reduce Armature duty cycle to zero.
2 - Reduce Field current to zero
3 - Turn off Main Contactor
4 - “Limp Home” in slow speed. Armature Duty Cycle = 75% Max, Field Min = 10.0 Amps
5 - Gradual reduction in armature Drive current limit
6 - Quickly reduce armature duty cycle to zero until speed sensor pulses reappear
7 - Gradual Reduction in Regen Current Limit
8 - Internal Scaled Throttle Signal set to Zero
9 - Commence Walk-Away Function

Fig. 7 Controller Faults and Troubleshooting

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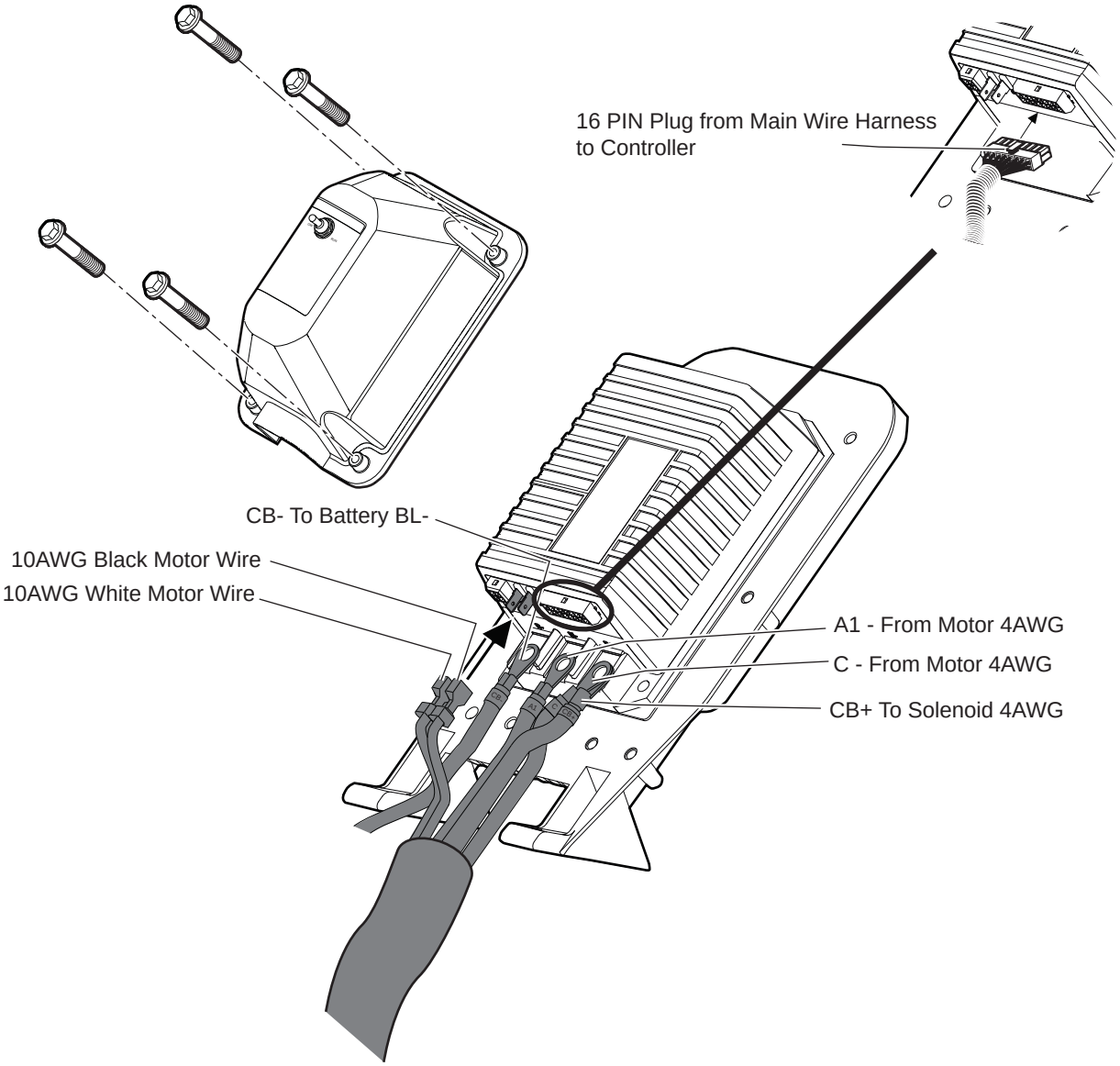

Fig. 8 Controller Connectors and Connections

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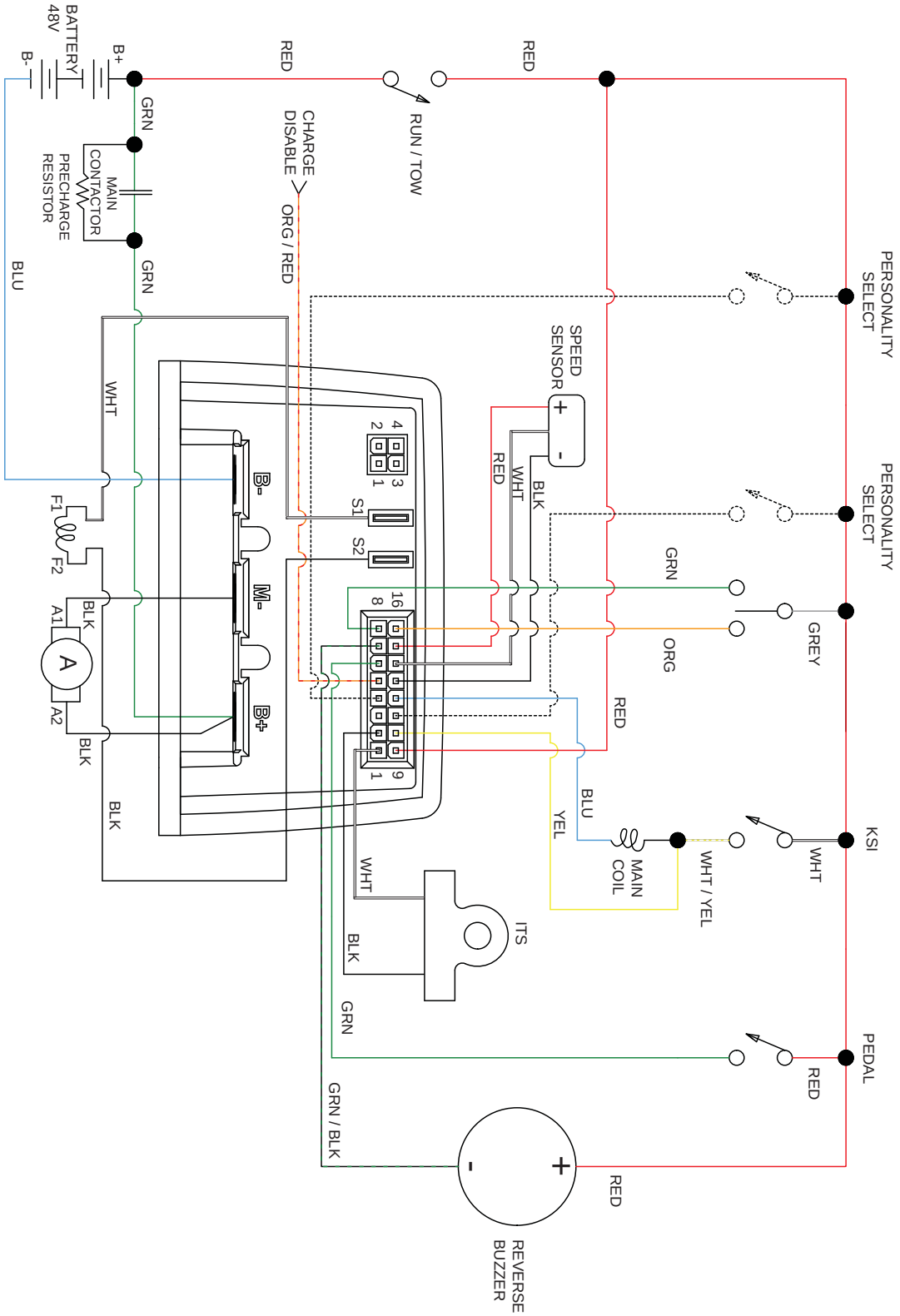

Fig. 9 Controller Wiring Diagram

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INDUCTIVE THROTTLE SENSOR (ITS) TESTING AND REPLACEMENT

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

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

Remove the driver side rocker panel insert and pull the floormat forward to expose the metal cover to the pedal box. Remove the cover and remove the two screws securing the plastic cover to the pedal box, remove the cover (Ref. Fig. 10 on Page E-10).

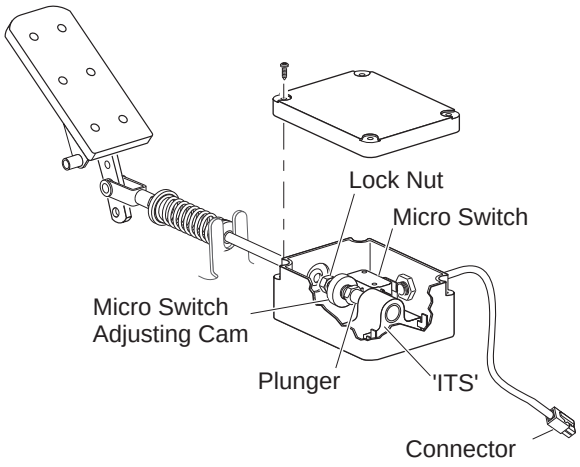

Fig. 10 ITS and Plunger

With the DVOM set to volts, probe the black 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 ± 0.3V when the solenoid clicks and 2.7V ± 0.5 volts at full pedal. 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 overlighten 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. 11 on Page E-11). **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.

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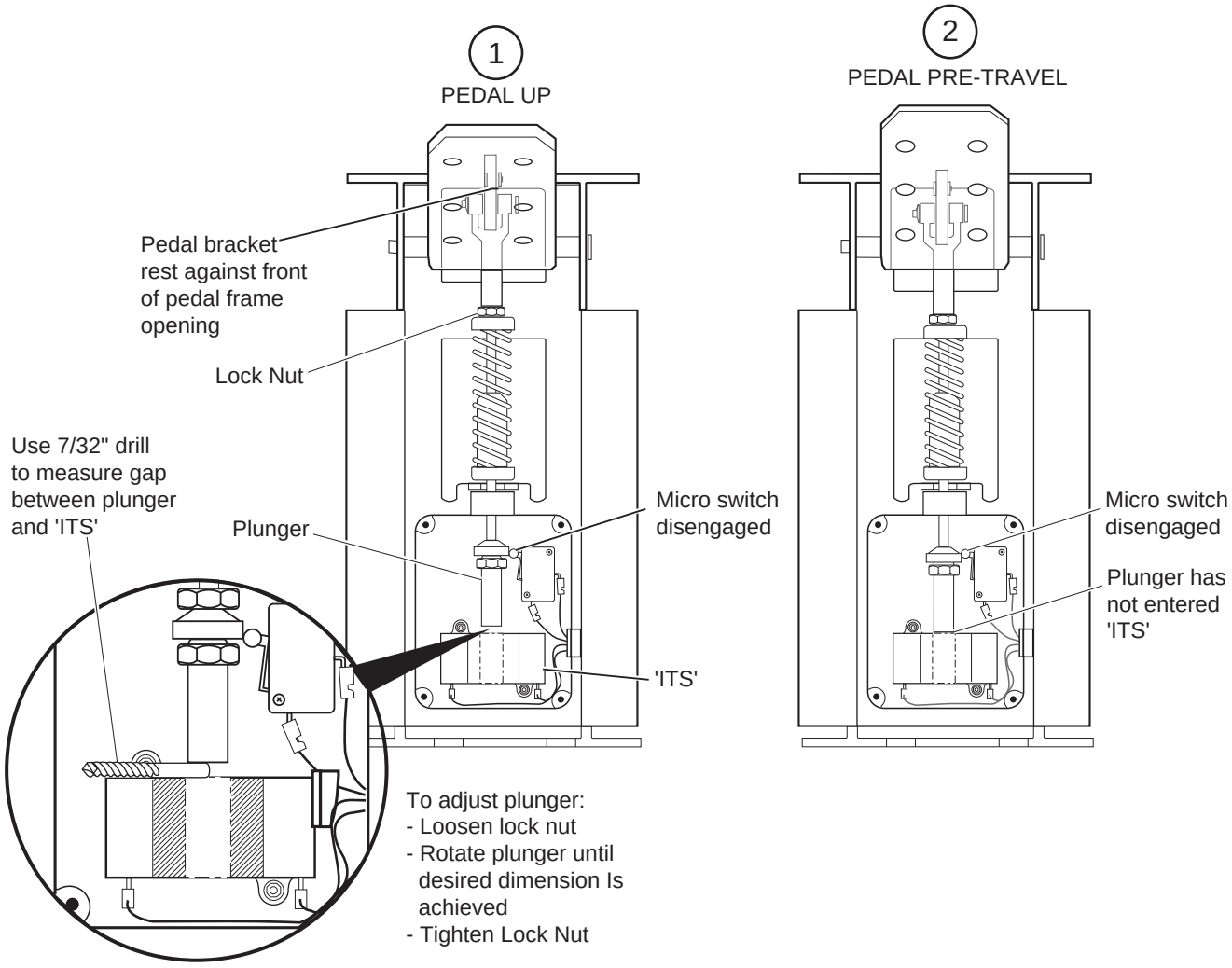

Fig. 11 ITS Adjustment (Sheet 1 of 2)

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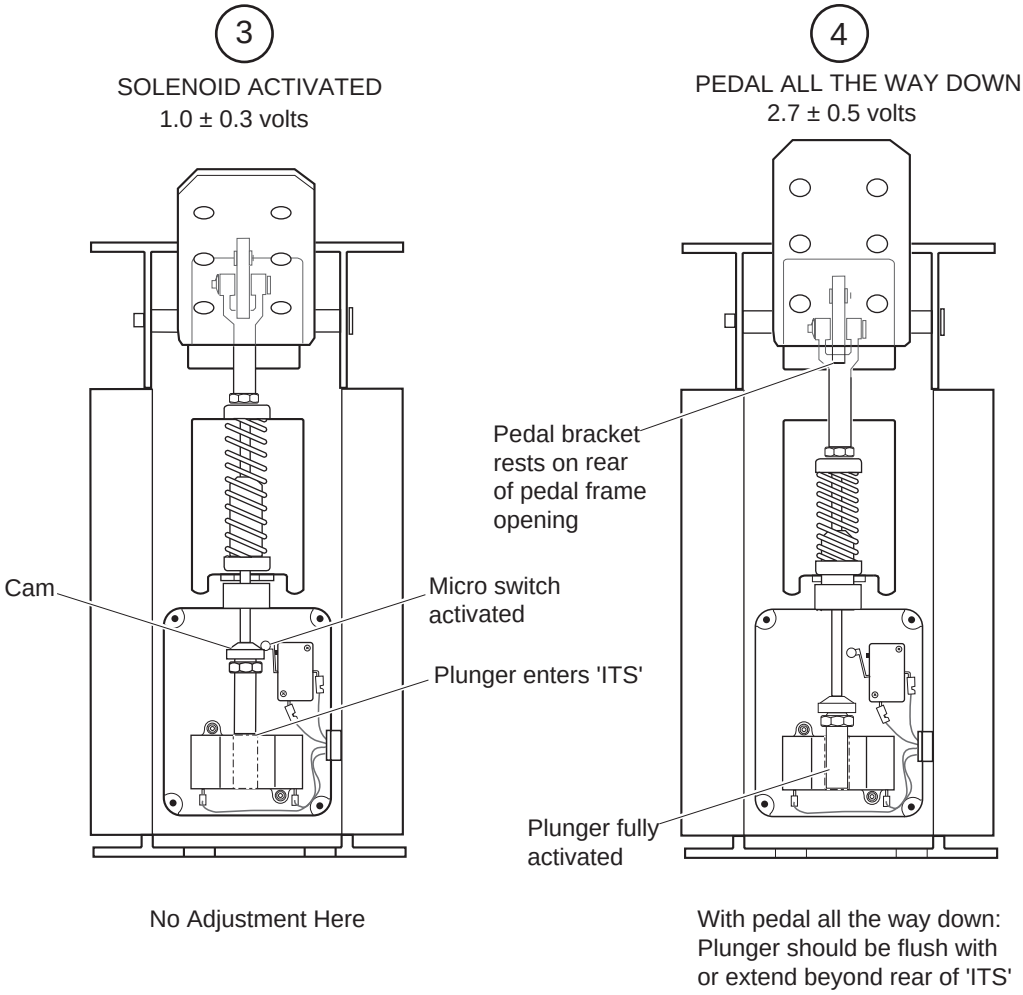

Fig. 12 ITS Adjustment (Sheet 2 of 2)

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CONTROLLER REPLACEMENT

Tool List	Qty. Required
Socket, 3/8", 3/8" drive	1
Socket, 7/16", 3/8" drive	1
Socket, 1/2", 3/8" drive	1
Socket, 1/4"	1
Ratchet, 3/8" drive	1
Extension, 6", 3/8" drive	1
Insulated wrench, 9/16"	1
Shop towel	1
Torque wrench, 3/8" drive, in. lbs.	1
Torque wrench, 3/8" drive, ft. lbs.	1
Large Screwdriver	1

Remove the seat.

⚠ CAUTION

Before any electrical service is performed on TCT 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 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.

⚠ 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.

NOTICE

Note the location of the wiring on the controller before removing wiring from controller (Ref. Fig. 8 on Page E-8).

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

Remove the environmental cover.

Remove the controller mounting bolts and remove the controller.

Mount new controller and reconnect wiring. Tighten the controller mounting bolts to 132 - 168 in. lbs. (15 - 19 Nm) torque and the terminal bolts to 120 - 144 in. lbs. (13.5 - 16.3 Nm) torque.

Replace the environmental cover and tighten the mounting bolts to 35 - 44 in. lbs. (4 - 5 Nm) torque.

Reconnect the BL- battery cable and replace the seat.

SOLENOID REPLACEMENT

Tool List	Qty. Required
Socket, 3/8", 3/8" drive	1
Socket, 7/16", 3/8" drive	1
Socket, 1/2", 3/8" drive	1
Socket, 5/16"	1
Ratchet, 3/8" drive	1
Extension, 6", 3/8" drive	1
Insulated wrench, 9/16"	1
Shop towel	1
Torque wrench, 3/8" drive, in. lbs.	1
Torque wrench, 3/8" drive, ft. lbs.	1
Large Screwdriver	1

Remove the seat.

⚠ CAUTION

Before any electrical service is performed on TCT 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 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.

⚠ 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.

NOTICE

Note the location of the wiring on the solenoid before removing wiring from solenoid (Ref. Fig. 13 on Page E-14)

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

Remove the environmental cover.

Remove the solenoid mounting bolts and remove the solenoid.

Mount new solenoid and reconnect wiring. Tighten the solenoid mounting nuts to 45 - 55 in. lbs. (5.1 - 6.2 Nm) torque, the #10 terminal nuts to 15 - 20 in. lbs. (1.7 - 2.3 Nm) and the 5/16" terminal nuts to 44 - 50.4 in. lbs (5 - 5.7 Nm) torque.

Replace the environmental cover and tighten the mounting bolts to 35 - 44 in. lbs. (4 - 5 Nm) torque.

Reconnect the BL- battery cable and replace the seat.

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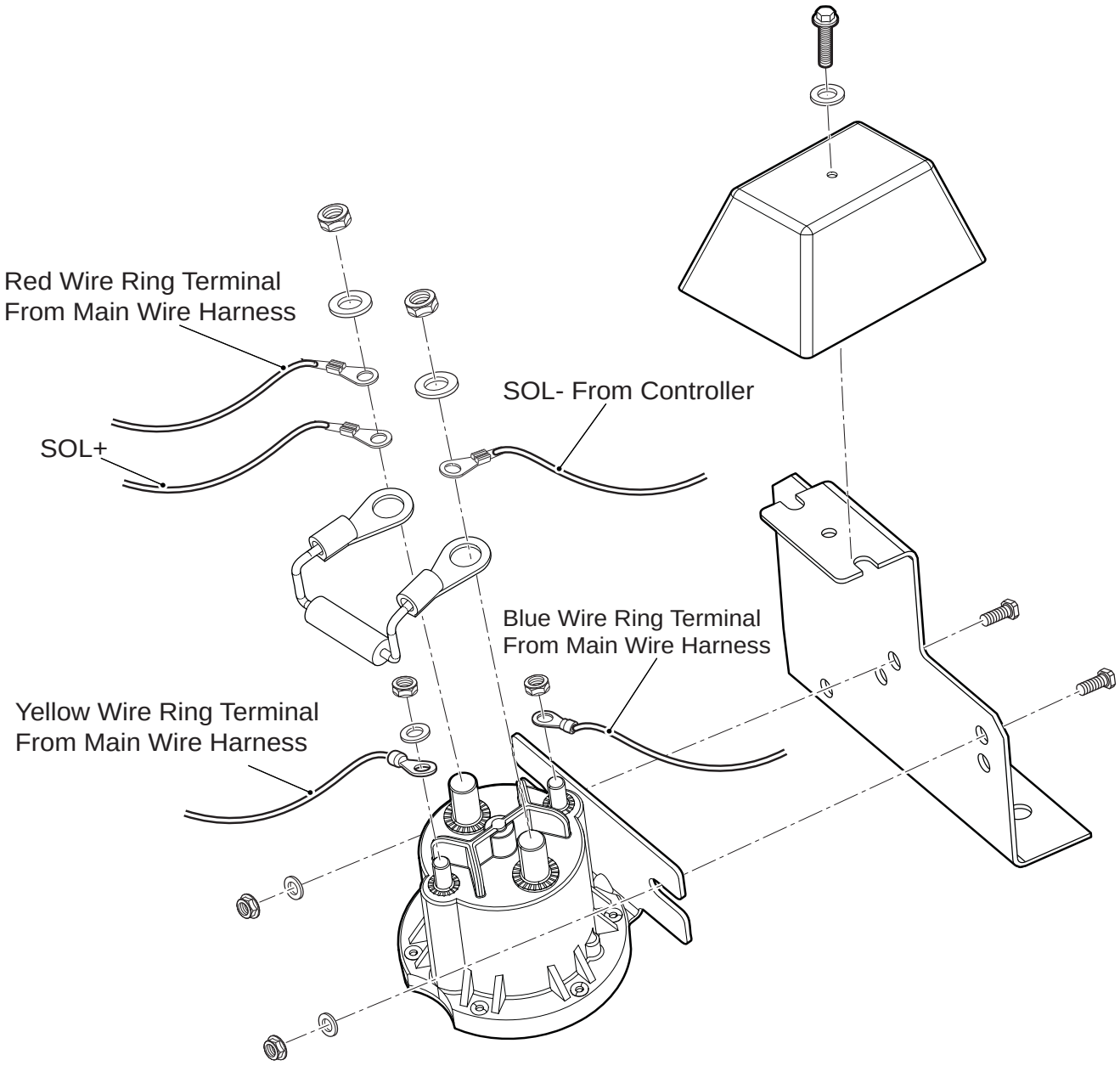

Fig. 13 Solenoid Wiring

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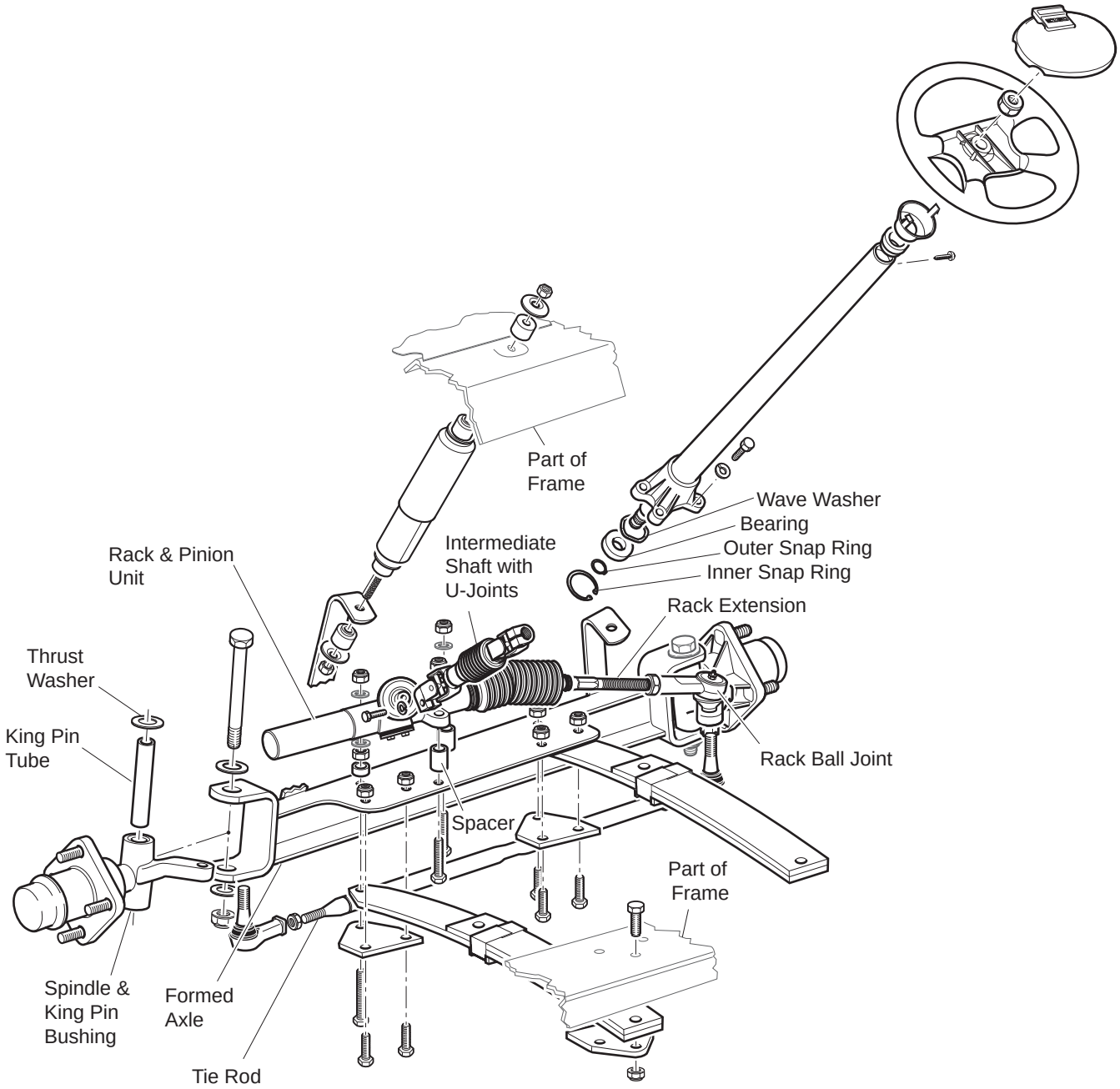

Fig. 1 Axle Mounted Steering and Front Suspension

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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 the correct adjustment of the front bearings and repack them in accordance with the Periodic Service Schedule or if a bearing replacement is required. Routine examination of the tires will provide indications if an alignment is required.

Lubrication

Tool List	Qty. Required
Grease gun	1
Shop towels	AR

Grease the rack ball joint (1) and tie rod ends (2 and 3) (Ref. Fig. 2 on Page F-2) per Periodic Service Schedule in Section A. Wipe off old grease that is forced out of rubber boot.

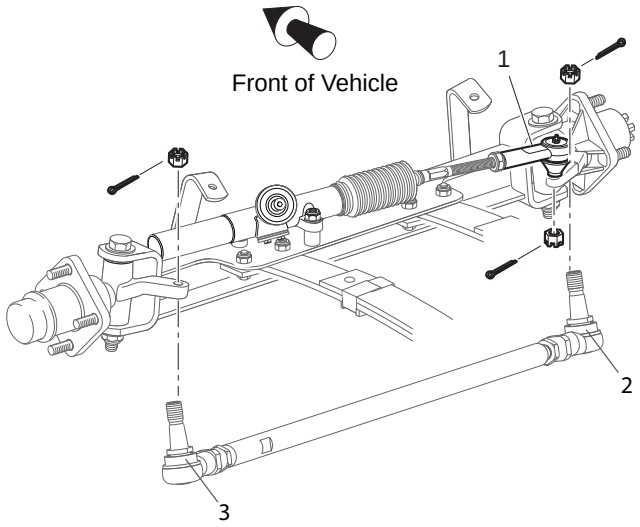

Fig. 2 Lubrication Points

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 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 before starting any repair procedure. 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.

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. “Wheel Bearing Packing” on Page F-2 “Wheel Bearing Adjustment” on Page F-3.

If the wheel bearing is satisfactory, a worn spindle bearing, which is not a serviceable item, is indicated and the spindle must be replaced. “Spindle Replacement” on Page F-12

Wheel Bearing Packing

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

Remove hub from spindle and disassemble. “Wheel Bearing and Race Replacement” on Page F-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. “Wheel Bearing and Race Replacement” on Page F-8.

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 recom-

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mended 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. “Hub Replacement” on Page F-7.

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

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

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

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

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

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

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

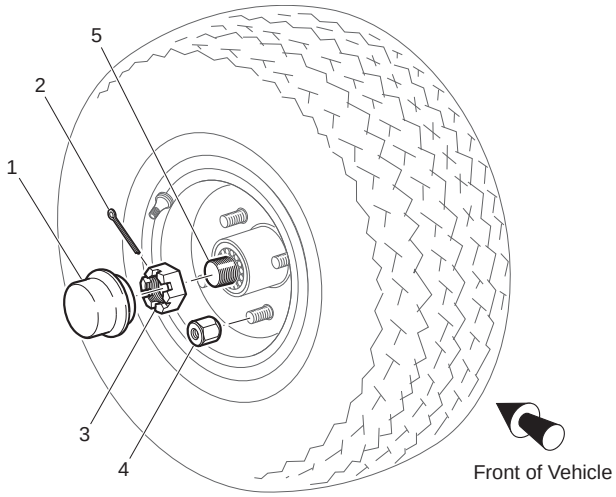

Fig. 3 Bearing Adjustment

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

Wheel Alignment

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

Lift the front of the vehicle and support on jack stands as per SAFETY section. Confirm the alignment of the front springs. “Front Spring Replacement” on Page F-6.

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

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

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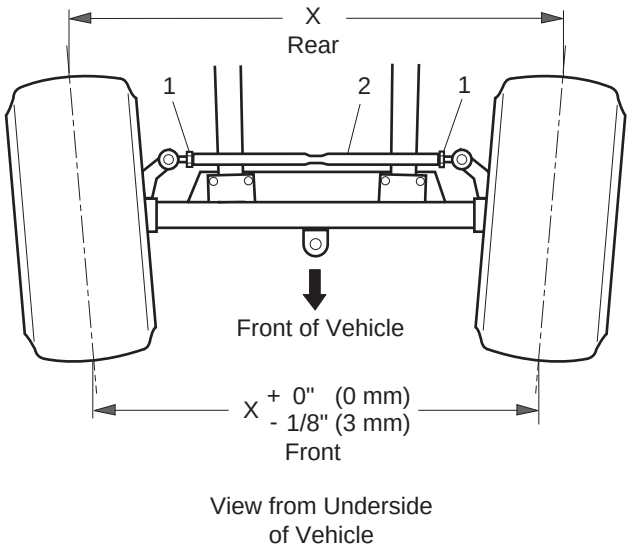

Fig. 4 Wheel Alignment

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 groove in the threaded tube has left hand threads while the end **without** the groove has conventional right hand threads.

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

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

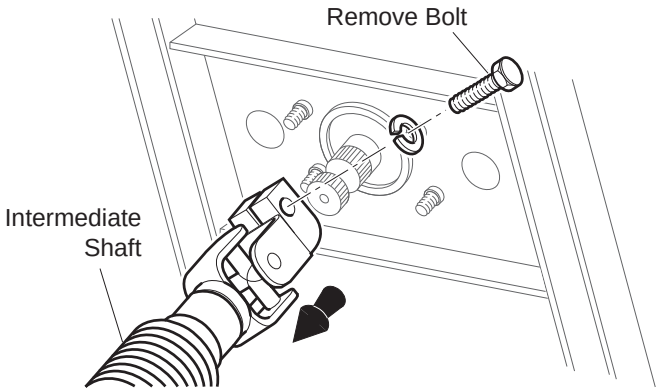

Fig. 5 Disconnect Intermediate Shaft to Center Steering Wheel

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FRONT SUSPENSION

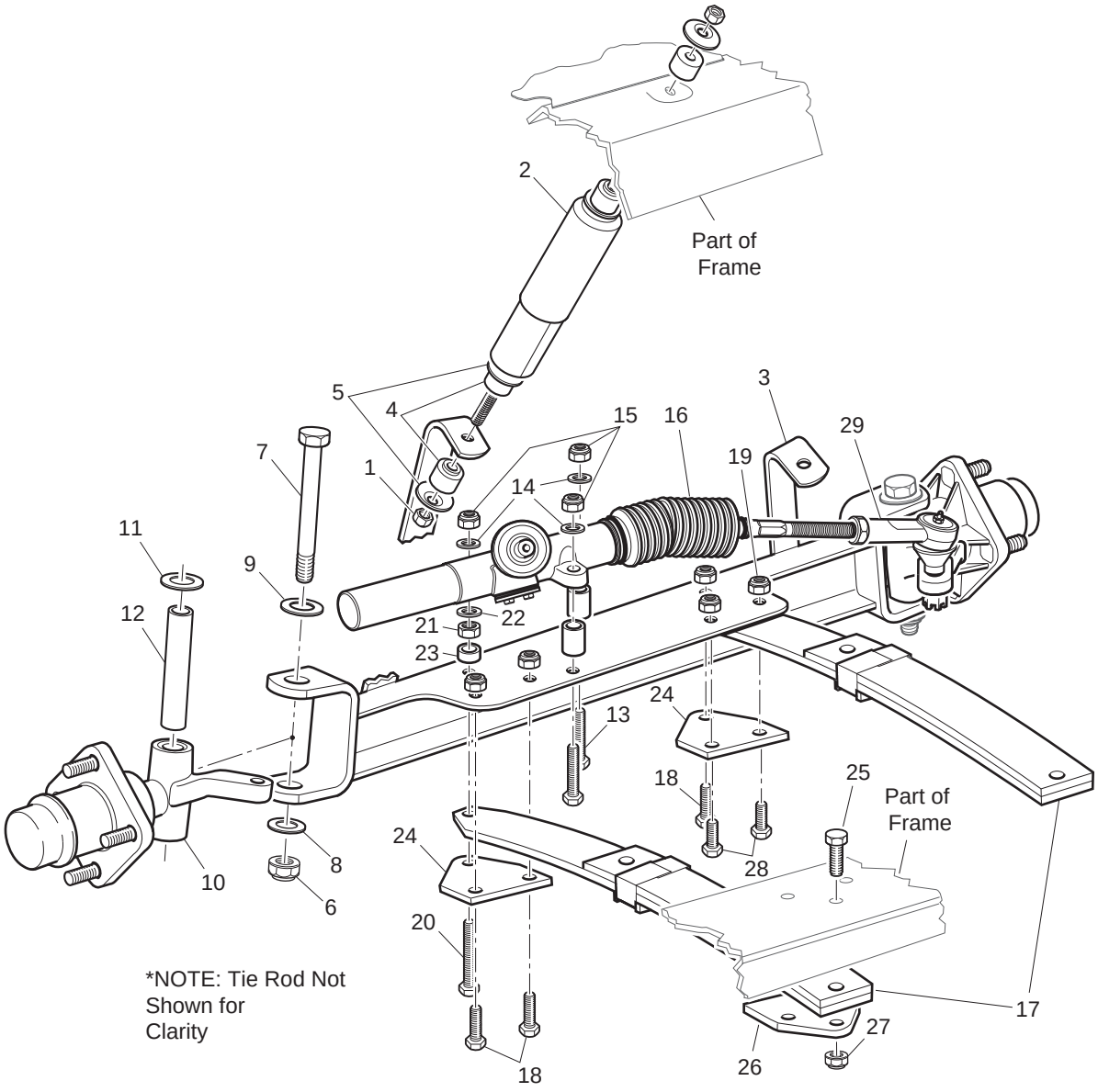

Fig. 6 Front Suspension Components

Front Shock Absorber Replacement

Tool List **Qty. Required**

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

Remove the nut (1) from the bottom of the shock absorber (2) at the front axle (3) (Ref. Fig. 6 on Page F-5).

Compress shock absorber to clear the mounting bracket.

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

Remove the shock absorber.

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

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Front Axle Replacement

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

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

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

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

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

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

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

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

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

Check front wheel alignment and adjust if necessary. “Wheel Alignment” on Page F-3.

Front Spring Replacement

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

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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 F-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 F-5).

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

To detach passenger side spring:

Remove the hardware (18, 19, 24, 28) securing the front of the passenger side leaf spring (17) to the axle (3) and discard lock nuts (19) (Ref. Fig. 6 on Page F-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. 7 on Page F-7). Tighten the spring hardware (21, 19, 27) first and rack and pinion unit hardware (15) next to 35 - 50 ft. lbs. (50 - 70 Nm) torque.

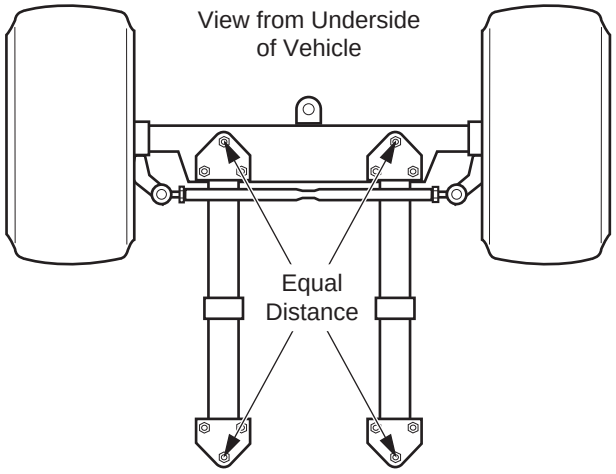

Fig. 7 Front Axle Alignment

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. “Wheel Alignment” on Page F-3.

Hub Replacement

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

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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. 8 on Page F-8). While holding outer wheel bearing (4) in place, slide hub (5) from spindle (6) and discard.

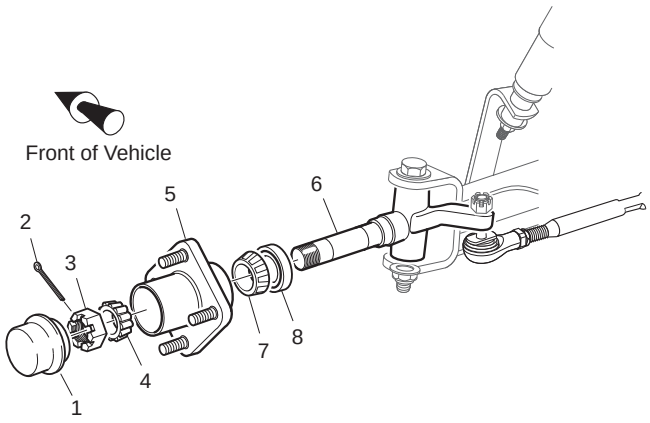

Fig. 8 Hub Replacement

Clean spindle and new hub thoroughly with solvent.

Pack new bearings with grease. “Wheel Bearing Packing” on Page F-2.

Apply a light coat of grease to inner race and place inner wheel bearing (7) in hub. Orient new grease seal (8) so the flange side of the seal is facing into the bore. Tap gently into place until seal is flush with end of hub. Lubricate lips of seal and spindle with grease (Ref. Fig. 9 on Page F-8).

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

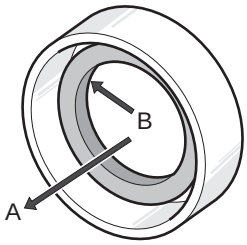

Fig. 9 Seal Installation

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

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

Adjust bearing. “Wheel Bearing Adjustment” on Page F-3.

Replace the dust cap (1).

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

Wheel Bearing and Race Replacement

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

Remove hub (1) from spindle (Ref. Fig. 10 on Page F-8). “Hub Replacement” on Page F-7.

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.

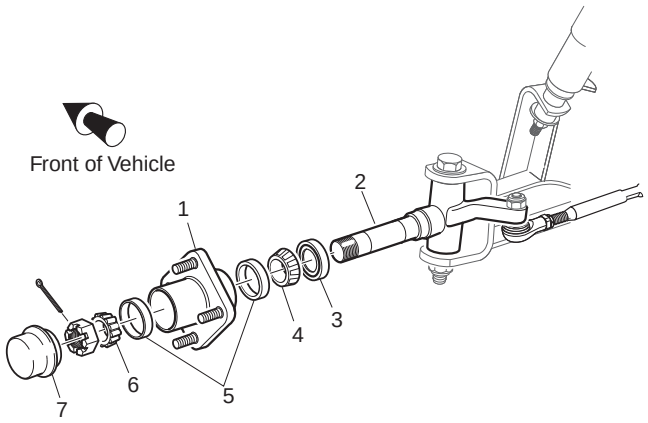

Fig. 10 Wheel Bearing Replacement

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. “Wheel Bearing Packing” on Page F-2.

Install inner wheel bearing (4) and new grease seal in hub and mount hub to spindle. “Hub Replacement” on Page F-7.

Adjust bearing. “Wheel Bearing Adjustment” on Page F-3.

Replace the dust cap (7).

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

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STEERING

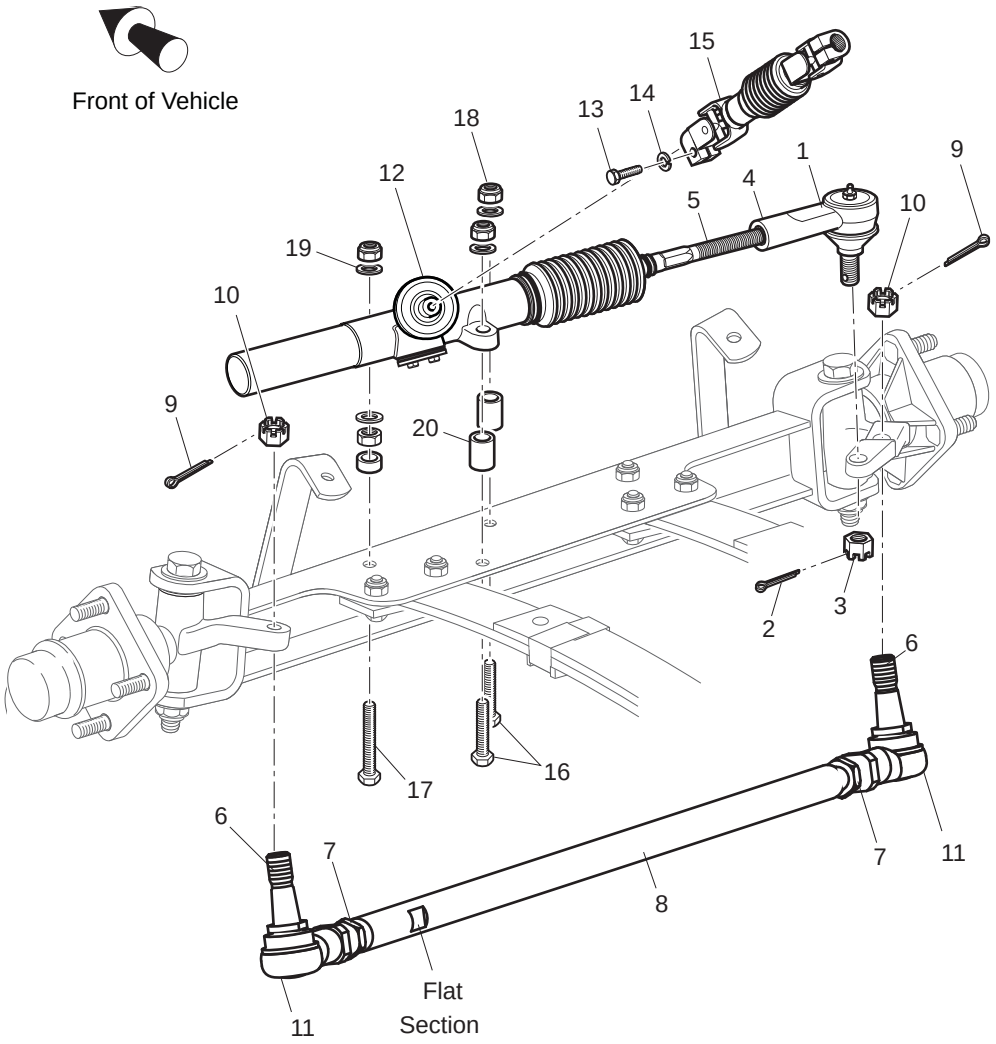

Fig. 11 Steering Components

Rack Ball Joint Replacement

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

To remove rack ball joint (1), loosen passenger side front wheel and lift and support front of vehicle per SAFETY section (Ref. Fig. 11 on Page F-9).

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.

To install new rack ball joint close to its correct position, measure amount of threads exposed from jam nut (Ref. Fig. 12 on Page F-10).

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.

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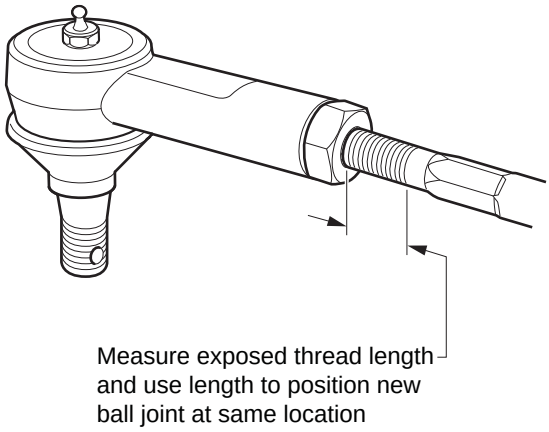

Fig. 12 Rack Ball Joint Installation

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. 19 on Page F-15).

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. “Checking/Adjusting Rack Extension-to-Rack and Pinion Unit Clearance” on Page F-14.

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

Check front wheel alignment and adjust if necessary. “Wheel Alignment” on Page F-3.

Tie Rod Inspection/Replacement

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

Grasp the tie rod (8) at ball joints (6) and check for any vertical motion which would indicate a worn condition and require replacement (Ref. Fig. 11 on Page F-9).

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

Remove front wheel.

To install new tie rod ball joint close to its correct position, measure distance to center of ball joint from jam nut (Ref. Fig. 13 on Page F-10).

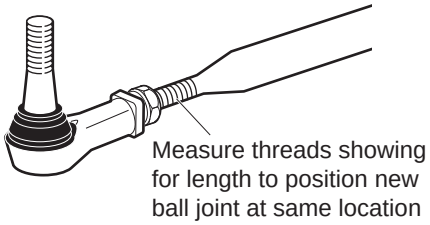

Fig. 13 Tie Rod Replacement

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. 11 on Page F-9).

The tie rod has different threads on each end. The end **with** the groove in the threaded tube has left hand threads (clockwise to loosen) while the end **without** the groove has conventional right hand threads (counter-clockwise to loosen) (Ref. Fig. 13 on Page F-10).

Remove cotter pin (9) and loosen castellated nut (10) until tie rod ball joint (6) threads are protected. Using a ball joint separator as a lever, apply pressure to ball joint and tap nut with plastic faced hammer to release tie rod from spindle arm. Remove nut to drop tie rod from spindle arm.

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

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

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NOTICE

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

Install rubber boot (11) and attach tie rod to spindle. The castellated nut (10) should be tightened to a **minimum** of 36 ft. lbs. (50 Nm) torque and continue tightening as required in order to insert a new cotter pin. 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. “Wheel Alignment” on Page F-3.

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

Bellows Replacement

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

To replace bellows (1) (Ref. Fig. 14 on Page F-11), first loosen passenger side front wheel and lift and support front of vehicle per SAFETY section.

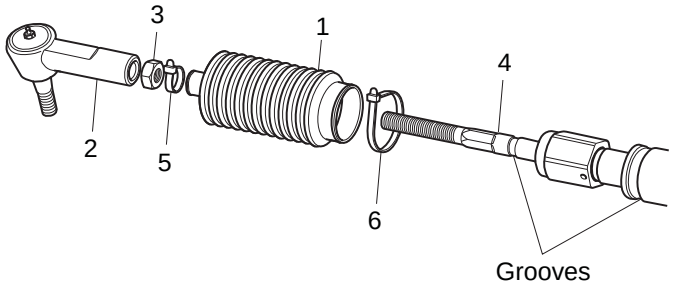

Fig. 14 Bellows Replacement

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). “Rack Ball Joint Replacement” on Page F-9.

Cut wire ties (5,6) and slide bellows off rack extension. Install new bellows aligning small end over groove in rack extension and secure with new wire tie (5). Leave large end loose until rack extension-to-rack and pinion unit clearance is checked or adjusted.

Install jam nut (3) and rack ball joint (2) on rack extension (4) and reattach to spindle arm. “Rack Ball Joint Replacement” on Page F-9.

⚠ 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. “Checking/Adjusting Rack Extension-to-Rack and Pinion Unit Clearance” on Page F-14.

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

Check front wheel alignment and adjust if necessary. “Wheel Alignment” on Page F-3.

Pinion Seal Replacement

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

⚠ CAUTION

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

To access the pinion seal, remove rack and pinion unit from vehicle. “Rack and Pinion Unit Replacement” on Page F-14. 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. 15 on Page F-12).

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

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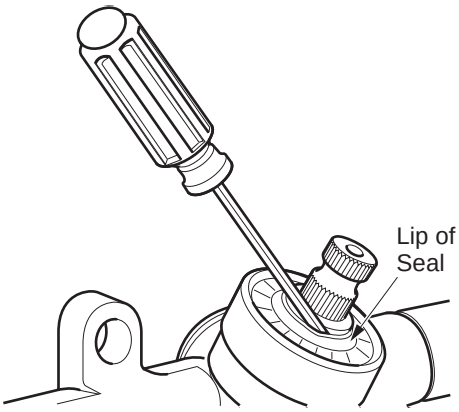

Fig. 15 Pinion Seal Replacement

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. “Rack and Pinion Unit Replacement” on Page F-14.

Spindle Replacement

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

⚠ CAUTION

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

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

Remove cotter pin (1) and loosen castellated nut (2) until tie rod ball joint (3) threads are protected (Ref. Fig. 16 on Page F-12). 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.

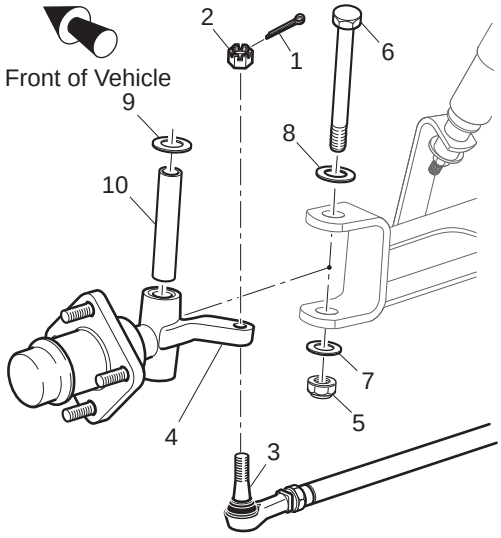

Fig. 16 Spindle Replacement

Spindle installation is the reverse order of disassembly.

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 castellated nut (2) 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).

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

Check front wheel alignment and adjust if necessary. “Wheel Alignment” on Page F-3.

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Rack and Pinion Unit Disassembly and Inspection

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

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. “Rack and Pinion Unit Replacement” on Page F-14 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. 17 on Page F-13). 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). “Pinion Seal Replacement” on Page F-11 Remove internal retaining ring (11) from rack and pinion unit and pull out pinion (4) and ball bearing (12) as an assembly.

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. “Rack and Pinion Unit Replacement” on Page F-14.

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

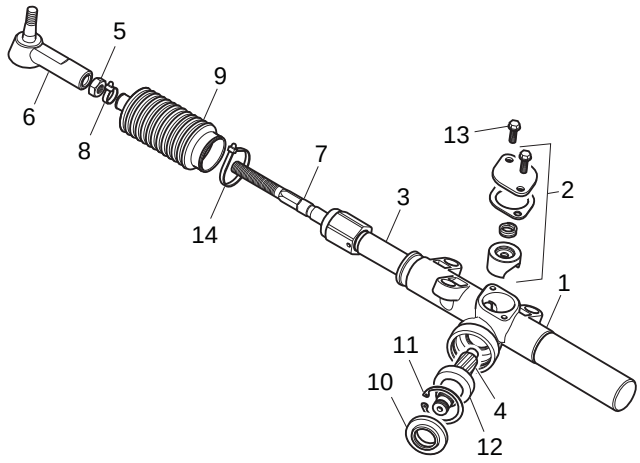

Fig. 17 Rack and Pinion Unit Disassembly

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. “Pinion Seal Replacement” on Page F-11 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. (115 - 138 kg cm) torque. Thread jam nut and rack ball joint to original location on rack extension and set jam nut hand tight.

Install rack and pinion unit on vehicle. “Rack and Pinion Unit Replacement” on Page F-14.

⚠ 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. “Checking/Adjusting Rack Extension-to-Rack and Pinion Unit Clearance” on Page F-14.

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Rack and Pinion Unit Replacement

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

To remove rack and pinion unit (12) (Ref. Fig. 11 on Page F-9), loosen front wheels and lift and support front of vehicle per SAFETY section. Remove front wheels.

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

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

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

Replace rack and pinion unit in reverse order of removal.

Use new lock nuts (18) and tighten them to 35 - 50 ft. lbs. (50 - 70 Nm) torque.

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

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

⚠ CAUTION

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

Set proper rack extension-to-rack and pinion unit clearance. “Checking/Adjusting Rack Extension-to-Rack and Pinion Unit Clearance” on Page F-14.

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

Check front wheel alignment and adjust if necessary. “Wheel Alignment” on Page F-3.

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

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

Check for proper rack extension-to-rack and pinion unit clearance by first turning steering wheel fully to the right. The rear spindle arm on the passenger side **must rest against** the front axle (Ref. Fig. 18 on Page F-14). If it does not, all adjustment is made at the rack ball joint (6) (Ref. Fig. 17 on Page F-13). Loosen jam nut (5) at rack ball joint and use wrench to thread shaft of rack extension (7) further into rack ball joint. This will provide more travel for the steering wheel to be turned to the right.

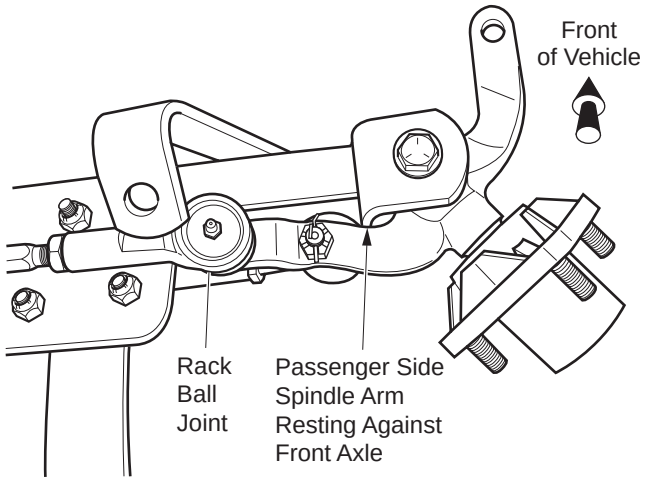

Fig. 18 Spindle Contact with Front Axle

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

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hex of rack extension. An 1/8" gap should exist between the large hex and the end of the rack and pinion unit.

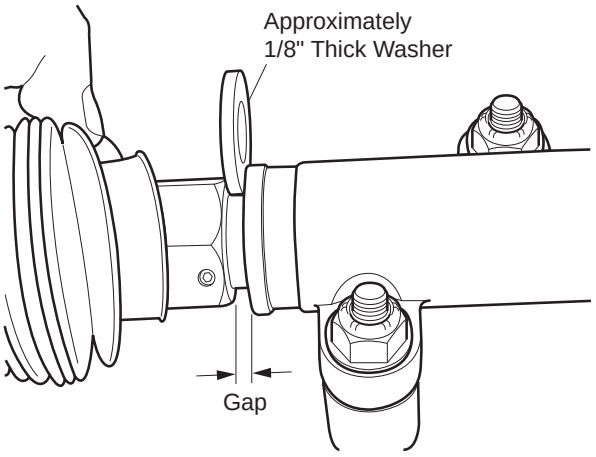

Fig. 19 Checking Gap

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

Steering Wheel Replacement

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

NOTICE

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

⚠ CAUTION

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

From the front side of the steering wheel (4), remove the clipboard (5) by first pulling straight up on the bottom of the clipboard to release the two bottom retaining tabs. Then, using thumb for leverage as shown, reach from behind steering wheel with fingertips to first pull down, and then push up to release the two top clipboard retaining tabs (Ref. Fig. 20 on Page F-15).

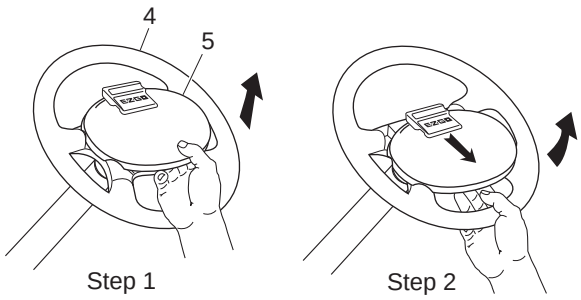

Fig. 20 Clipboard Removal

Loosen the steering wheel retaining nut (6) two to three turns (Ref. Fig. 21 on Page F-15). 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.

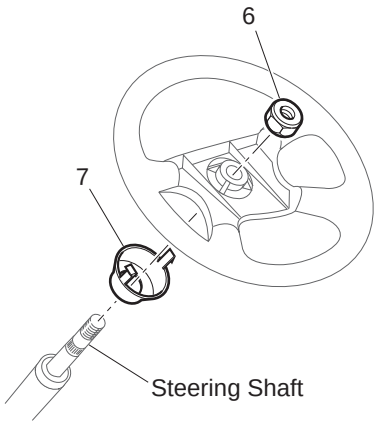

Fig. 21 Steering Replacement

⚠ 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

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ahead position, align the steering wheel on the steering shaft and slide wheel on shaft. Tighten the steering wheel nut (6) to 15 - 20 ft. lbs. (20 - 27 Nm) torque.

Inspect the four retaining tabs on the clipboard (5) for white stress lines (Ref. Fig. 20 on Page F-15). If stress lines are present, replace clipboard. Install by carefully pressing, first the top two, then the bottom two retaining tabs into the matching slots in steering wheel.

Steering Shaft and Column Replacement

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

To remove steering shaft (4) (Ref. Fig. 22 on Page F-16), remove the steering wheel. “Steering Wheel Replacement” on Page F-15.

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).

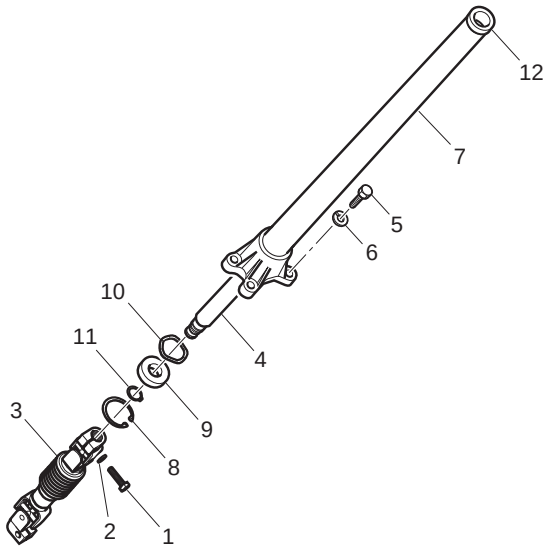

Fig. 22 Steering Shaft and Column

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

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

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

To assemble steering shaft, first press new bearing onto shaft until it stops against shoulder. Then, with small retaining ring oriented with arch up, slide ring onto shaft as far as possible using snap ring pliers (Ref. Fig. 23 on Page F-16). Use fingers to push retaining ring fully into groove.

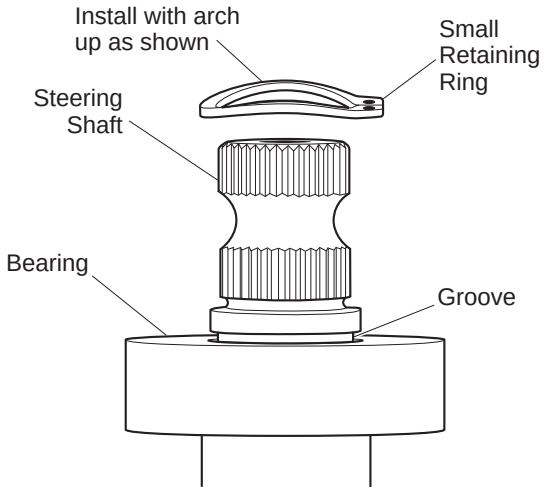

Fig. 23 Small Retaining Ring Orientation

Slide wave washer into base of steering column.

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

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

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

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

Install steering wheel. “Steering Wheel Replacement” on Page F-15.

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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.

Neither the motor housing nor armature is available as service items, therefore in the unlikely event of a failure in either of these components, the entire motor must be replaced.

Motor Removal

⚠ CAUTION

Before any electrical service is performed on TCT 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 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.

⚠ WARNING

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

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

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

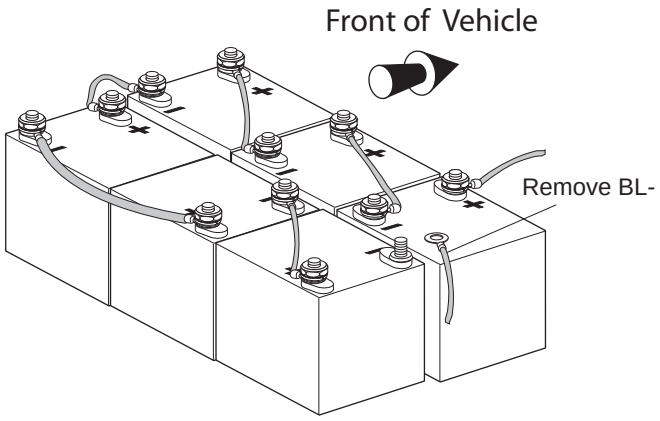

Fig. 1 Disconnect Battery Cable

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

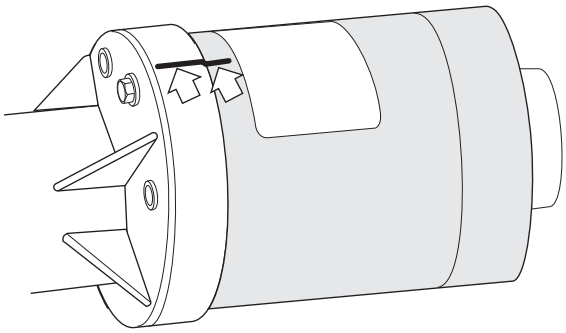

Fig. 2 Mark Axle and Motor

On TCT motors, remove the snap ring and remove the speed sensor from the motor end cover.

⚠ 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.

Motor Disassembly

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

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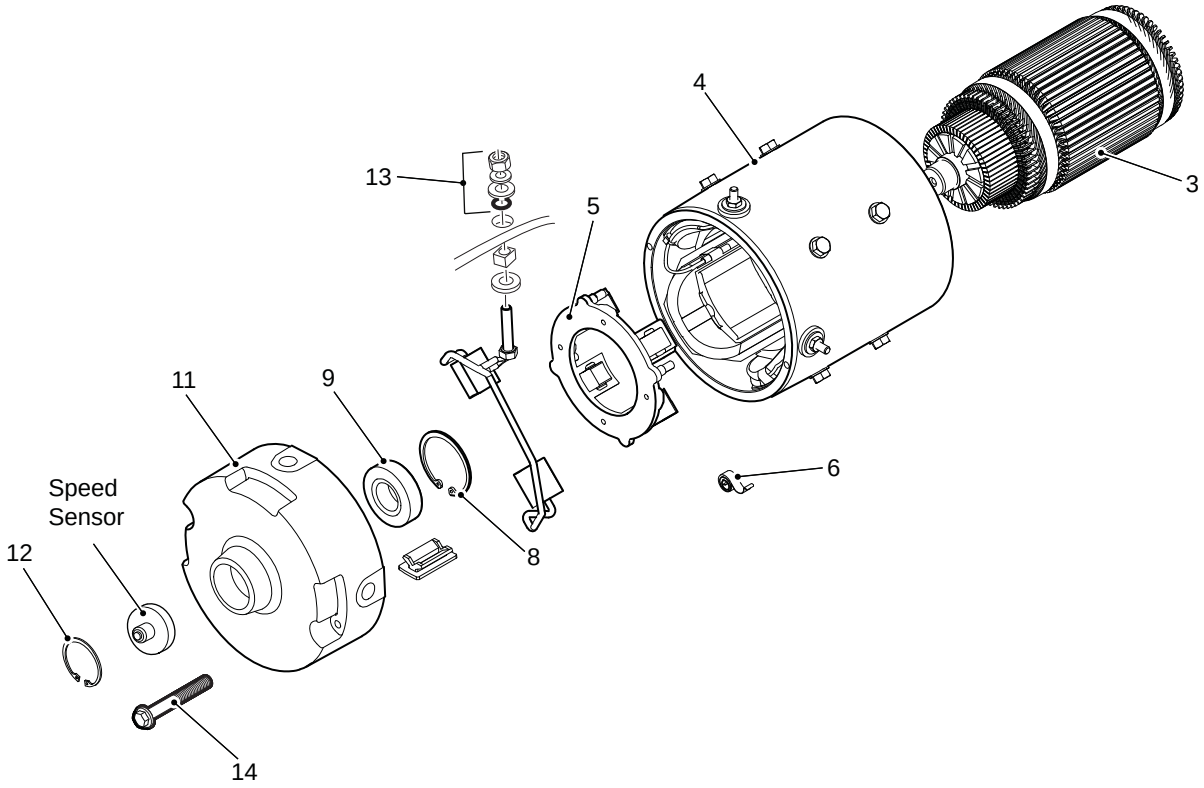

Fig. 3 Motor Components

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On TCT motors, remove the magnet on the end of the armature by carefully removing the snap rings and attaching screw.

Remove bolts (14) that hold the commutator end cover (11) to the motor housing (4).

Pull on commutator end cover to remove armature (3) and cover (as an assembly) from the housing. A light tap on the end cover may be necessary to loosen.

Bearing Replacement

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

⚠ CAUTION

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

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

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

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

Push back each brush until its spring (6) is resting against the side of the brush. This keeps the brushes out of the way during bearing replacement (Ref. Fig. 5 on Page G-4).

Remove internal snap ring (8) and heat the commutator end cover again. Press bearing (9) out from commutator end cover (11).

⚠ 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.

⚠ 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.

Brush Replacement

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

Brushes should be measured as shown and replaced when the minimum dimension of .62" (16 mm) is reached (Ref. Fig. 4 on Page G-3).

Remove brush terminal hardware (13) at A1 and A2 (Ref. Fig. 3 on Page G-2).

Remove screws securing brush plate (5). Remove brushes, rigging and brush plate.

Pull back each brush until each of the springs (6) rest against the side of its brush (Ref. Fig. 5 on Page G-4).

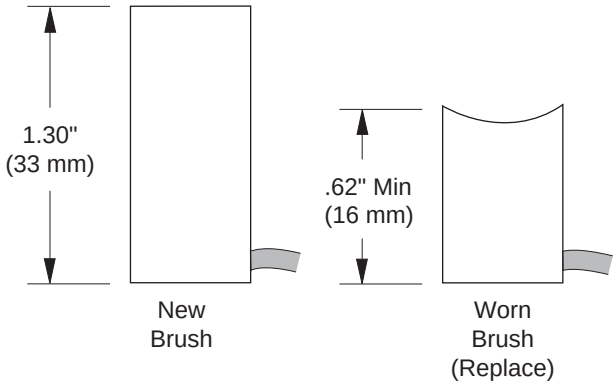

Fig. 4 Brush Wear

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

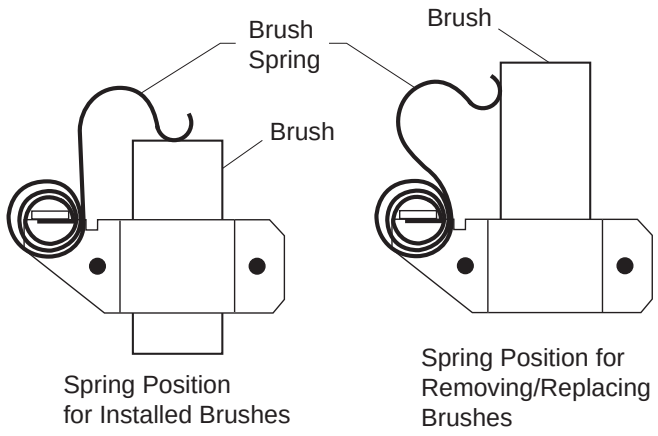

Fig. 5 Securing Brushes

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

Motor Assembly

Tool List **Qty. Required**

Socket, 3/8", 3/8" drive 1

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

Align the commutator end cover with the holes in the motor housing and assemble (Ref. Fig. 3 on Page G-2). Secure the commutator end cover to the motor housing with bolts (14) and tighten to 90 in. lbs. (10 Nm) torque. For TCT vehicles, attach ring magnet to armature shaft with screw. Insert speed sensor and secure with the snap ring (Ref. Fig. 3 on Page G-2).

Motor Tests

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

Motor Installation

Tool List **Qty. Required**

Socket, 7/16", 3/8" drive 1

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

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

Attach the four motor wires to motor (Ref. Fig. 6 on Page G-4). Tighten the nuts to 66 in. lbs. (7 Nm) torque. For TCT motors, install speed sensor to end cover.

MOTOR WIRING

Motor Terminal	Wire Marker	From
F1	F1	Controller "F1"
F2	F2	Controller "F2"
A1	A1	Controller "A1"
A2	A2	Solenoid

Fig. 6 Motor Wiring

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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. Required**
Insulated wrench, 9/16"	1
Battery carrier	1
Hydrometer	1
Battery maintenance kit P/N 25587-G01	1
Battery Protective Spray	1

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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 on Page H-2).

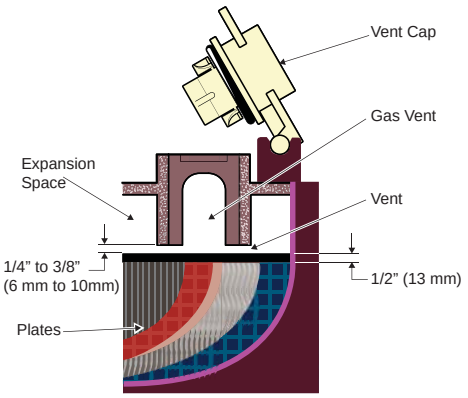

Fig. 1 Correct Electrolyte Level

This level will leave approximately 1/4" - 3/8" (6 - 10 mm) of space between the electrolyte and the vent tube. The electrolyte level is important since **any portion** of the plates exposed to air will be ruined beyond repair. Of equal importance is too much water which will result in electrolyte being forced out of the battery due to gassing and the increase in volume of the electrolyte that results from the charging cycle.

⚠ CAUTION

Do not overfill batteries. The charging cycle will expel electrolyte and result in component damage.

A battery being charged will 'gas' with the majority of the gassing taking place at the end of the charging cycle. This gas is hydrogen which is lighter than air. Water and sulfuric acid droplets will be carried out of the battery vents by the hydrogen gas; however, this loss is minimal. If the battery electrolyte level is too high, the electrolyte will block the vent tube and the gas will **force** it out of the vent tube and battery cap. The water will evaporate but the sulfuric acid will remain where it can damage vehicle components and the storage facility floor. Sulfuric acid loss will weaken the concentration of acid within the electrolyte and reduce the life of the battery.

Over the life of the battery, a considerable amount of water is consumed. It is important that the water used be pure and free of contaminants that could reduce the life of the battery by reducing the chemical reaction. The water must be distilled or purified by an efficient filtration system. Water that is not distilled should be analyzed and if required, filtration installed to permit the water to meet the requirements of the water purity table (Ref. Fig. 2 on Page H-2).

Impurity	Parts Per Million
Color	Clear
Suspended	Trace
Total Solids	100
Calcium & Magnesium Oxides	40
Iron	5
Ammonia	8
Organic & Volatile Matter	50
Nitrites	5
Nitrates	10
Chloride	5

Fig. 2 Water Purity Table

Even if the water is colorless, odorless, tasteless and fit for drinking, the water should be analyzed to see that it does not exceed the impurity levels specified in the table.

Automatic watering devices such as the one included in the Battery Maintenance Kit (P/N 25587-G01) can be used with an approved water source (Ref. Fig. 3 on Page H-3). These watering devices are **fast and accurate** to use and maintain the correct electrolyte level within the battery cells.

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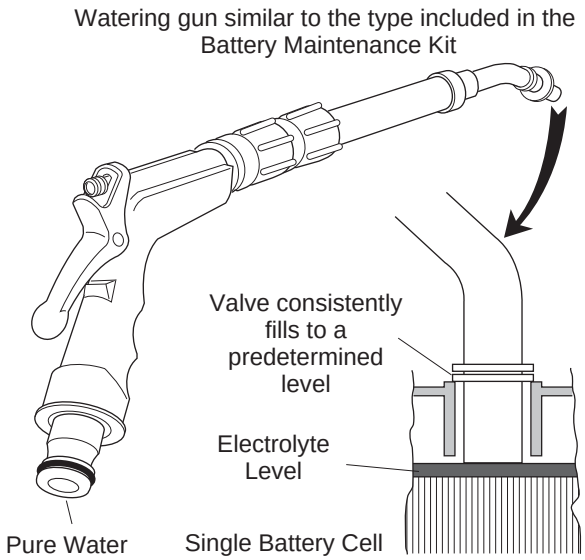

Fig. 3 Automatic Watering Gun

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

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 on Page H-3). In addition to the batteries, special attention should be paid to metallic components adjacent to the batteries which should also be sprayed with the sodium bicarbonate (baking soda) solution.

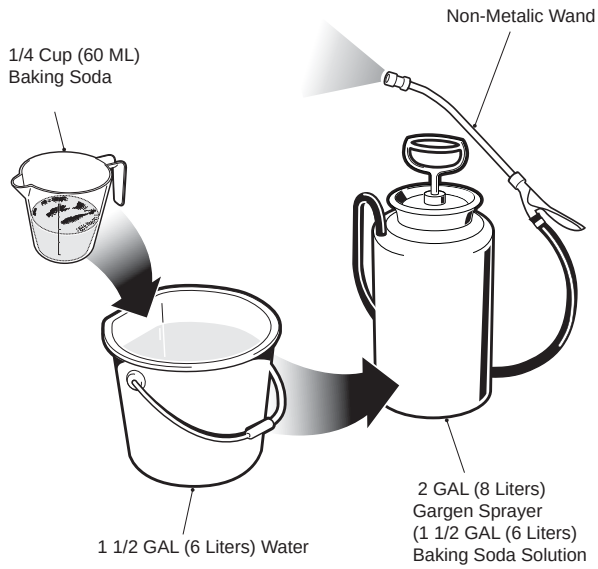

Fig. 4 Preparing Acid Neutralizing Solution

Allow the solution to sit for at least three minutes; use a soft bristle brush or cloth to wipe the tops of the batteries in order to remove any residue that could cause the self discharge of the battery. Rinse the entire area with low pressure clear water. All of the items required for complete battery cleaning and watering are contained in the Battery Maintenance Kit (P/N 25587-G01).

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.

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

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(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 on Page H-4). Ensure that all battery terminals are installed with crimp up. Tighten the battery post hardware to 95 - 105 in. lbs. (11 - 12 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..

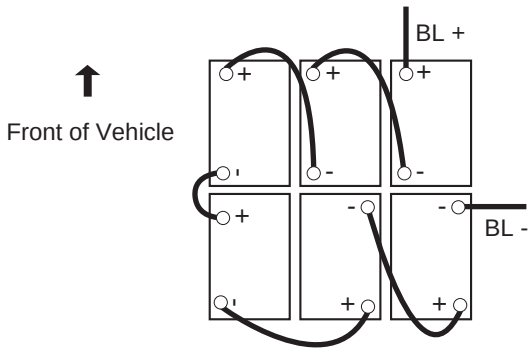

Fig. 5 Battery Connections

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

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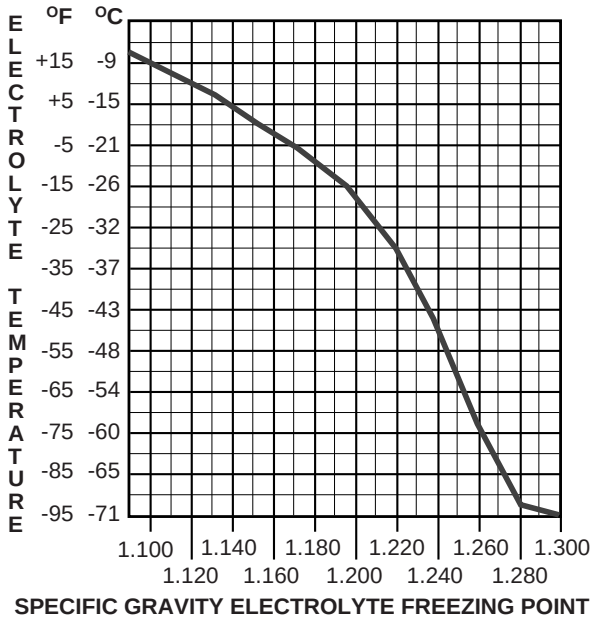

Fig. 6 Freezing Point of Electrolyte

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

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Hydrometer

A hydrometer (P/N 50900-G1) is used to test the state of charge of a battery cell (Ref. Fig. 7 on Page H-6). This is performed by measuring the density of the electrolyte, which is accomplished by measuring the specific gravity of the electrolyte. The greater the concentration of sulfuric acid, the more dense the electrolyte becomes. The higher the density, the higher the state of charge.

⚠ 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.

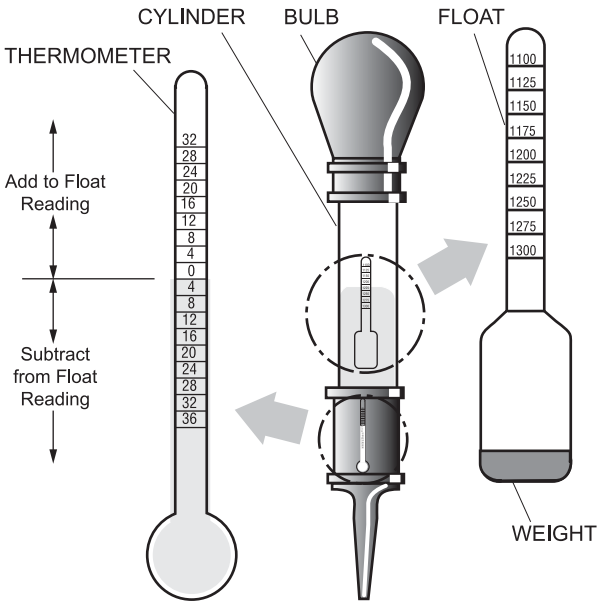

Fig. 7 Hydrometer

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.

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

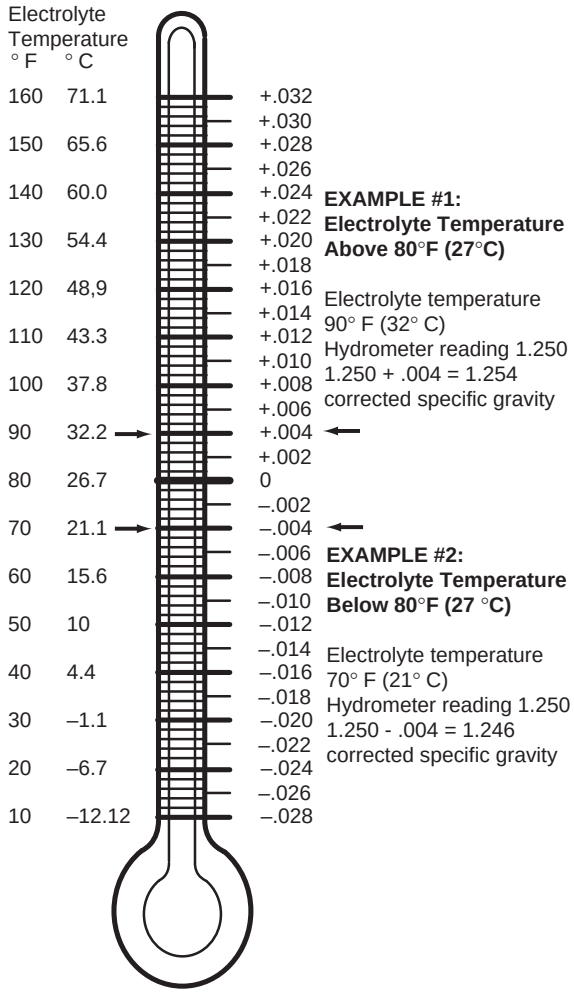

Fig. 8 Hydrometer Temperature Correction

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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.

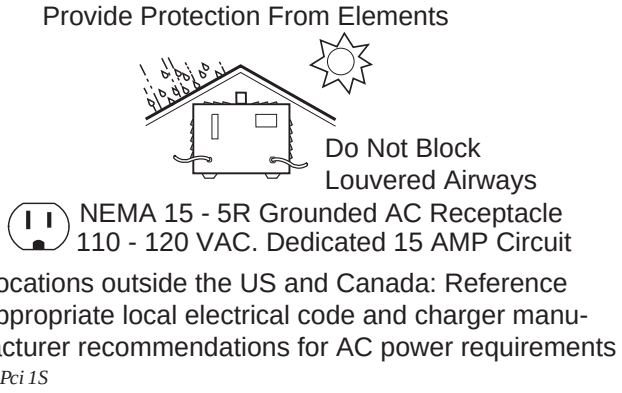

Fig. 1 Charger Installation

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.

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BATTERY CHARGER

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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.

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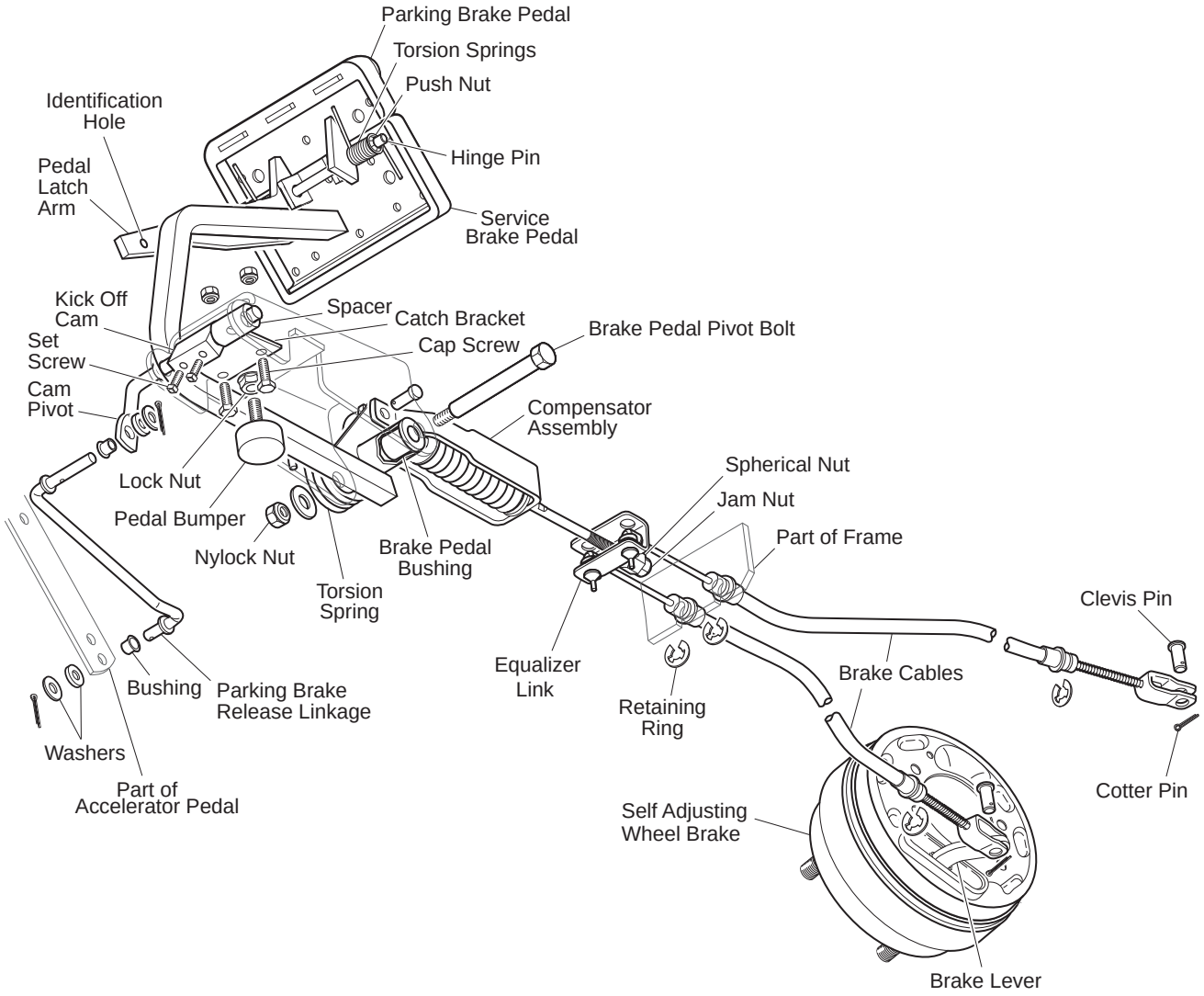

Fig. 1 Mechanical Brake System

BRAKE SYSTEM OVERVIEW

General Description

This vehicle is equipped with a mechanically activated rear drum brake system. The brake system consists of a service brake and parking brake pedal, parking brake release linkage, compensator assembly, equalizer link, brake cables and self adjusting wheel brake assemblies (Ref. Fig. 1 on Page K-1).

Although the brake system is similar to an automobile, it is **different in important ways**. The system operates in a very severe environment. Fertilizer, dust, grass clippings, tree roots and other objects can cause corrosion and physical damage to the brake components. Unlike automotive hydraulic brakes, mechanical brakes depend on the travel of the brake cables to move the brake shoes against the brake drums. The travel of the brake cables is governed by the brake pedal. If the cables cannot travel far enough to absorb the slack (free travel) in the system and still apply the shoes to the drums, the braking effort at the wheel brake will not be adequate. The self adjusting mechanism in the wheel brakes 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.

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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 on Page K-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.

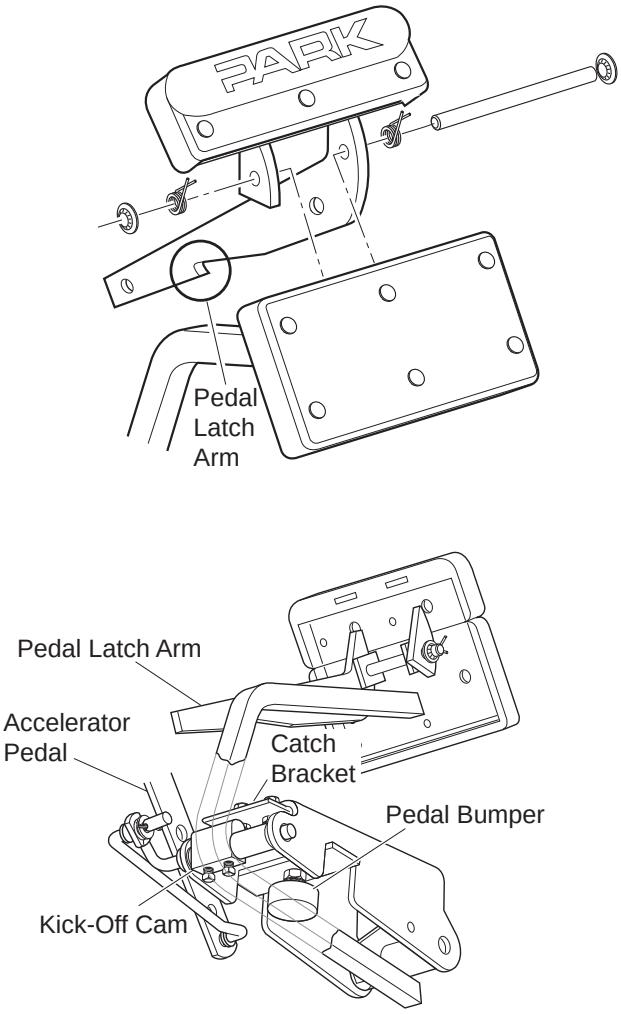

Fig. 2 Parking Brake and Kick-Off Mechanism

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.

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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 on Page K-3). The brake compensator assembly applies a spring load to the parking brake system and insures that the parking brake remains under tension whenever it is engaged.

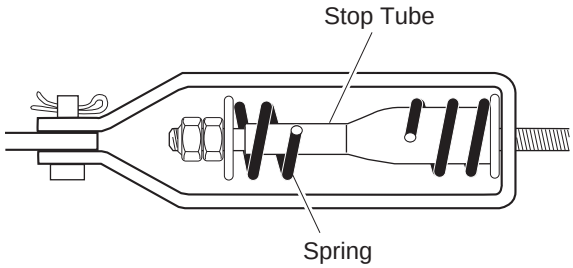

Fig. 3 Compensator Assembly

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.

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TROUBLESHOOTING FLOWCHART

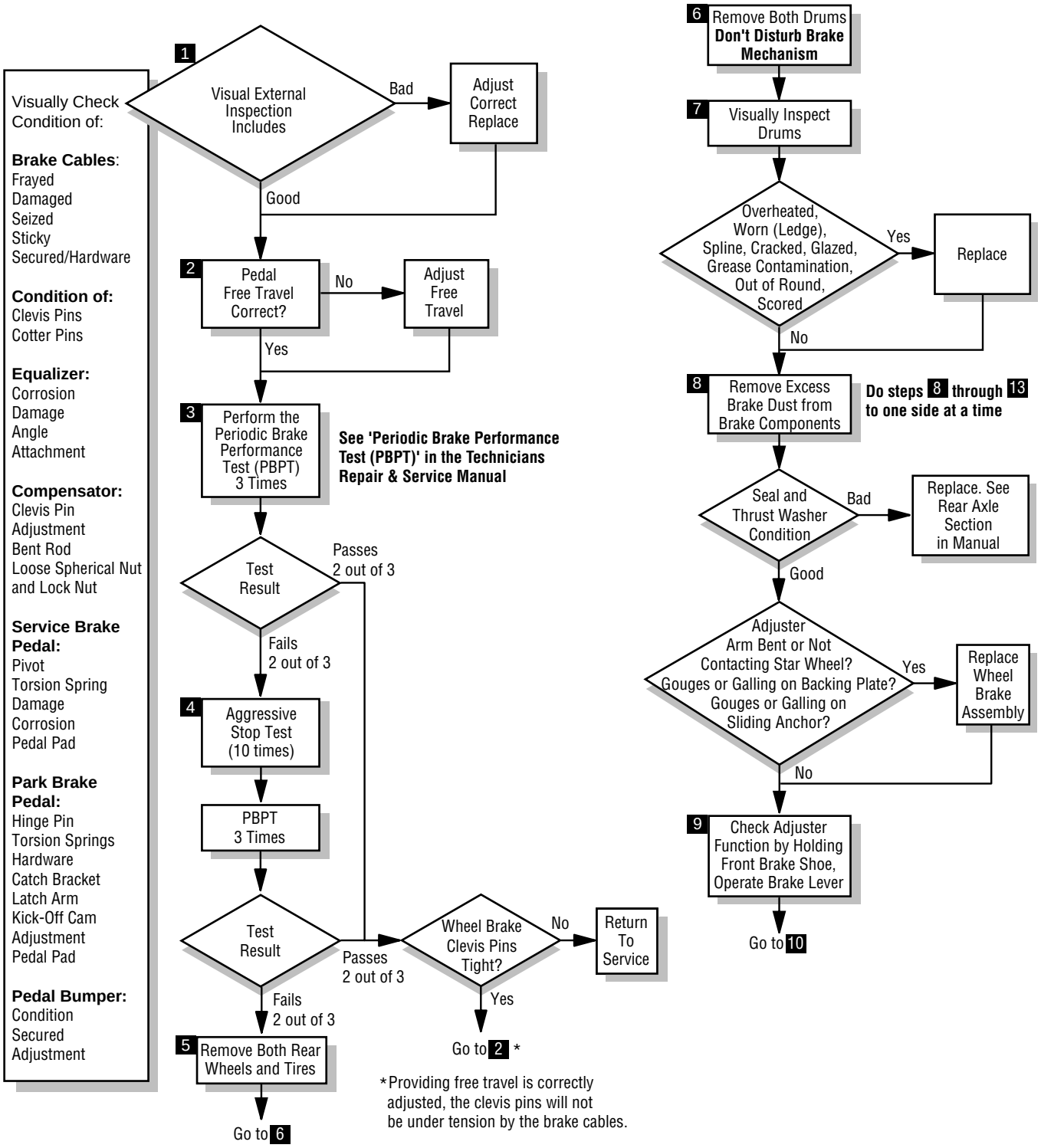

Fig. 4 Troubleshooting Flowchart

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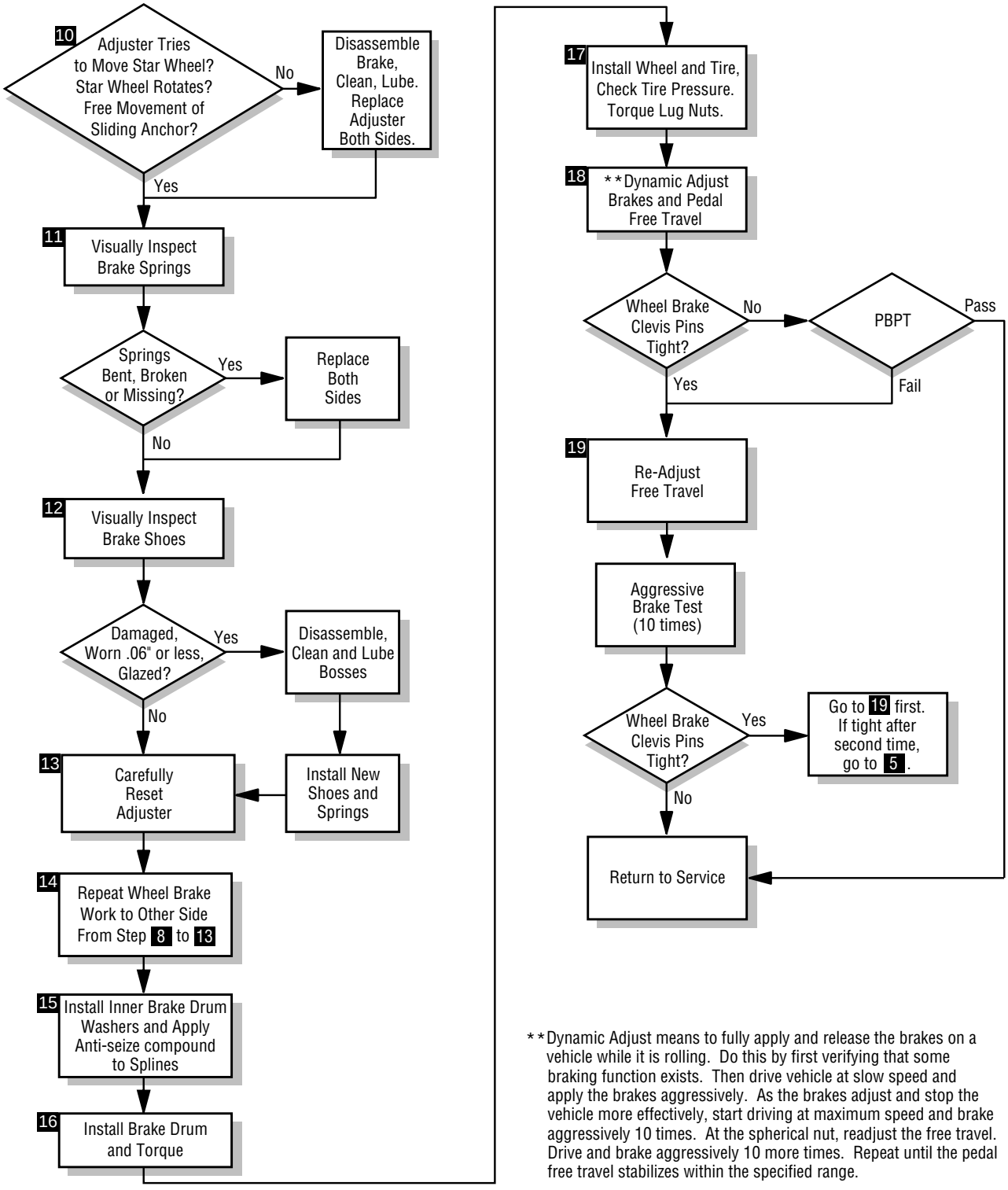

**Dynamic Adjust means to fully apply and release the brakes on a vehicle while it is rolling. Do this by first verifying that some braking function exists. Then drive vehicle at slow speed and apply the brakes aggressively. As the brakes adjust and stop the vehicle more effectively, start driving at maximum speed and brake aggressively 10 times. At the spherical nut, readjust the free travel. Drive and brake aggressively 10 more times. Repeat until the pedal free travel stabilizes within the specified range.

Fig. 5 Troubleshooting Flowchart

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TROUBLESHOOTING TABLE

Refer to the following troubleshooting table only after the thorough visual inspection, Periodic Brake Performance Test (PBPT), and Aggressive Stop Test is performed (Ref. Fig. 6 on Page K-6).

Condition	Possible Cause	Correction
Fails Brake Performance Test by stopping in a longer distance than normal	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
Starting 2001 Model Year - In excess of 1 1/8" (2.9 cm) free pedal travel (Soft Pedal) **Prior to 2001 Model Year - In excess of 2 1/4" (5.7 cm) free pedal travel (Soft Pedal)**	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
Starting 2001 Model Year - Less than 7/8" (2.2 cm) free pedal travel (Hard Pedal) **Prior to 2001 Model Year - Less than 2" (5 cm) free pedal travel (Hard Pedal)**	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

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Condition	Possible Cause	Correction
Neither wheel locks when park brake is latched. (Note: At full speed the wheels may not lock, but should brake aggressively).	Incorrect compensator spring adjustment	Return to factory specification
	Excessive brake pedal free travel	Adjust per manual
Unequal braking (one wheel locks while other rotates)	Wheel not locking is not adjusting	Check brake operation of wheel that is **not** 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
Neither wheel locks	Brake system requires complete adjustment	Adjust entire system
	Brake pedal not returning	Check for binding of brake pedal Check brake pedal free travel
Grabbing brakes (oversensitive)	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
Parking brake hard to latch	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
Parking brake will not stay latched	Excessive wear	Check for worn latch mechanism

Fig. 6 Troubleshooting Table

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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. “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 in detail under “MAINTENANCE AND REPAIRS” on page 14 .

⚠ CAUTION

Satisfactory brake performance does not eliminate the need for routine brake testing and inspection as shown on the Periodic Service Schedule in Section A. Continued proper brake operation depends on periodic maintenance.

Brake Pedal and Linkage Inspection

1. **Inspect brake pedal return bumper.**
   Be sure that the brake pedal is contacting the pedal return bumper when released, that the bumper is in good condition and that a 1/4 - 3/8" (6 - 9.5 mm) gap exists between the brake pedal arm and the setscrew heads of the kick-off cam (Ref. Fig. 7 on Page K-8). Replace or adjust the pedal bumper if required. “Pedal Bumper Adjustment” on page 20.

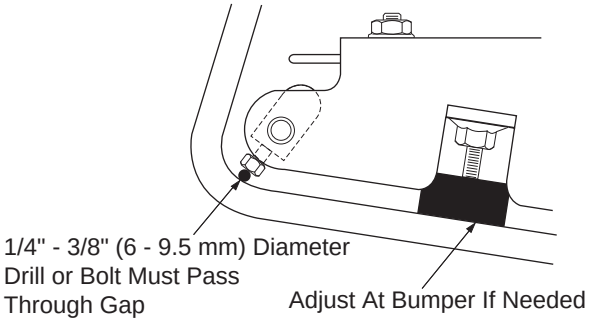

Fig. 7 Brake Pedal Bumper Inspection

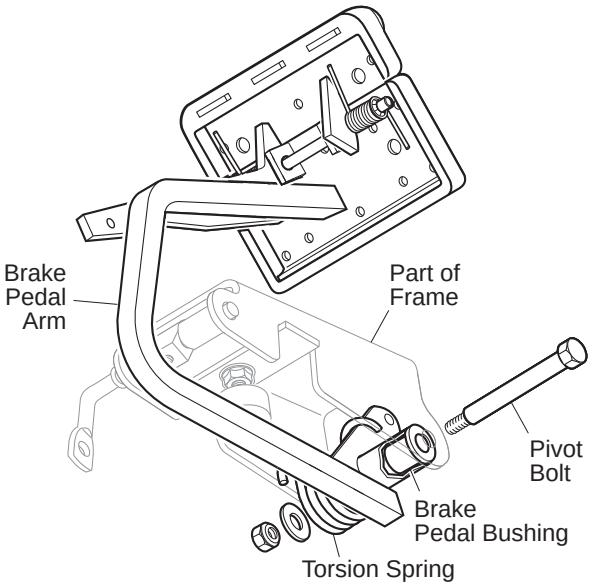

Fig. 8 Brake Pedal Inspection

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 on Page K-8). Replace pedal, spring, bushings and bolt as required. “Brake Pedal Removal and Installation” on page 19

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

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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.

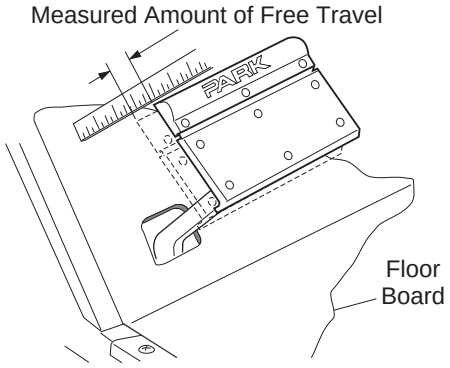


Fig. 9 Check for Excessive Free Travel

NOTICE

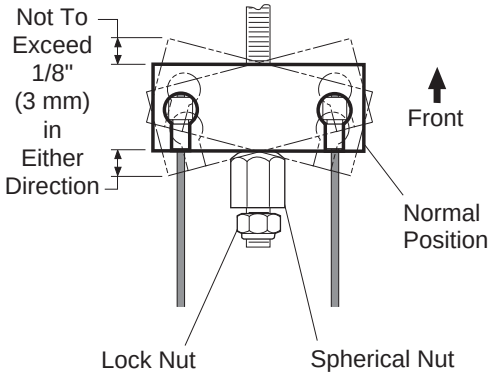
Adjustment of free travel depends on manufacturing date.

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.

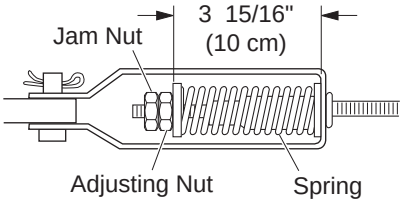


Fig. 10 Equaliser and Compensator

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).

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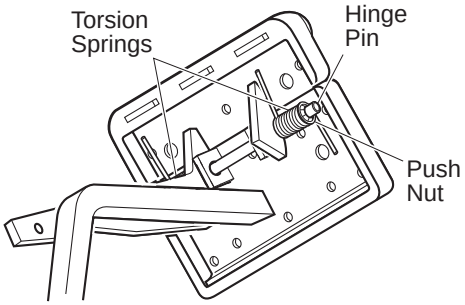

Fig. 11 Parking Brake Pedal Hinge Inspection

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 on Page K-10).
11. **Inspect the parking brake kick-off cam.**
    Look for wear and for correct adjustment. With the parking brake engaged and fully latched, there must be no gap between the top of the cam and the latch arm. Adjust the kick-off cam (3) if required (Ref. Fig. 12 on Page K-10). It is very important that the correct setscrews are used to hold the kick-off cam to the pivot rod. Use of longer screws prevents correct adjustment of pedal bumper (pedal travel) and may prevent the brakes from adjusting properly.
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.

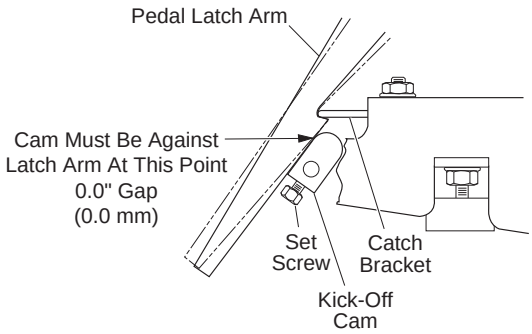

Fig. 12 Kick-Off Cam Inspection

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.

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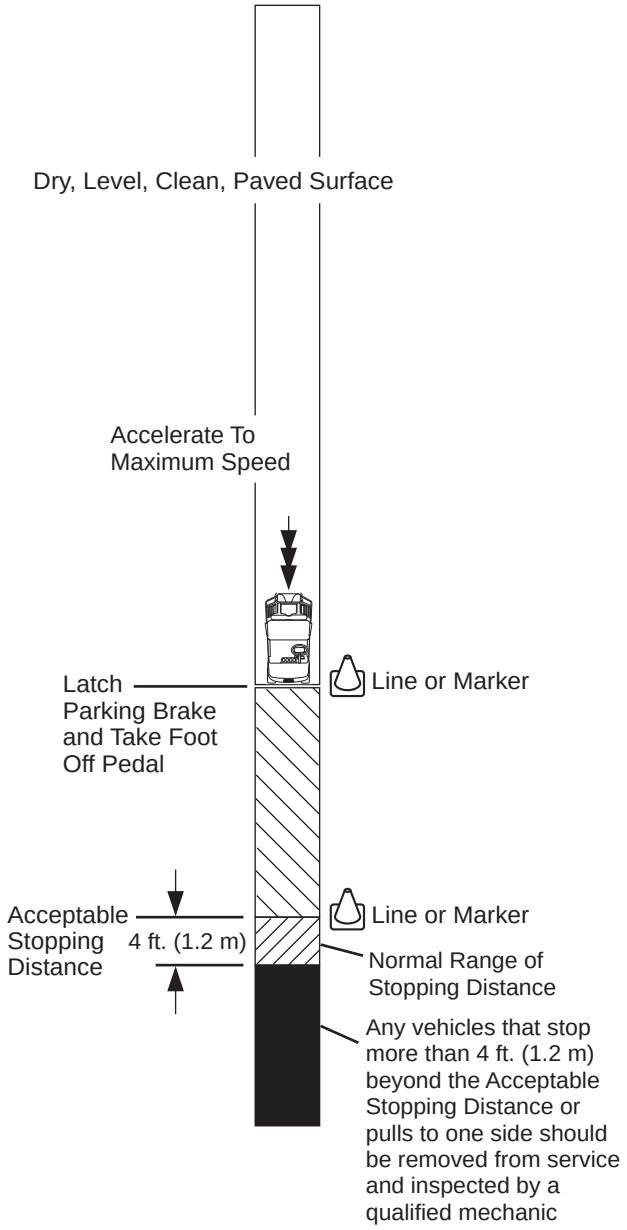

Fig. 13 Periodic Brake Performance Test

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 on Page K-11). Quickly depress the brake pedal to latch the parking brake at the line or marker in the test area and remove foot from pedal. The vehicle should stop aggressively. The wheel brakes may or may not lock. Observe the vehicle stopping location or measure the vehicle stopping distance from the point at which the brakes were latched. The vehicle should stop within the “normal” range of stopping distances. If the vehicle stops more than 4 ft. (1.2 m) beyond the acceptable stopping distance or pulls to one side, the vehicle has failed the test.

Repeat test two more times.

If the vehicle fails to pass two of three Periodic Brake Performance Tests, perform the Aggressive Stop Test 10 times as described below, then repeat the Periodic Brake Performance Test three more times (second set of three).

If the vehicle passes two of three Periodic Brake Performance Tests, check that the clevis pins at the brake levers are loose. If they are loose, return vehicle to service. If they are tight, adjust free travel. “Adjusting Brake Pedal Free Travel” on page 14 Then repeat the Periodic Brake Performance Tests. If vehicle fails, remove from service and refer to ‘Wheel Brake Inspection’, , to evaluate the reason for failure.

Aggressive Stop Test

WARNING

To prevent serious injury or death, all brake tests must be done in a safe location with regard for the safety of all personnel.

Always conduct a visual inspection and evaluate pedal travel before operating a vehicle to verify some braking function is present.

The purpose of this test is to attempt to fully expand and release the brake adjusters on a vehicle which has failed the first set of Periodic Brake Performance Tests. It is important that the technician/mechanic exercise care and perform the test in a non-congested area with regard for the safety of all personnel.

To perform an Aggressive Stop Test, equally load both sides of the vehicle (Ref. Fig. 14 on Page K-12) 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.

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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.

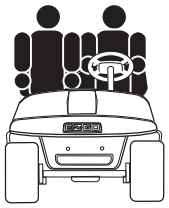

Fig. 14 Equally Loaded Vehicle

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 on Page K-12).

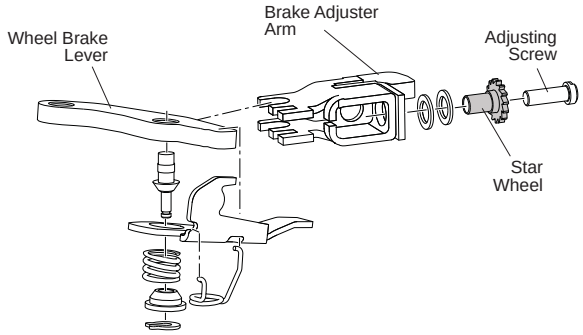

Fig. 15 Adjuster Mechanism

If the adjuster arm **engages and turns** the star wheel, proceed. If the arm **fails to engage** the star wheel, it has been damaged and both wheel brake assemblies must be replaced.
If the adjuster arm engages the star wheel but **fails to rotate it**, the adjuster assemblies must be replaced with new color-coded adjusters. Note the location of the two Teflon coated washers (Ref. Fig. 22 on Page K-16).

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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 on Page K-13). 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. “Adjusting Brake Pedal Free Travel” on page 14 This includes all linkage and wheel brake components.

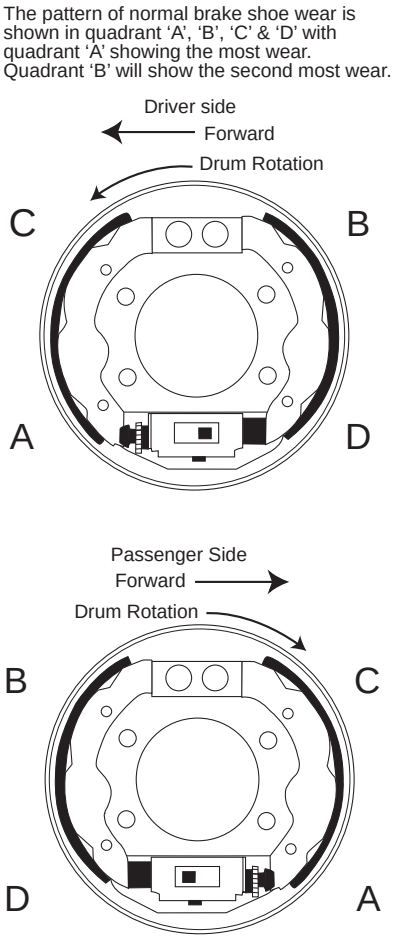

Fig. 16 Brake Shoe Wear

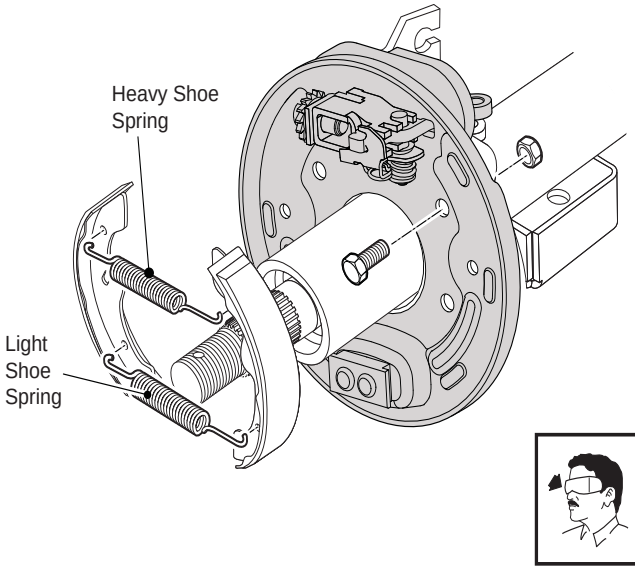

Fig. 17 Orientation of Brake Shoe Springs

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MAINTENANCE AND REPAIRS

Tool List	Qty. Required
Hydraulic floor jack	1
Scale	1
Jack stands	4
Wheel chocks	4
Socket, 1/2", 1/2" drive	1
Socket, 3/4", 1/2" drive	1
Socket, 11/16", 1/2" drive	1
Socket, 15/16", 1/2" drive	1
Socket, 1 1/8", 1/2" drive	1
Socket, 1/4", 3/8" drive	1
Torque wrench, 1/2" drive, ft. lbs.	1
Torque wrench, 3/8" drive, in. lbs.	1
Extension, 6", 1/2" drive	1
Ratchet, 1/2" drive	1
Open end wrench, 1/4"	1
Open end wrench, 1/2"	1
Open end wrench, 5/8"	1
Straight blade screwdriver	1
Straight blade screwdriver, narrow	1
Pliers	1
Vernier/Dial calipers	1
Plastic tipped hammer	1
Puller (P/N 15947-G1)	1
Pry bar	1
Dust mask	1
Emery cloth	1

Parts Replacement vs. Repair

Some maintenance or repair tasks can take considerable labor to do correctly. Assessment of the condition of worn components is critical to the operation of the brake system. In some cases, component replacement may be more cost effective than the removal, cleaning, inspection and reassembly of the component(s).

Adjusting Brake Pedal Free Travel

⚠ CAUTION

Brake pedal free travel MUST be checked and adjusted any time that the brake system is serviced or when parts are replaced.

Brake pedal free travel is the distance the pedal travels from rest to the point at which the brake cables start to move the brake levers. This should not be confused with the light resistance that is felt as the brake pedal is depressed enough to remove slack from the compensator and cables. Correct adjustment of free travel is essential to proper brake function. Too much pedal free travel will limit braking capability. Too little pedal free travel may cause the brakes to drag (not fully released). Either condition can prevent the brakes from adjusting properly.

⚠ WARNING

This procedure is intended to adjust the brakes and seat brake system components. The brake system may not be effective for the first few applications of the brake pedal.

Pre-adjust service brake pedal free travel to the correct setting by loosening the jam nut and adjusting the spherical nut (Ref. Fig. 18 on Page K-14). Tighten the jam nut to 10 - 11 ft. lbs. (14 - 15 Nm).

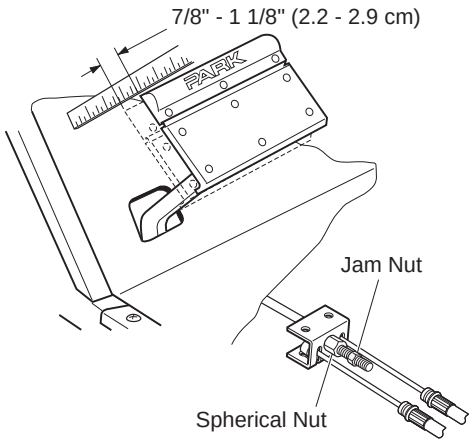

Fig. 18 Free Travel Adjustment

The correct brake pedal free travel should be set to 7/8" - 1 1/8" (2.2 - 2.9 cm).

Press the brake pedal aggressively 4 - 6 times to establish known free travel.

⚠ WARNING

All brake tests must be done in a safe location with regard 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.

Repeat the previous step(s) until the pedal free travel does not change during the aggressive braking.

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Check to see that the clevis pins attaching the brake cables to the brake levers are loose (Ref. Fig. 19 on Page K-15). If they are not loose, inspect system again and correct as required. If the clevis pins are loose, tighten jam nut to 10 - 11 ft. lbs. (14 - 15 Nm) at the spherical nut.

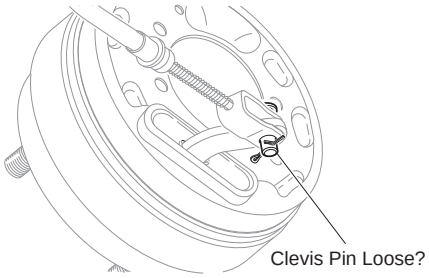

Fig. 19 Check Clevis Pins

The parking brake latching force can be checked as verification after setting brake pedal free travel. To check parking brake latching force, place a 'bathroom' scale on the service and parking brake pedals. Using both feet press the scale down against the parking brake pedal until it latches. The parking brake should latch between 65 and 75 lbs. (29 - 34 kg) indicated on the scale (Ref. Fig. 20 on Page K-15).

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

Brake Drum Removal and Installation

Remove the dust cap (1) to gain access to the castellated nut (2) and the cotter pin (3) (Ref. Fig. 21 on Page K-15).

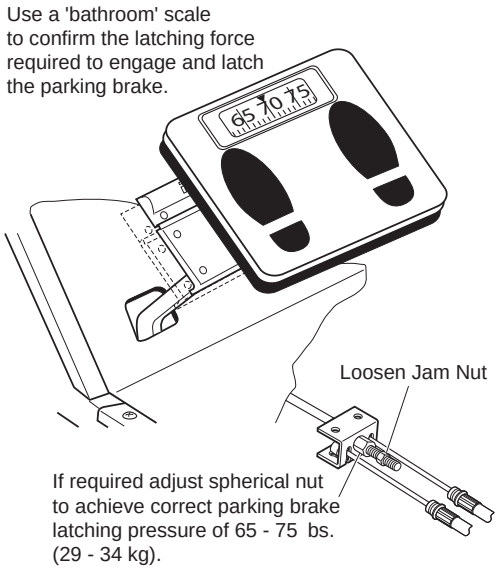

Fig. 20 Checking Parking Brake Latching Pressure

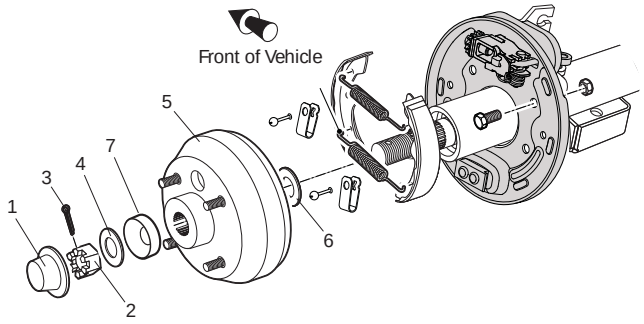

Fig. 21 Brake Assembly

Remove the cotter pin 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) and spindle cap adapter (7).

Slide the brake drum (5) from the axle shaft. If required, tap the drum with a plastic faced hammer to loosen it from the axle shaft or use drum puller (P/N 15947-G1).

⚠ 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.

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

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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. “Brake Shoe Removal” on page 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 on Page K-16).

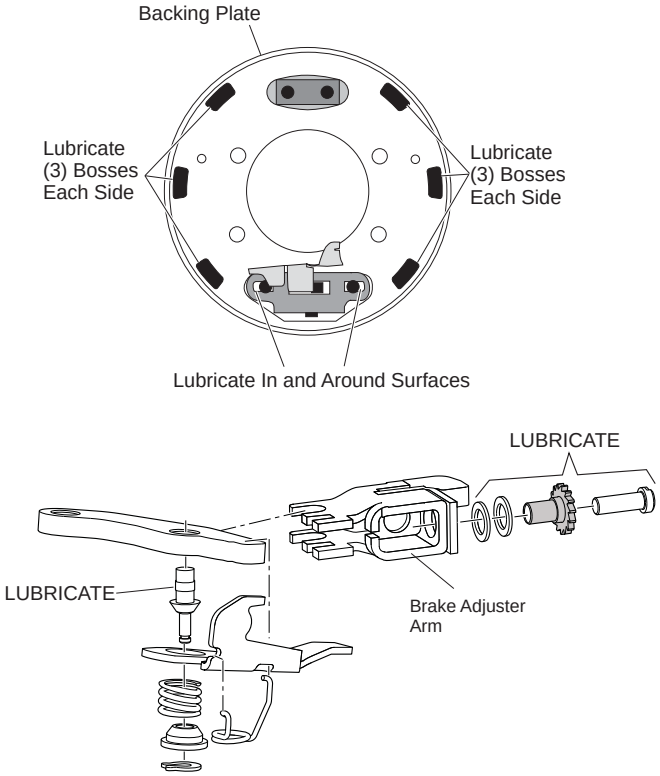

Fig. 22 Wheel Brake Lubrication Points

Install the actuator components, adjuster components and brake shoes “Brake Shoe Installation” on page 17. If the brake shoes and drum are not to be replaced, sand the friction surfaces lightly with emery cloth to remove any foreign material.

⚠ 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. “Adjusting Brake Pedal Free Travel” on page 14.

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Backing Plate/Entire Wheel Brake Assembly Removal and Installation

Remove the four bolts (1) and lock nuts (2) securing the wheel brake backing plate to the flange on the axle tube (Ref. Fig. 23 on Page K-17).

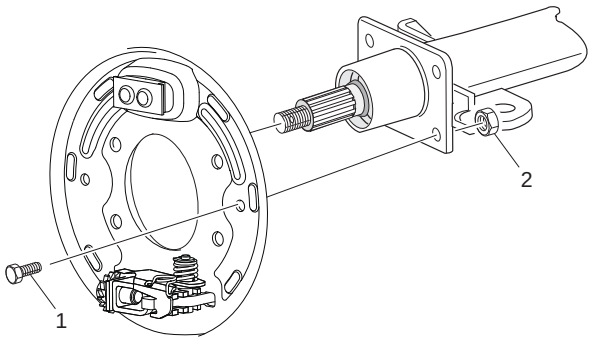

Fig. 23 Backing Plate Removal and Installation

Remove the clevis pin securing the brake cable to the brake lever.

Installation is the reverse of removal. Connect the brake cable to the wheel brake with the clevis pin installed from the top down and a new cotter pin. Install the brake assembly or backing plate to the axle tube flange. Install new hardware (locknut should only be used once) and tighten to 23 - 28 ft. lbs (31 - 38 Nm) torque.

Brake Shoe 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. 27 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).

Brake Shoe Installation

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

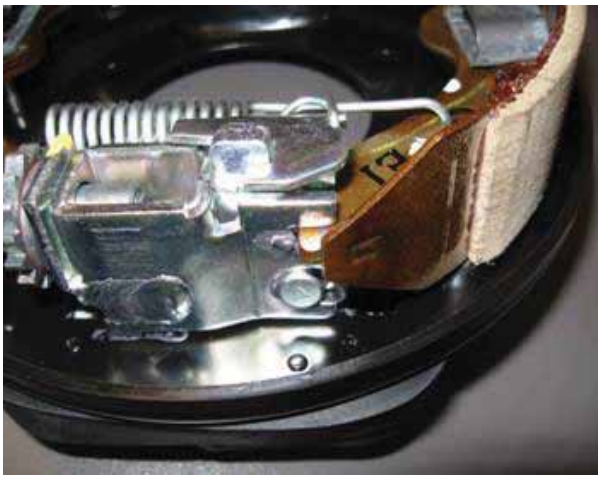

Fig. 24 Brake Shoe '17L'

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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 on Page K-18).

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

Fig. 25 Brake Shoe ’17T’

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

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. “Brake Drum Removal and Installation” on page 15.

Repeat on other side of vehicle.

Adjust the brake pedal free travel. “Adjusting Brake Pedal Free Travel” on page 14.

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. 26 on Page K-18). Inspect the hardware and replace if needed. Remove the brake cable and equalizer assembly and discard.

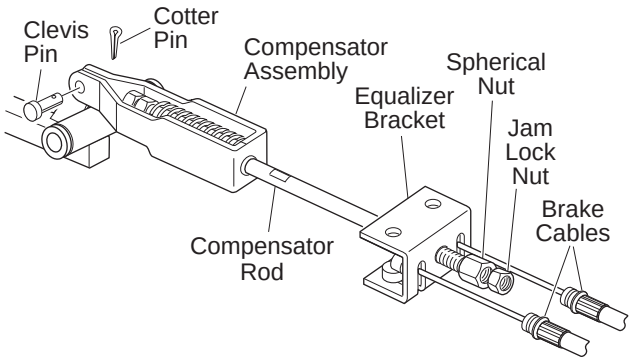

Fig. 26 Brake Cable, Equaliser and Compensator

Slide the equalizer link of the new assembly over the compensator rod. Loosely install the spherical nut and new locking jam nut. Insert the cables into the frame and axle brackets. Install new retaining rings. Connect the cables to the brake levers using new clevis pins and new cotter pins.

Adjust the brake pedal free travel. “Adjusting Brake Pedal Free Travel” on page 14.

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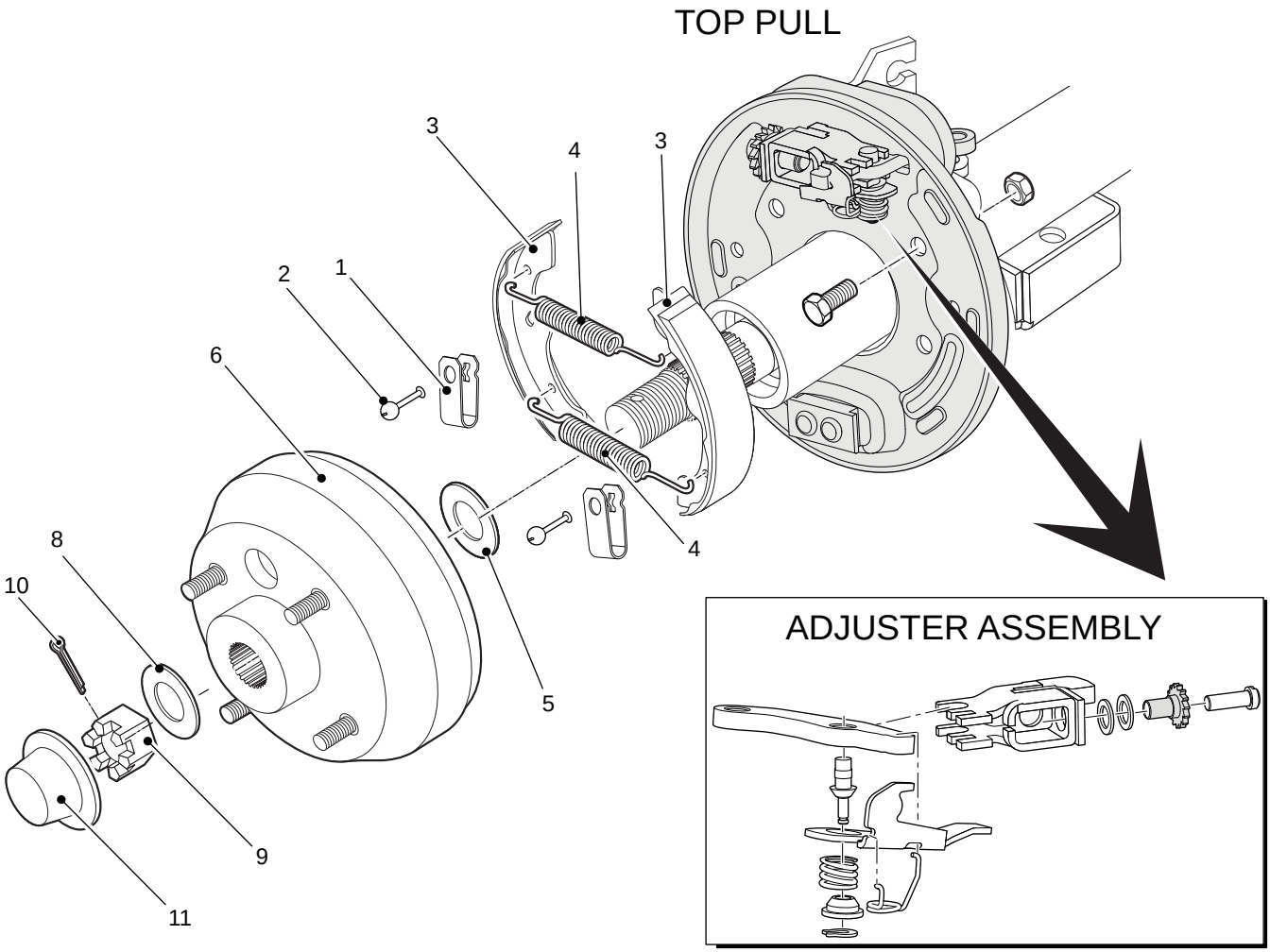

Fig. 27 Brake shoes and Springs

Compensator Assembly, Removal and Installation

Disconnect the compensator assembly from the brake pedal by removing the cotter pin and clevis pin (Ref. Fig. 26 on Page K-18).

Loosen and remove the jam nut and the spherical nut connecting the compensator rod to the equalizer link. Remove the compensator assembly.

Installation is the reverse of removal. Use new cotter pins in the clevis pin.

Adjust the brake pedal free travel. “Adjusting Brake Pedal Free Travel” on page 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 on Page K-20). 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. “Adjusting Brake Pedal Free Travel” on page 14

Check for proper brake light operation if equipped.

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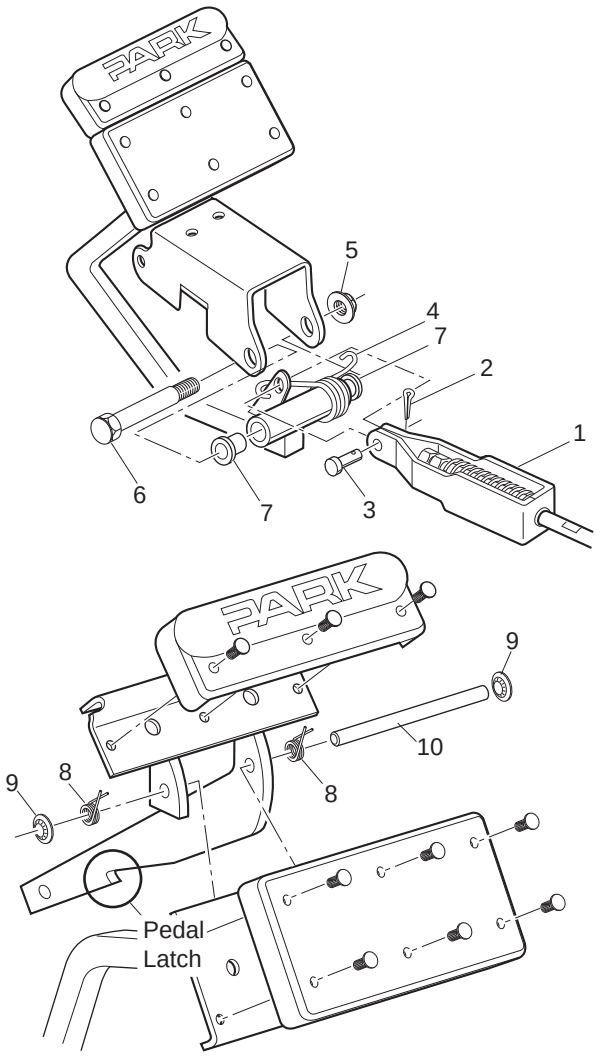

Fig. 28 Brake Pedal Removal and Installation

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.

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 on Page K-20).

If required, adjust the kick-off cam (3). “Parking Brake Kick-Off Cam Removal, Replacement and Installation.” on page 21

Install wheel. See WHEELS AND TIRES section.

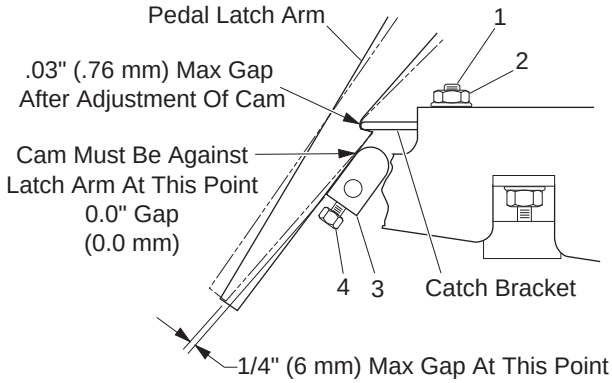

Fig. 29 Catch Bracket and Latch Arm

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). “Parking Brake Kick-Off Cam Removal, Replacement and Installation.” on page 21

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

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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).

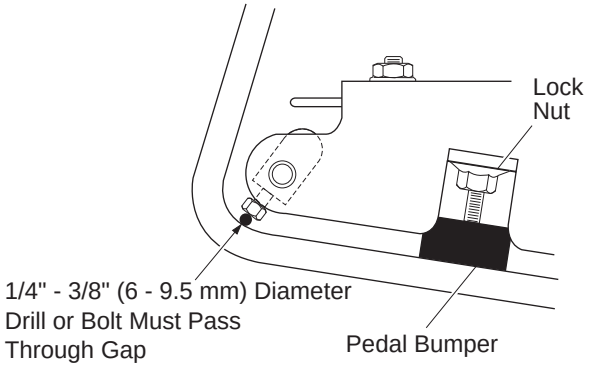

Fig. 30 Pedal Bumper Adjustment

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 on Page K-21).

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). “Parking Brake Kick-Off Cam Removal, Replacement and Installation.” on page 21.

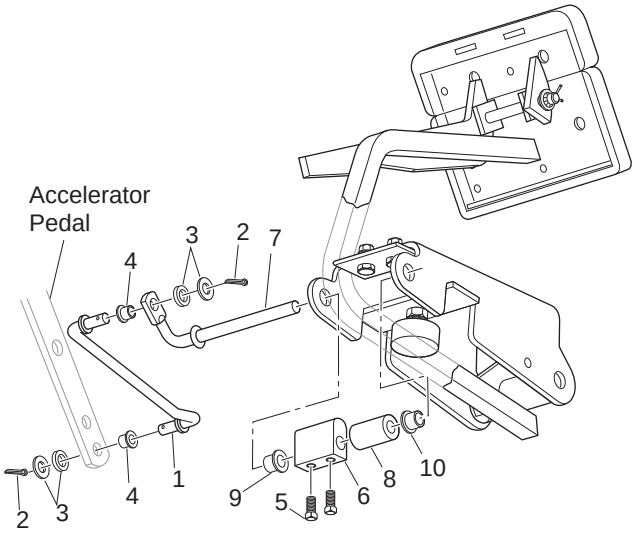

Fig. 31 Parking Brake Release Linkage and Kick-Off Cam Removal and Installation.

Parking Brake Kick-Off Cam Removal, Replacement and Installation.

Disconnect the parking brake release linkage as described above. Loosen the two setscrews (5) from the cam (6) and remove the cam pivot (7), cam and spacer (8) (Ref. Fig. 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.

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DIRECTION SELECTOR

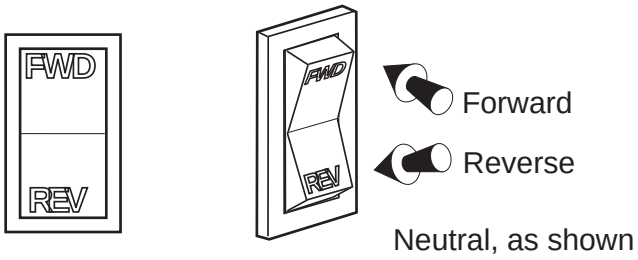

Fig. 1 Direction Selector Switch

Removing Direction Selector

Tools List	Qty. Required
Wrench, 7/16"	2
Wrench, 5/16"	1
Phillips screwdriver	1
Digital Volt Ohm Meter (DVOM)	1

NOTICE

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

⚠ WARNING

To prevent an electrical arc that could cause an electrical explosion, 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.

The battery positive (+) cable must be removed before starting work on vehicle.

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.

Before replacing a suspect direction selector switch or replacing the buzzer, ensure the electrical wires are firmly attached and the wire is in good condition. Test suspect component to ensure it is not in good condition before replacing. It is not necessary to remove the direction selector switch to replace the reverse buzzer.

Prior to removing the direction selector switch from the body, the battery positive cable must be disconnected to prevent the possibility of electrical spark or 'shorting out' the battery, either of which could result in an explosion and severe personal injury or death.

The reverse buzzer be removed without removing the direction selector switch from the vehicle.

Replacing the Reverse Warning Buzzer

Before replacing the warning buzzer, test it to ensure it is not working properly. To test the reverse warning buzzer, carefully remove the two electrical wires from the buzzer. Using two test leads, attach one lead to each terminal. Touch the loose end of one wire to the (+) battery terminal and the other wire to the (-) terminal. If the buzzer is in good condition the buzzer will sound. If no sound is heard, the buzzer will need to be replaced.

Remove the wires from the failed buzzer and attach the wires to the replacement buzzer. Test as above to ensure replacement buzzer is in good condition. After restoring power, test the wiring to ensure it is operational by connecting wires to replacement buzzer and moving the direction selector to "REVERSE' position before continuing. Once it is determined that the buzzer and wiring are good, remove the failed buzzer from the direction selector assembly and replace with new buzzer.

Replacing the Direction Selector Switch

Before replacing the direction selector switch, turn off the ignition switch and disconnect the positive (+) battery cable.

To remove the direction selector switch, the key switch panel must be removed from the dash panel. Drill out the rivet, as shown in BODY section, and pull plate from dash. To remove the direction selector switch, squeeze the four clips, two each on the top and bottom of the switch, and push switch through the dash panel from the back side.

Make note of wire locations and remove one wire at a time from the bad switch and place it on the same terminal of the new switch. Once all three wires have been attached to the new switch, ensure each is securely fastened and push switch back through the dash from the front until the four clips have snapped in place securely attaching switch in the dash.

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DIRECTION SELECTOR

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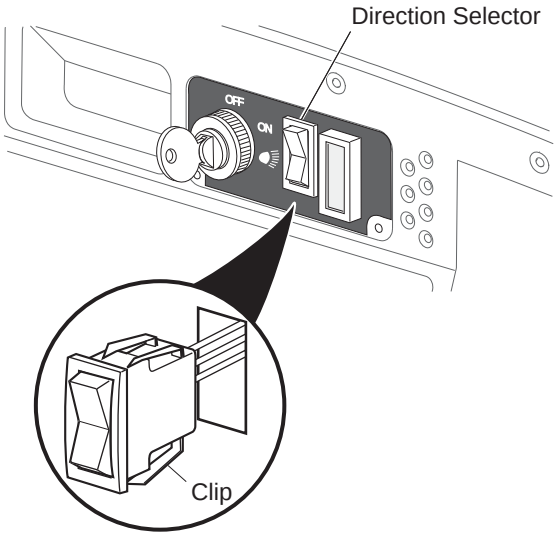
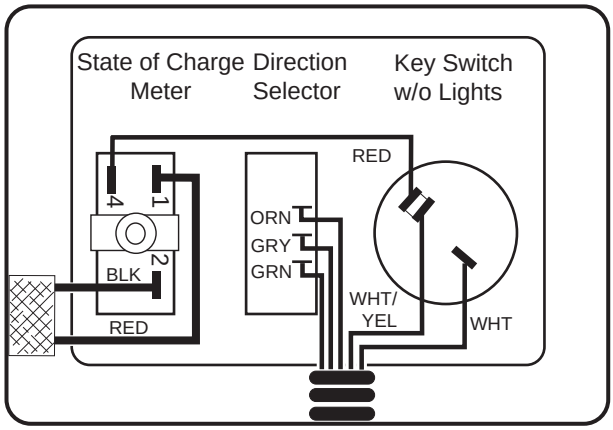


Fig. 2 Direction Selection Switch Replacement



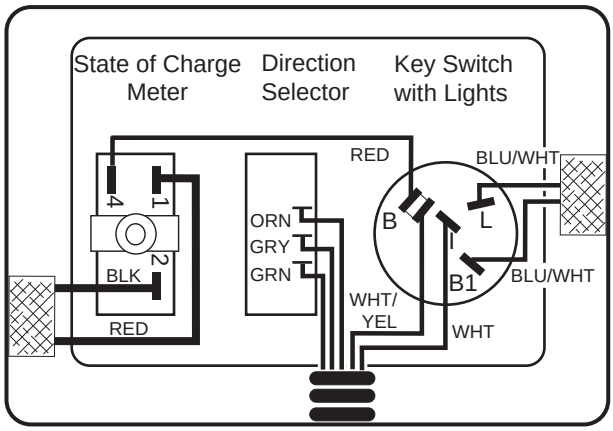


Fig. 3 Direction Selector Switch Connections

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DIGITAL VOLT OHM METER

A typical DVOM (digital volt ohm meter) is shown (Ref. Fig. 1 on Page M-1). A recommended model is available through the Service Parts Department as P/N 27481-G01. For the purpose of this section, the red probe (+) and black probe (-) are used. Any DVOM may be used, however the controls, displays, accuracy and features may vary depending on the make and model. Always follow the meter manufacturer's recommendations and instructions for the use and care of the meter.

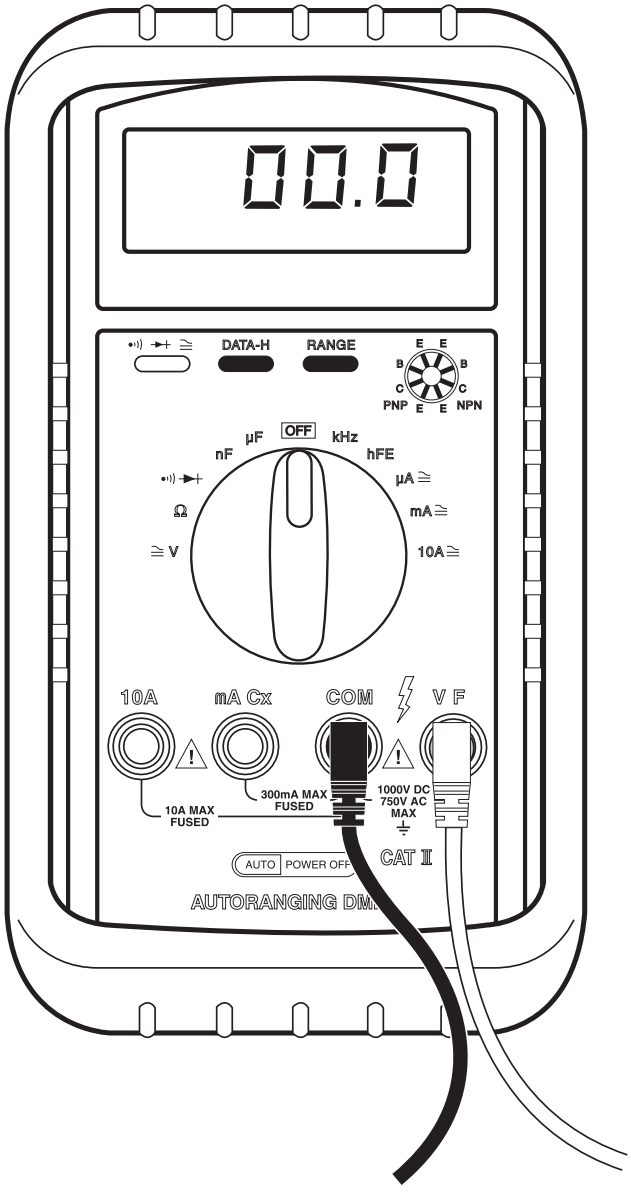

Fig. 1 DVOM

TROUBLESHOOTING

In order to effectively troubleshoot the circuits that include the horn, lighting, brake/turn signals and gauges, the technician must be able to use the wiring diagram and a DVOM.

The wiring diagram shows the path followed by voltage or a signal from its origination point to its destination (Ref. Fig. 2 on Page M-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.

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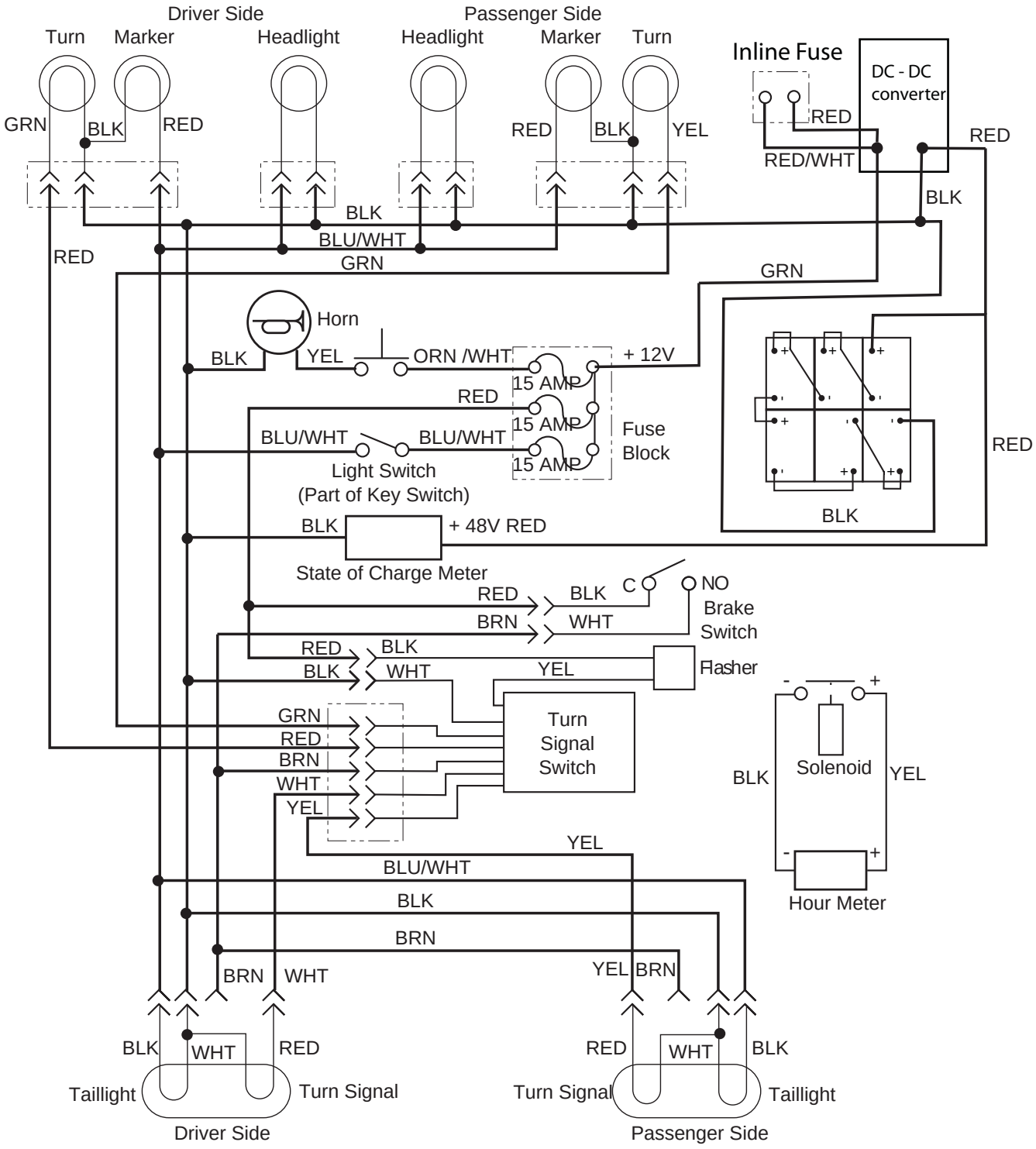

For vehicles without turn signals, remove WHT wire from left rear turn signal remove YEL wire from right rear turn signal connect BRN wire to RED

● Indicates butt connection within wiring harness

Fig. 2 Accessory Wiring Diagram

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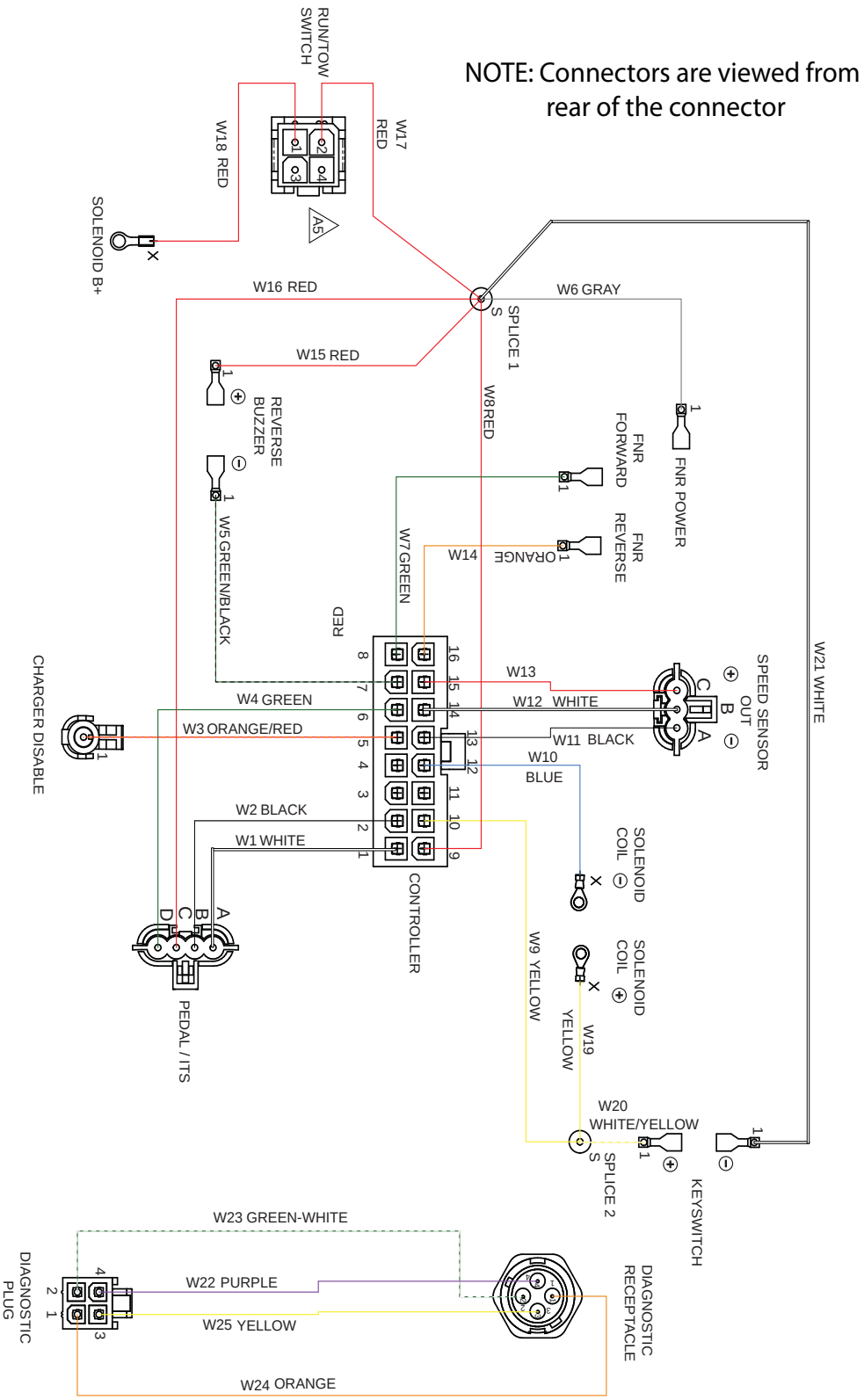

Fig. 3 Main Harness Wiring Diagram

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POWER SUPPLY

Tool List **Qty. Required**

DVOM 1

1. Check For Loose or Bare Wires

Check for loose wires at each terminal connection and for worn insulation or bare wires touching the frame. **Bare wires may cause a short circuit**.

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.

MAIN & 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 M-2) and (Ref. Fig. 3 on Page M-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.

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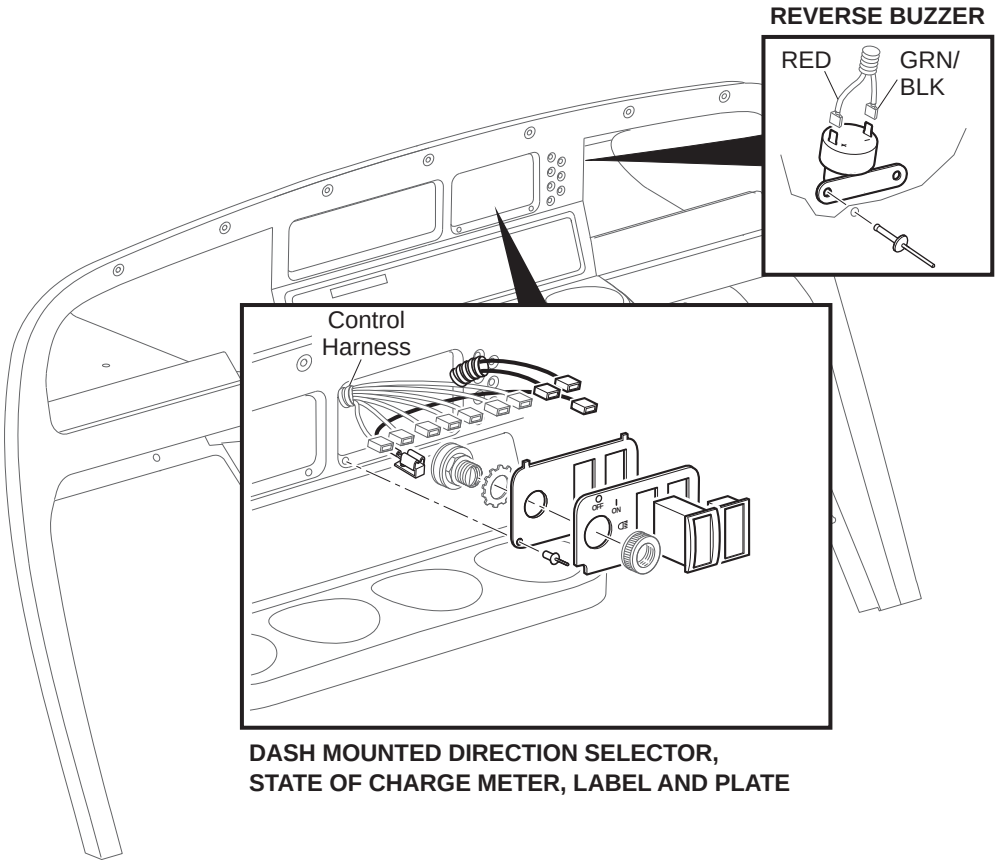

Fig. 3 Electrical Accessories

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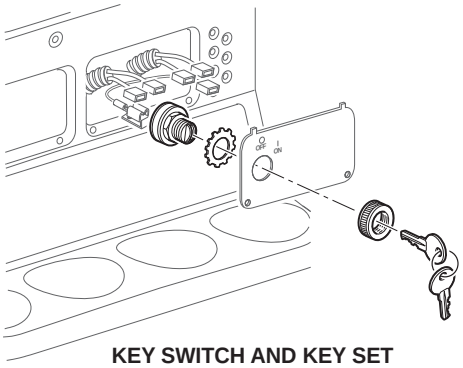
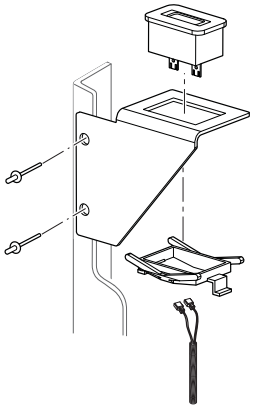
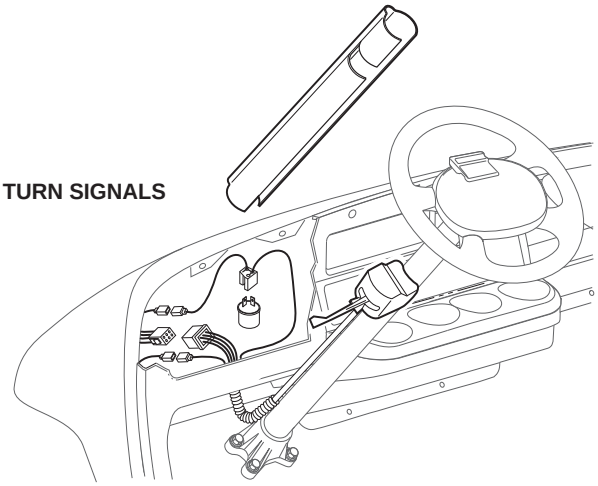


KEY SWITCH AND KEY SET

HOUR METER DETAIL



TURN SIGNALS



HORN BUTTON

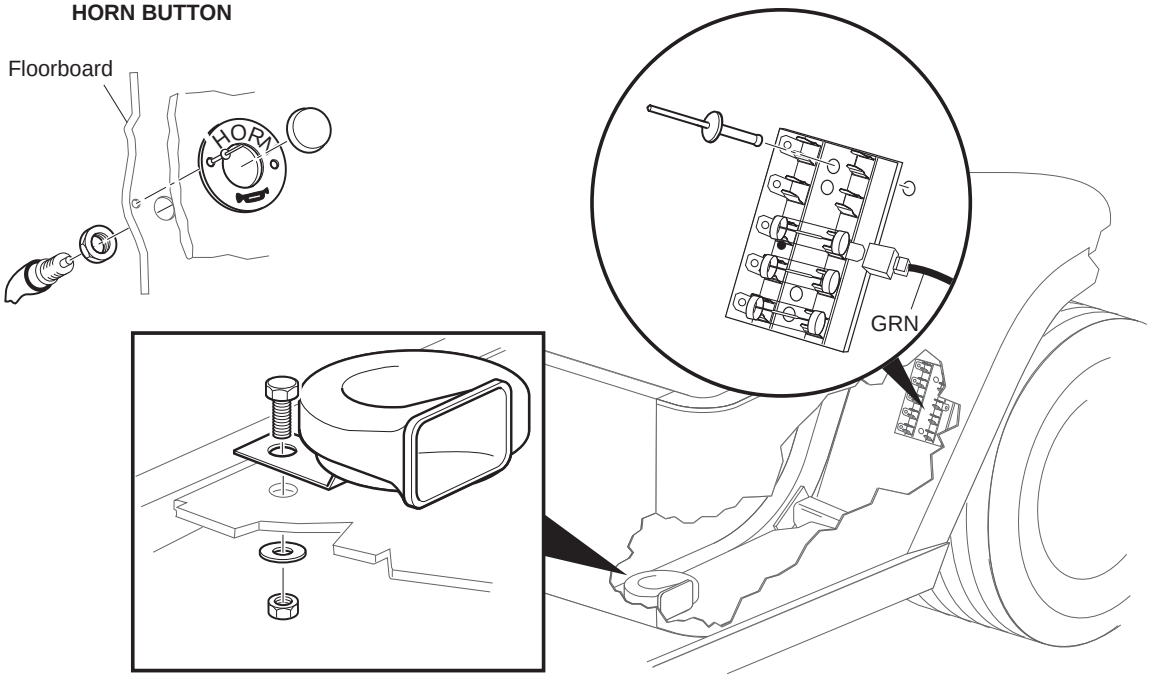


Fig. 4 Electrical Accessories

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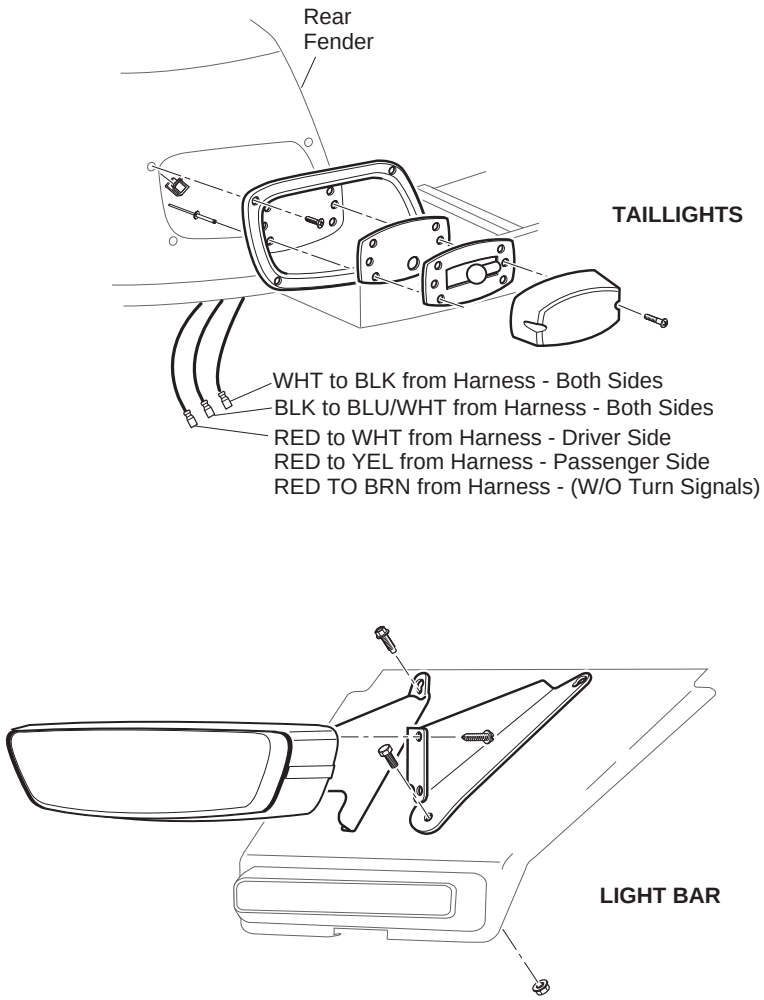

Fig. 5 Electrical Accessories

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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. Required
Wheel chocks	4
Jack stands	4
Floor jack	1
Wrench, 1/2"	1
Wrench, 9/16"	1
Wrench, 3/4"	1
Socket, 1/2", 3/8" drive	1
Socket, 9/16", 3/8" drive	1
Socket, 9/16", deepwell, 3/8" drive	1
Extension, 3", 3/8" drive	1
Ratchet, 3/8" drive	1
Torque wrench, in. lbs., 3/8" drive	1
Torque wrench, ft. lbs., 3/8" drive	1
Insulated wrench, 9/16"	1

The rear suspension consists of the rear axle and attachments that secure it to the springs and shock absorbers (Ref. Fig. 3 on Page N-3). Rear axle shaft removal is covered in REAR AXLE section.

Shock Absorber Removal

⚠ WARNING

To reduce the possibility of personal injury, follow the lifting procedure in Section "B" of this manual. Place wheel chocks in front and behind the front wheels and check the stability of the vehicle on the jack stands before starting any repair procedure. Never work on a vehicle that is supported by a jack alone.

Raise the rear of the vehicle in accordance with the instructions provided in Section 'B' of this manual and support the rear of the vehicle on the outer ends of the rear bumper.

Remove the bottom shock absorber nut (1) (Ref. Fig. 3 on Page N-3).

Compress the shock absorber (2) and remove the top shock absorber nut (3).

Remove the shock absorber (2).

Shock Absorber Installation

Shock absorber installation is in the reverse order of disassembly except that the shock absorber nuts (1, 3) must be tightened until the shock absorber bushings (4) expand to the diameter of the shock absorber washer (5).

Rear Spring Removal

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 (1) (Ref. Fig. 3 on Page N-3).

Place a floor jack under the center section of the rear axle (6) 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) can be removed.

Remove the rear spring shackle assembly (9) and the front spring mounting hardware (10).

Remove the spring (11).

Rear Spring Installation

Spring installation is in the reverse order of disassembly.

The shock absorber nuts (1,3) must be tightened until the shock absorber bushings (4) expand to the diameter of the shock absorber washer (5) (Ref. Fig. 3 on Page N-3).

Tighten front (10) and rear (9) spring mounting hardware to 18 - 23 ft. lbs. (24 - 31 Nm) torque.

Tighten axle mounting hardware (8) to 16 - 20 ft. lbs. (22 - 27 Nm) torque.

Rear Axle Assembly 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

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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.

⚠ CAUTION

Before any electrical service is performed on TCT 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 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.

Disable the electrical system to the motor by turning the key switch to the 'OFF' position and disconnect negative (-) battery cable from the battery.

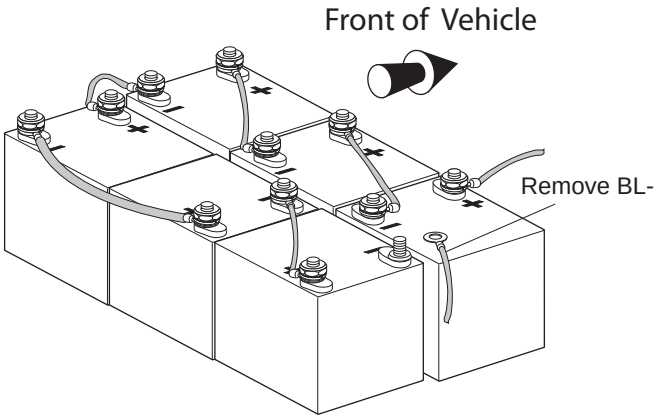

Fig. 1 Disconnect Battery Cable

Remove the wires to the motor, being careful to prevent the axle assembly (6) from rotating, remove the bottom shock mounting hardware and the springs from the rear axle as detailed elsewhere in this 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 disassembly. Tighten motor terminal hardware to 66 in. lbs. (7 Nm) torque (Ref. Fig. 2 on Page N-2) (Ref. Fig. 3 on Page N-3).

Install new cotter pins.

MOTOR WIRING

Motor Terminal	Wire Marker	from
F1	F1	Controller "F1"
F2	F2	Controller "F2"
A1	A1	Controller "A1"
A2	A2	Solenoid

Fig. 2 Motor Wiring

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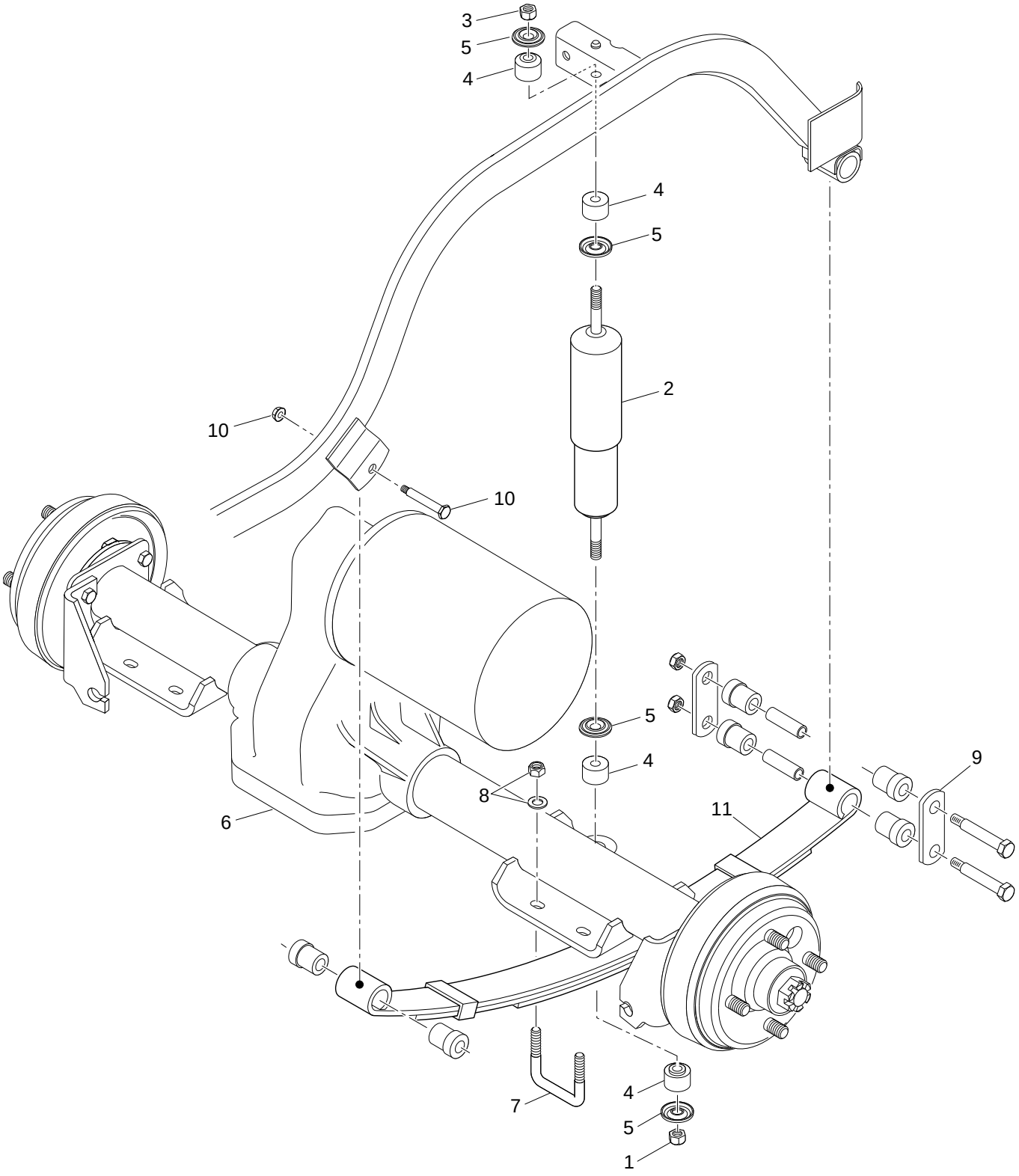

Fig. 3 Rear Suspension

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For further axle information, see Electric Rear Axle Manual P/N 28148-G01.

Refer to REAR SUSPENSION section for axle removal.

REAR AXLE MAINTENANCE

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

Checking the Lubricant Level

Clean the area around the check/fill plug and remove plug. The correct lubricant level is just below the bottom of the threaded hole. If lubricant is low, add lubricant as required. Add lubricant slowly until lubricant starts to seep from the hole. Install the check/fill plug. In the event that the lubricant is to be replaced, the vehicle must be elevated and the oil pan removed or the oil siphoned out through the check/fill hole (Ref. Fig. 1 on Page P-1).

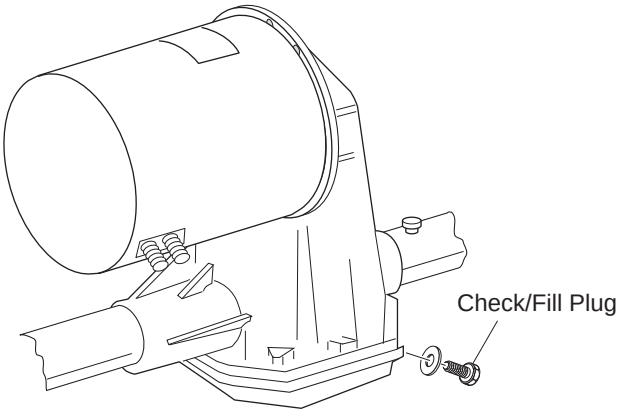

Fig. 1 Add, Check and Drain Rear Axle Lubricant

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.

Axle Shaft Removal and Disassembly

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

For brake drum removal, see BRAKES section.

Remove the outer snap ring from the axle tube (Ref. Fig. 2 on Page P-1).

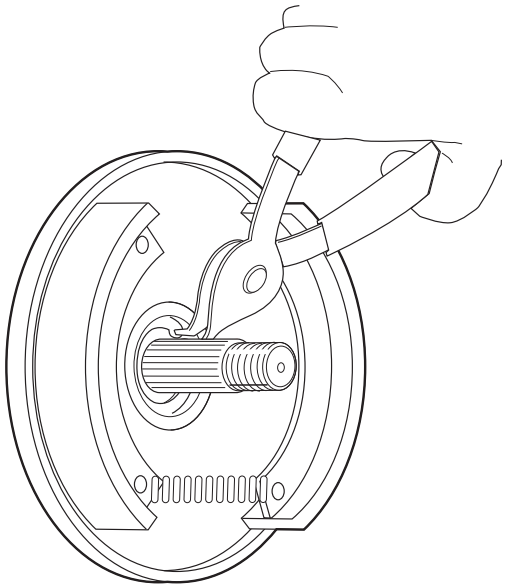

Fig. 2 Removing/Installing Outer Snap Ring

Attach a slide hammer to the axle shaft thread and remove the axle and bearing from the axle tube (Ref. Fig. 3 on Page P-2).

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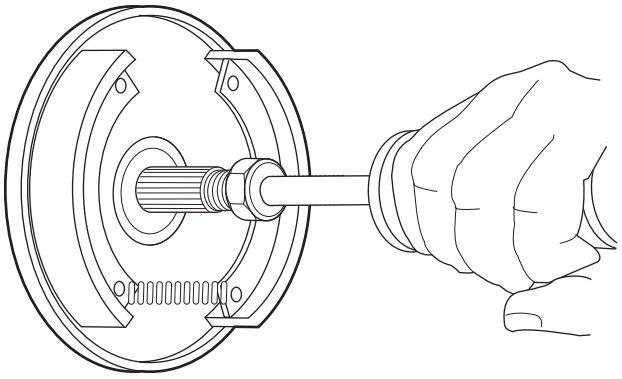

Fig. 3 Removing/Installing Axle Shaft

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 on Page P-2).

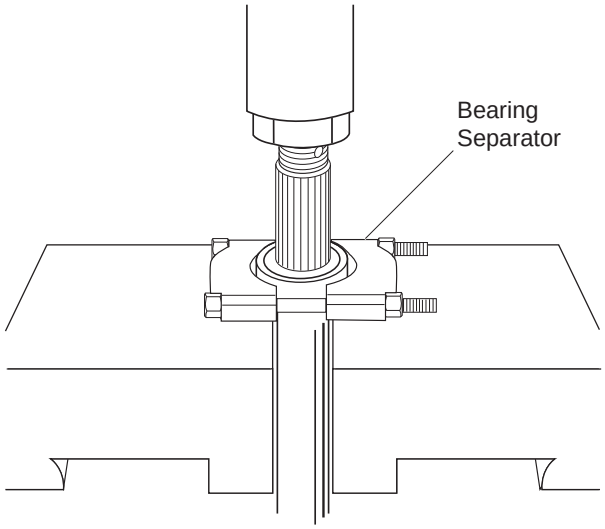

Fig. 4 Pressing Bearing from Axle Shaft

Axle Shaft Seal Removal and Replacement

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

⚠ 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 P-2). Use a puller to remove the seal (Ref. Fig. 6 on Page P-2).

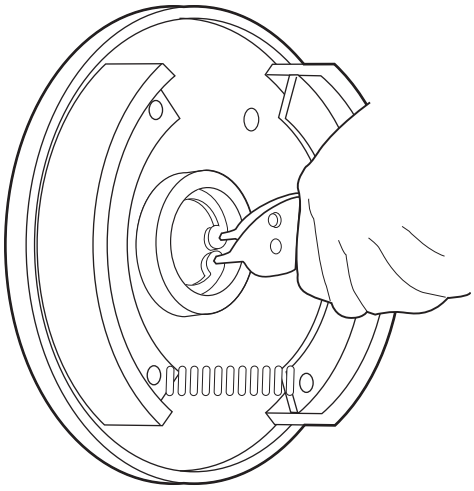

Fig. 5 Removing/Installing Inner Snap Ring

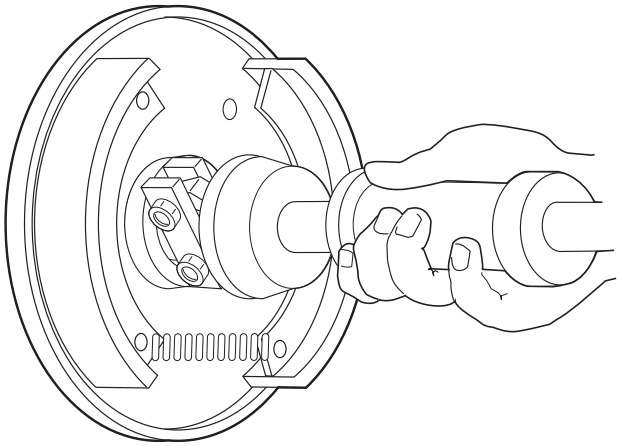

Fig. 6 Removing Seal

To install the seal, use the special seal installer to drive the seal into its correct position (Ref. Fig. 7 on Page P-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 P-2).

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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 on Page P-3).

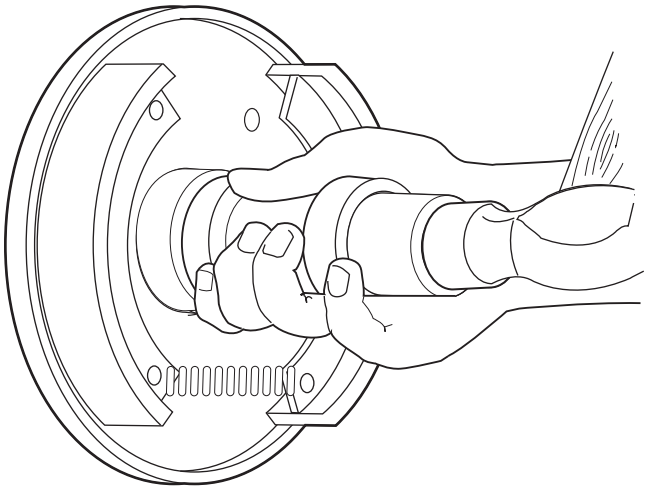

Fig. 7 Installing Seal

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.

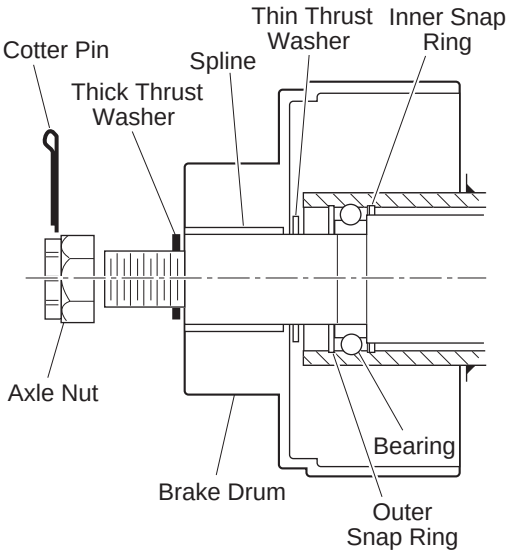

Fig. 8 Cut Away of Outer Bearing and Brake Drum

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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.

Trailering

⚠ WARNING

Personal injury to occupants of other highway vehicles may occur is vehicle and contents are not adequately secured to trailer.

Do not ride on vehicle being trailered.

Remove windshield before trailering. Maximum speed with top is 50 mph (80 kph).

If the vehicle is to be transported on a trailer at highway speeds, the windshield and top must be removed and the seat bottoms secured. Always check that the vehicle and contents are adequately secured before trailering the vehicle.

GOLF CAR SUN TOP

Rear Support Installation

1. Using a plastic faced hammer, tap end caps (17) into the top of each rear strut (2) (Ref. Fig. 1 on Page Q-2) (See Detail D).

2. Place washer (3) onto bolt (4) and insert bolt just through the top hole in the seat back support (3 - 4 threads). Place the teflon washer (5) on the end of the bolt. This teflon washer is needed to prevent squeaking.

3. Insert rear strut (2) through the square hole in the top of the seat back support and push the bolt through the top hole in the rear strut. Place washer (3) and lock nut (6) on the end of the bolt just enough to prevent the bolt from falling out.

4. At the lower hole, slide a teflon washer (5) between rear strut and seat back support and align holes. Insert bolt (4) with washer (3) through lower hole and secure with washer (3) and lock nut (6). Finger tighten hardware to allow for adjustment.

5. Repeat steps 2 through 4 for the other side.

Front Strut

1. Remove and discard the four bolts from the front cowl (See Detail B).

2. At the upper hole (both sides of vehicle), install the front strut (7) with bolt (8) and lock washer (9) on the outside of strut, and a spacer (10) between the front cowl and strut. Finger tighten hardware to allow for adjustment.

3. At the lower hole, secure the strut with bolt (8) and lock washer (9) on the outside of strut, and two washers (11) between the front cowl and strut as shown. Finger tighten hardware to allow for adjustment.

Sun Top

1. Place sun top (1) onto struts (See Detail D).

2. Secure sun top loosely with screws ((16) at front and (12) at rear)), plastic spacers (13), washers (14), and lock nut (15). See illustrations for installation sequence.

3. Tighten all sun top hardware to 3 - 5 ft. lbs. (4 - 7 Nm) torque.

4. Tighten all rear strut hardware to 13 - 15 ft. lbs. (18 - 20 Nm) torque.

5. Tighten all front strut hardware to 17 - 19 ft. lbs. (23 - 26 Nm) torque.

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WEATHER PROTECTION

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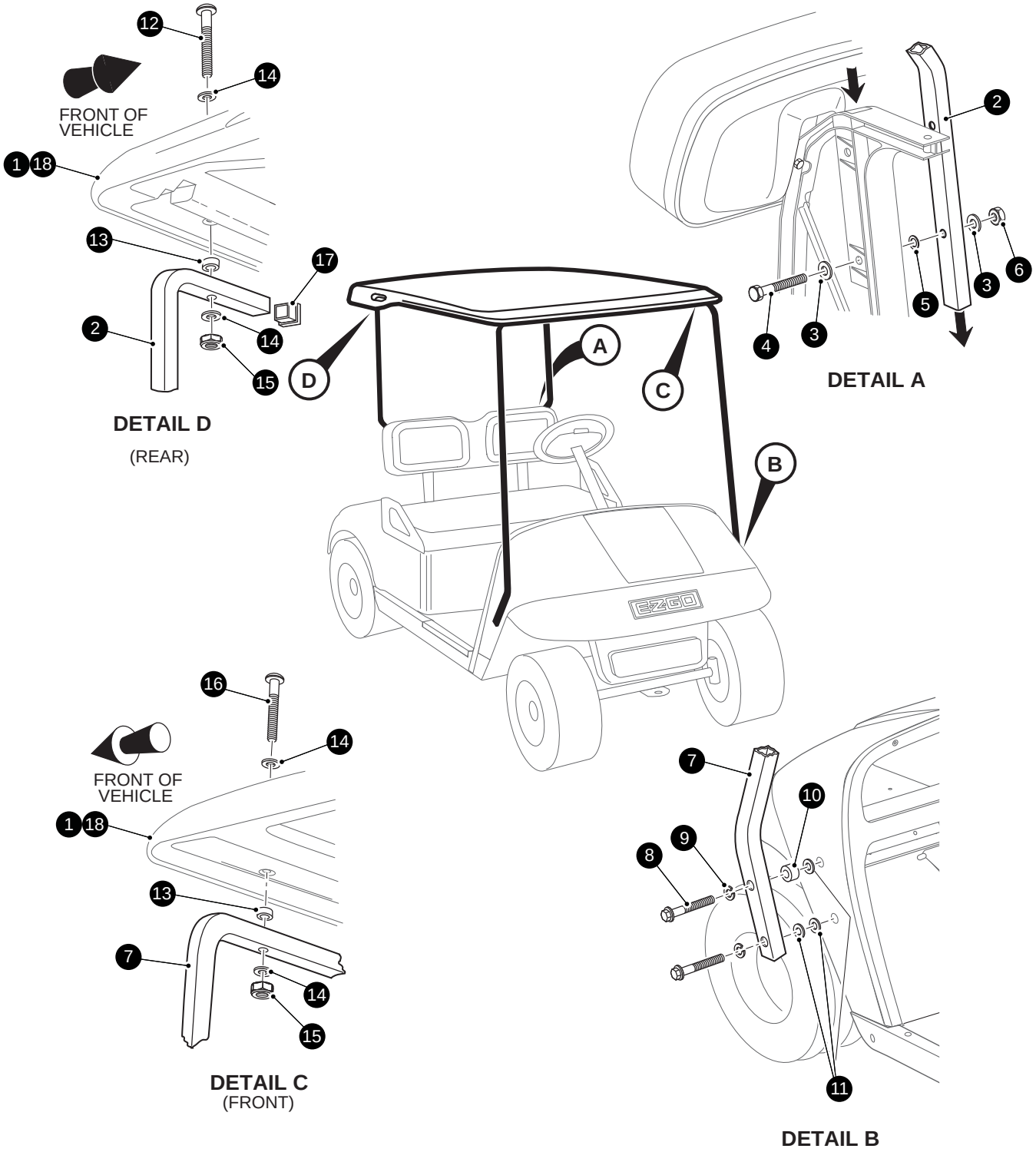

Fig. 1 Golf Car Sun Top

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SPLIT WINDSHIELD

Remove protective covering from the windshield (2) (Ref. Fig. 2 on Page Q-3).

Install sash (3) on each side of the lower section of windshield. Using a rubber 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).

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.

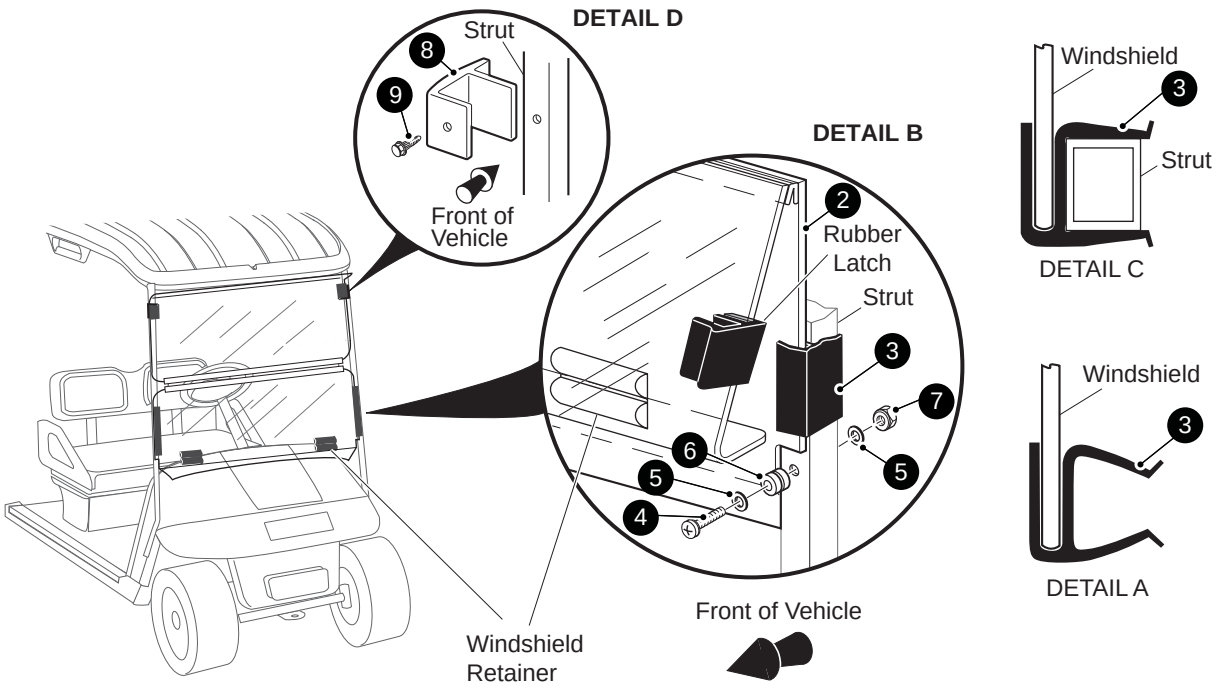

Fig. 2 Split Windshield

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ONE-PIECE FRONT WINDSHIELD

Remove protective covering from the windshield (2) (Ref. Fig. 3 on Page Q-4).

Install sash (3) on each side of the windshield. Using a rubber 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.

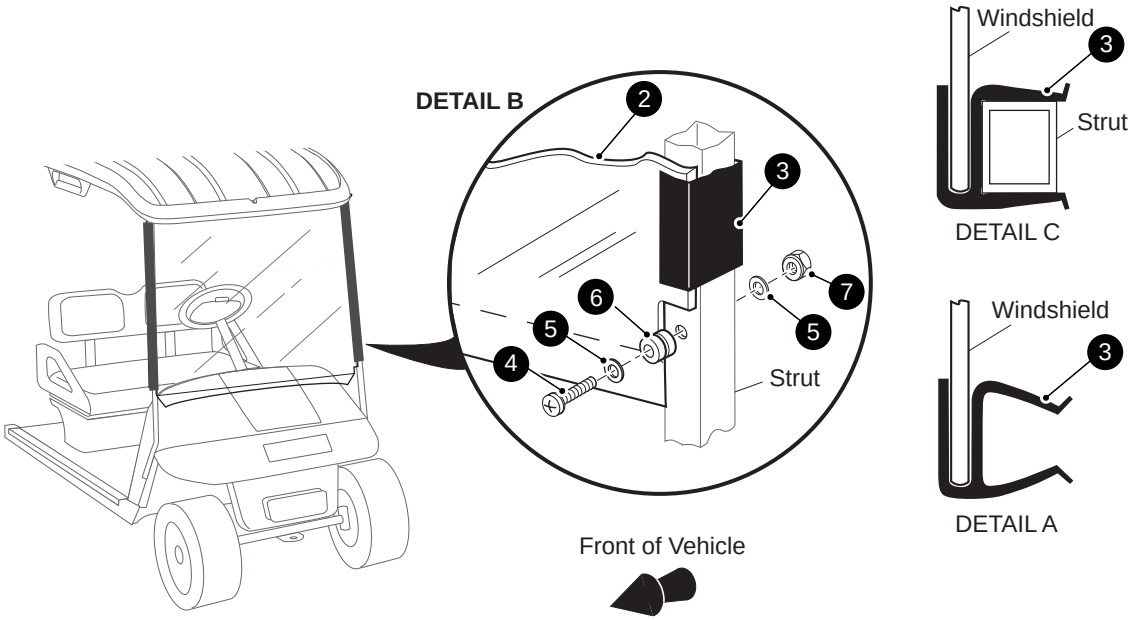

Fig. 3 Front Windshield

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REAR WINDSHIELD

Remove protective covering from rear windshield (2) (Ref. Fig. 4 on Page Q-5).

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

Insert screw (4) through washer (5), rubber grommet (6) and existing hole in rear strut. Secure with washer (5) and lock nut (7) (See Detail B). ***Do not over-tighten or squeeze grommet***.

Place bottom section of rear windshield on rubber grommets and press the sash, starting at the bottom, onto the rear strut so that it snaps into place (See Details B and C). Repeat for opposite side of rear windshield.

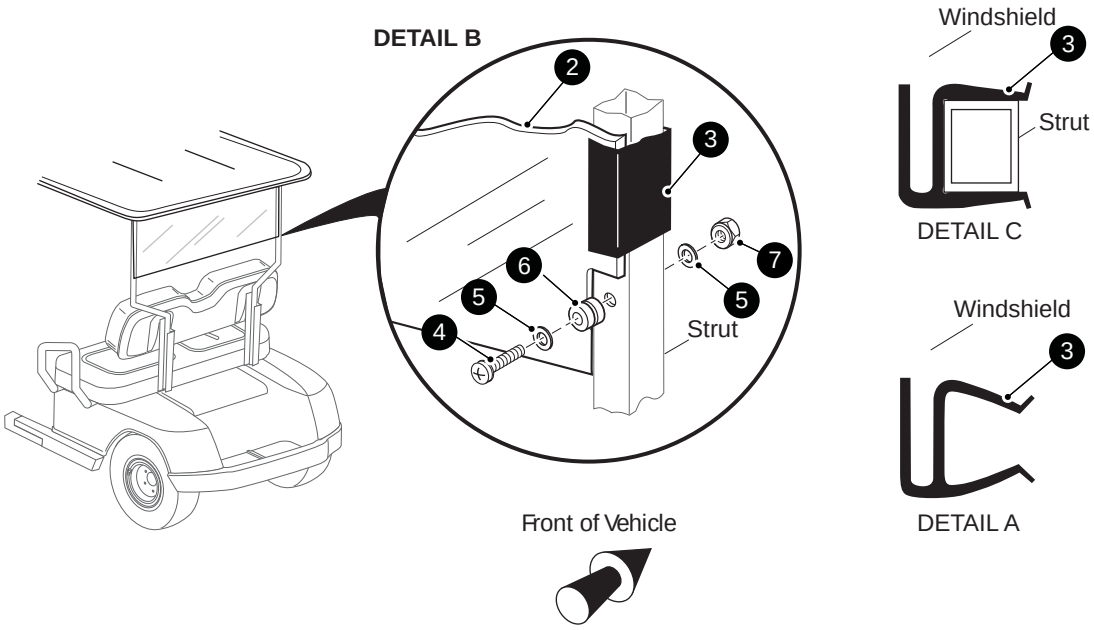

Fig. 4 Rear Windshield

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HOW TO USE THE HANDHELD PROGRAMMER

The Curtis handheld Programmer is used for programming, testing, troubleshooting, tuning, diagnosing and parameter adjsutments for speed controller and auxiliary devices.

Fig. 1 Curtis Handheld Programmer

A cable interface is used with all Curtis Controller. E-Z-GO utilizes a 4 pin Molex or a Molex to Tyco adaptor for vehicle diagnostic port.

⚠ WARNING

Plug the Curtis handheld programmer into Curtis programmer port only. If plugged into the wrong port, voltage from other interface circuits may result in permanent damage to the programmer.

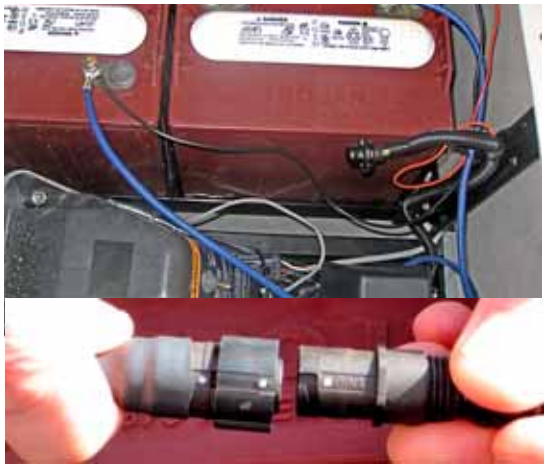
NOTICE

Handheld programmer will not work when Run-Tow switch is in the Tow position and also when the battery charger is connected to the vehicle.

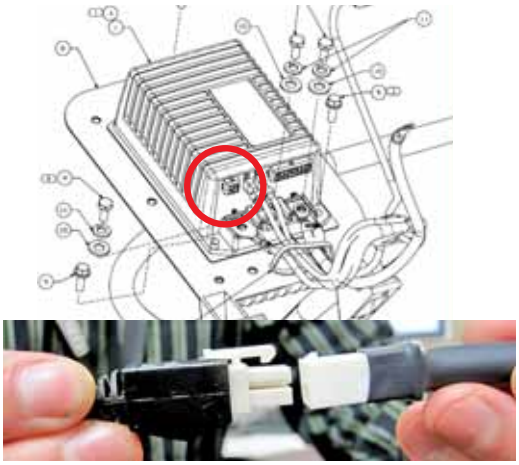
The main menu appears after the data is uploaded from the unit (controller, charger etc), the main menu will not be displayed if there are no entries within a menu.

PRIMARY CONNECTION: 4 PIN TYCO

- Located under passenger seat
- Remove protective water cap
- Use both harness adapters
- Align white dots on connector
- Engage and twist sleeve to secure



ALTERNATE CONNECTION: 4 PIN MOLEX



- Located under controller cover
- Remove cover for access
- Use single molex harness
- Locate 4 pin molex on controller
- Push molex pin into controller

NAVIGATION

A blinking square on the left edge indicates the position of the cursor and the blinking square moves up or down when up or down navigation key is pressed. Press down the right arrow on the navigation key to display a column of sub-menus and again press down the right arrow for more than one level of sub-menus to be displayed.

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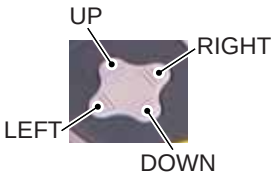
Press down the left arrow once or more on the navigation key to display the main menu.



CHANGING DATA VALUE

Press down the Data Increase or Data Decrease key to change the value of the parameter.

BOOKMARK

To set a position in the Menu, hold a Bookmark Key down for four seconds, until the Bookmark set screen is displayed. To jump to a selected Bookmark position, press the appropriate Bookmark Key.

MAIN MENU DEFINITIONS

- PROGRAM - Shows vehicle profile setting and adjustability.
- MONITOR - Shows vehicle real-time diagnostics
- FAULTS - Shows active and past faults
- FUNCTIONS - Shows parameter setting uploads and downloads
- INFORMATION - Shows controller information
- PROGRAMMER SETUP - Shows handheld information and adjustment

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Menu	Submenu 1	Submenu 2	Submenu 3	Data Range	Default Value	Units
Program	Profile Selection			1 - 5	-	-
	Freedom Enable			ON/OFF	OFF	
	Profiles	1 - Airport	Speed	4 - 8	6	mph
			Accel Selection	1 - 2	1	-
			Braking Selection	1 - 2	1	-
		2 - Golf Flat	Speed	10.2 - 14.8	14.8	mph
			Accel Selection	1 - 3	1	-
			Braking Selection	1 - 3	1	-
		3 - Golf Mild Hills	Speed	10.2 - 14.8	13.8	mph
			Accel Selection	1 - 3	2	-
			Braking Selection	1 - 3	2	-
		4 - Golf Steep Hills	Speed	10.2 - 14.8	12.8	mph
			Accel Selection	1 - 3	2	-
			Braking Selection	1 - 3	3	-
		5 - Freedom	Speed	14.5 - 19.5	18.5	mph
			Accel Selection	1 - 2	1	-
			Braking Selection	1 - 2	1	-
Monitor	Battery	Amp Hours		0 - 100000		AmpHr
		Battery Voltage		0 - 100		V
		Elasped Meters	Amp Hours Trip	0 - 100000		AmpHr
	Vehicle	Speed		0 - 25		mph
		Odometer		0 - 100000		miles
		Hour Meter		0 - 100000		Hrs
	I / O	Throttle		0 - 100		%
		Speed Pulses		ON / OFF		-
		Pers. Input 0		ON / OFF		-
		Pers. Input 1		ON / OFF		-
		Foot Input		ON / OFF		-
		Key Input		ON / OFF		-
		Forward Input		ON / OFF		-
		Reverse Input		ON / OFF		-
		Charger Inh bit		ON / OFF		-
		Main Cont Driver		ON / OFF		-
	Controller	Profile		1 - 5		
		Temperature		-55 - 125		C
		Arm Current		-300 - 300		A
		Field Current		0 - 20		A
		Armature PWM		0 - 100		%
		Field PWM		0 - 100		%
	Fault Counters	Throttle Fault		0 - 255		-
		Low Battery Voltage		0 - 255		
		Overvoltage		0 - 255		
		Thermal Cutback		0 - 255		
		HPD		0 - 255		-
		Main Drvr OverCurrent		0 - 255		-
		Neg Ia 250		0 - 255		-
		Neg Ia 300		0 - 255		-

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HANDHELD DIAGNOSTICS

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

Menu	Submenu 1	Submenu 2	Submenu 3	Data Range	Default Value	Units
Monitor	Fault Counters	Main Welded		0 - 255		-
		Speed Sensor Fault		0 - 255		-
		Main Driver On		0 - 255		-
		Main Coil Open		0 - 255		-
		Main Dropout 1		0 - 255		-
		Motor Stall		0 - 255		-
		Main Driver Off		0 - 255		-
		Main Dropout 2		0 - 255		-
		Curent Sense Fault		0 - 255		-
		M - Shorted		0 - 255		-
		Field Missing		0 - 255		-
		Hardware Failsafe		0 - 255		-
	Fault Counter Hour Meter	Throttle Fault		0 - 100000		Hrs
		Low Battery Voltage		0 - 100000		Hrs
		Overvoltage		0 - 100000		Hrs
		Thermal Cutback		0 - 100000		Hrs
		HPD		0 - 100000		Hrs
		Main Drvr OverCurrent		0 - 100000		Hrs
		Neg Ia 250		0 - 100000		Hrs
		Neg Ia 300		0 - 100000		Hrs
		Main Welded		0 - 100000		Hrs
		Speed Sensor Fault		0 - 100000		Hrs
		Main Driver On		0 - 100000		Hrs
		Main Coil Open		0 - 100000		Hrs
		Main Dropout 1		0 - 100000		Hrs
		Motor Stall		0 - 100000		Hrs
		Main Driver Off		0 - 100000		Hrs
		Main Dropout 2		0 - 100000		Hrs
		Curent Sense Fault		0 - 100000		Hrs
		M - Shorted		0 - 100000		Hrs
		Field Missing		0 - 100000		Hrs
		Hardware Failsafe		0 - 100000		Hrs
Faults	System Faults			Display active faults.		
	Fault History			Display non-active (past) faults.		
	Clear Fault History			YES / NO		
Functions	Settings	Get Settings From Controller		OK / ABORT		
		Write Settings to Controller		OK / ABORT		
		Reset All Settings		YES / NO		
Information	Model Number			Display controller model number		
	Serial Number			Display controller serial number		
	Software Number			Display controller software number		
	Hardware Version			Display controller hardware version		
	Protocol Version			Display controller protocol version		
	Param Block Version			Display controller param block version		

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Menu	Submenu 1	Submenu 2	Submenu 3	Data Range	Default Value	Units
Programmer Setup	Program	LCD Contrast		-150 - 150		
		Language		English	English	
		Set Security Code		Display security code creation		
	Faults	Fault History		Display fault history of the handheld		
		Clear Fault History		YES / NO		
	Information	OEM Info		Display OEM information		
		Reconfigured		Display reconfigure status		
		Model Number		Display handheld model number		
		Serial Number		Display handheld serial number		
		Manufacture Date		Display handheld manufacture number		
		Software Version		Display handheld software version		
		Hardware Version		Display handheld hardware version		
		MC - Protocol Ver		Display MC- Protocol version		
		ES - Protocol Ver		Display ES - Protocol version		
		S - Protocol Ver		Display S - Protocol version		
		Device Type		Display device type		

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1206HB-5201 Controller Faults and Troubleshooting

1311 Display	Explanation	Tested When	Controller Response	Recover When	Possible Cause
HW FAILSAFE	Hardware Failsafe Error	Throttle applied to cause contactor to initially close	1,2,3	KSI cycled	1. Controller defective 2. Controller power cables mis-wired
FIELD MISSING	Motor Field Winding open	Contactor closed	2,8	Condition clears	1. Field Winding or its connection open
M- SHORTED	Armature PWM pulses not detected	Contactor Closed	1,2	Condition clears	1. Controller defective 2. Power cables shorted
CURRENT SENSE FAULT	Armature Current reading at invalid Zero Amps level Out-of-Range value	KSI OFF -> ON, Continuous	1,2,3	KSI OFF-> ON when condition cleared	1. Controller defective 2. Excessive Plug Current detected
MAIN DROPOUT 2	Contactor detected as opening during Regen	Contactor commanded to be closed	3,9	Throttle reapplied	1. Contactor opened 2. Contactor coil or wiring opened
MAIN DRIVER OFF	Main Driver FET detected as not turning ON	Throttle applied to cause Contactor to close	3,8	Condition clears	1. Controller defective
MOTOR STALL	High Armature Current when no Speed Pulses detected	Contactor closed	6	Speed Pulses appear	1. Motor is stalled 2. Defective speed sensor or wiring
MAIN DROPOUT 1	Contactor detected as opening during Drive	Contactor commanded to be closed	3,9	Throttle reapplied	1. Contactor opened 2. Contactor coil or wiring opened
MAIN COIL OPEN	Main Contactor coil detected as open	Continuous while KSI ON	3	Condition clears	1. Contactor coil or wiring open
MAIN DRIVER ON	Main Driver FET detected as ON when commanded to be OFF	Continuous while KSI ON and Contactor commanded to be open	4	Condition clears	1. Controller defective 2. Pin 12 short to ground
SPEED SENSOR FAULT	No speed pulses detected	Contactor closed	4	Condition clears	1.Defective or missing speed sensor 2. Open speed sensor wiring
MAIN WELDED	Main Contactor detected as stuck closed	Contactor commanded to be Open	4	Contactor commanded to Open and does Open	1. Welded Contactor
NEG IA 300	Very high Regen Current	Continuous	No Action	Throttle reapplied	1. High Regen Current
NEG IA 250	High Regen Current	Continuous	No Action	Throttle reapplied	2. High Regen Current
MAIN DRIVER OVERCURRENT	High Driver Current Detected	Continuous while Contactor is commanded to be closed	No Action	Throttle reapplied	1. Main Contactor coil or wiring shorted 2. Electrical Noise

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TROUBLESHOOTING

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1311 Display	Explanation	Tested When	Controller Response	Recover When	Possible Cause
HPD (HIGH PEDAL DISABLE)	High Pedal Disable Controller powers up with Key, Direction and Throttle applied OR Throttle applied before Key and Direction switch applied	KSI ON, Forward or Reverse ON	8	Throttle < 25%	1. Incorrect sequence of Vehicle input controls 2. Defective Throttle device
THERMAL CUTBACK	Over/Under Temperature Cutback	Continuous	5	Condition clears	1. Temperature >85°C or < -25°C 2. Excessive load on vehicle 3. Improper mounting of controller 4. Operation in extreme environment
OVERVOLTAGE	Battery Voltage > OVERVOLTAGE MIN parameter	Continuous	7	Condition clears	1. Battery Voltage > Shutdown limit
LOW BATTERY VOLTAGE	Battery Voltage < LOW VOLTAGE MAX parameter	Continuous	5	Condition clears	1. Battery Voltage < Cutback Limit 2. Corroded Battery Terminal 3. Loose Battery or Controller terminal
THROTTLE FAULT	Throttle Input Fault	Continuous	8	Condition clears	1. Throttle wiring open or shorted 2. Defective Throttle device

Controller Fault Responses
1 - Reduce Armature duty cycle to zero.
2 - Reduce Field current to zero
3 - Turn off Main Contactor
4 - “Limp Home” in slow speed. Armature Duty Cycle = 75% Max, Field Min = 10.0 Amps
5 - Gradual reduction in armature Drive current limit
6 - Quickly reduce armature duty cycle to zero until speed sensor pulses reappear
7 - Gradual Reduction in Regen Current Limit
8 - Internal Scaled Throttle Signal set to Zero
9 - Commence WalkAway Function

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LIGHTNING PROTECTION AND GROUNDING

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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.

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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-

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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).

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LIGHTNING PROTECTION AND GROUNDING

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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 manufacturers instructions to protect from overspray and air borne mist.

⚠ CAUTION

Provide protection from overspray to vehicle and surrounding area.

Minor Scratches

For minor scratches, the manufacturer suggests the following steps be taken to repair the Durashield™ body:

i Thoroughly clean the surface to be repaired with alcohol and dry.

ii Touch up damaged area with sequential coats (two coats minimum recommended, allowing 30 - 45 minutes between coats, increasing to 45 - 60 minutes in higher humidity) using brush on touch-up paint, until coating layer is visible, slightly above the surface of the part.

iii Use 400 grit "wet" sand paper to blend touch up area level with the rest of the part being repaired. Use a polishing compound (3M Finesse or automotive grade) to renew gloss and to further blend and transition newly painted surface.

iv Clean with alcohol and dry.

v (Optional but recommended) Follow this process with clear coat to renew and protect depth of finish.

vi Wax or polish with Carnauba base product, available at any automotive parts distributor.

Larger Scratches

For larger scratches, the manufacturer suggests the following steps be taken to repair the Durashield™ body:

i Thoroughly clean the surface to be repaired with alcohol and dry.

ii Mask the area to be painted (common masking tape is adequate) prior to repair and use aerosol type touch-up paint.

iii Apply spray touch up paint in light even overlapping strokes. Multiple coats may be applied to provide adequate coverage and finish. Always remember to shake the can for a minimum of one minute to mix the paint and achieve the best color match.

iv After painting, allow to dry overnight. Smooth the mask lines using 400 grit "wet" sand paper to blend touch up area level with the rest of the part being repaired. Use a polishing compound (3M Finesse or automotive grade) to renew gloss and to further blend and transition newly painted surface.

v Clean with alcohol and dry.

vi (Optional but recommended) Follow this process with clear coat to renew and protect depth of finish.

vii Wax or polish with Carnauba base product, available at any automotive parts distributor.

Complete Panel Repair

In situations where large panels or areas must be painted, touch up paint is not recommended. In such cases professional painting or panel replacement is called for. The manufacturer suggests body panel replacement be considered as a cost effective alternative to painting. If the decision to repaint is taken, the task can be accomplished by any paint and body shop with experience in painting 'TPE' panels. TPE is a common material in modern automobile bodies and all body shops should be familiar with the materials and processes required.

The finish will include an application of a primer coat, a base color coat and a clear coat. The manufacturer does not supply these materials due to the variety of paint manufacturers and the preferences of the individual painter.

Most paint manufacturers can perform a computer paint match to assure accurate color matching.

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A Textron Company

MODEL: TXT 48V FLEET GOLF CAR
TYPE: ELECTRIC 48V FLEET GOLF CAR
MODEL YEAR 2010
Part No. : 612623

PRODUCT SPECIFICATION

CONFIGURATION HIGHLIGHTS

TrueCouse Technology: Programmable to any golf course terrain, wi h expanded regenerative braking function, and vehicle charger lockout

- Solid State con inuously variable seperately excited speed controller
- Dash Mounted direction selector switch (Forward-Neutral-Reverse)
- Anti-roll back, walkaway braking and alarm
- Programmable regenerative braking, acceleration and speed
- Six, 8 Volt Deep Cycle
- Full torque, reduced speed reverse
- Inductive throttle sensor
- Handheld vehicle diagnostics and rounds tracking

Battery Charger: PowerWise™48QE high frequency, fully line compensating. 10ft(3m) DC Cord. Underwriters Lab. (U.L.) Listed, (C.S.A. Certified)

- Indput 120 Volts AC, 50/60Hz, 8 amps
- Output: 48Volts DC at 13 amps

Motor: 48 Volt DC shunt wound, brazed armature, solid copper windings

Drive Train: Direct motor shaft connected to transaxle pinion shaft

Electrical System: 48 Volt DC, six, 8 volt deep cycle batteries (117 minute minimum, 170 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

PRODUCT OVERVIEW

Dimensions	
Overall Length	91.0 in (231 cm)
Overall Wid h	47.0 in (119 cm)
Overall Height (No Canopy)	46.5 in (118 cm) (Top of steering wheel)
Overall Height (With Canopy)	68.0 in (173)
Wheel Base	66.0 in (168 cm)
Front Wheel Track	34.0 in (86 cm)
Rear Wheel Track	38.5 in (97 cm)
Ground Clearance (at Differential)	4.5 in (11cm)

Vehicle Power	
Power Source	48 Volts DC
Motor Type	Shunt Wound
Horsepower (kw)	3.0 HP (2.2 kW) Continuous
Electrical System	48 Volt
Batteries (Qty, Type)	Six, 8 Volt Deep Cycle
Key or Pedal Start	Pedal Start
Battery Charger	48 VDC PowerWise QE, 120 VAC, UL/CSA
Speed Controller	250 Amp Solid State Controller
Drive Train	Motor Shaft Direct Drive
Transaxle	Differential with helical gears
Gear Selection	Dash Mounted Forward-Neutral-Reverse
Rear Axle Ratio	12.44:1

Performance	
Seating Capacity	2 Person
Dry Weight	557 lb (253 kg) (Withough Batteries)
Curb Weight	935 lb (424 kg) (Trojan T-875)
Vehicle load capacity	800 lb (360 kg)
Outside Clearance Circle	19.0 ft (5.8 m)
Speed (Level Ground)	10.2 - 14.8 mph (16.4 - 23.8 kph)
Towing Capacity	3 Golf Cars wi h Approved Permanent Tow Bar

Steering & Suspension	
Steering	Self-compensa ing rack and pinion
Front Suspension	Leaf springs wi h hydraulic shock absorbers
Rear Suspension	Leaf springs with hydraulic shock absorbers
Service Brake	Rear wheel mechanical self-adjusting drum
Praking Brake	Self-compensating, single point engagement
Front Tires	Hold-in-One 18 x 8.50 - 8 (4 Ply Rated)
Rear Tires	Hold-in-One 18 x 8.50 - 8 (4 Ply Rated)

Body & Chassis	
Frame	Welded steel. Durashield™powder coat
Body & Finish	Injection modled TPO
Standard Color	Champagne

Noise & Vibration	
Noise	Sound pressure; continued A - weighted equal to 68 db(A)
Vibration, HAV	The average H/A Vibration Exposure is 4.5 m/s2 The uncertainty of measurement is 0.6.8 m/s2

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GENERAL SPECIFICATIONS

A Textron Company

MODEL: TXT 48V FREEDOM GOLF CAR
TYPE: ELECTRIC 48V FREEDOM GOLF CAR
MODEL YEAR 2010
Part No. : 614265

PRODUCT SPECIFICATION

CONFIGURATION HIGHLIGHTS

TrueCouse Technology: Programmable to any golf course terrain, with expanded regenerative braking function, and vehicle charger lockout

- Solid State continuously variable seperately excited speed controller
- Dash Mounted direction selector switch (Forward-Neutral-Reverse)
- Anti-roll back, walkaway braking and alarm
- Programmable regenerative braking, acceleration and speed
- Six, 8 Volt Deep Cycle
- Full torque, reduced speed reverse
- Inductive throttle sensor
- Handheld vehicle diagnostics and rounds tracking

Battery Charger: PowerWise™48QE high frequency, fully line compensa ing. 10ft(3m) DC Cord. Underwriters Lab. (U.L.) Listed, (C.S.A. Certified)

- Indput 120 Volts AC, 50/60Hz, 8 amps
- Output: 48Volts DC at 13 amps

Motor: 48 Volt DC shunt wound, brazed armature, solid copper windings

Drive Train: Direct motor shaft connected to transaxle pinion shaft

Electrical System: 48 Volt DC, six, 8 volt deep cycle batteries (117 minute minimum, 170 amp-hour @ 20 hr. discharge rate)

Transaxle: Differential with helical gears

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Motor Type	Shunt Wound
Horsepower (kw)	3.0 HP (2.2 kW) Continuous
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Batteries (Qty, Type)	Six, 8 Volt Deep Cycle
Key or Pedal Start	Pedal Start
Battery Charger	48 VDC PowerWise QE, 120 VAC, UL/CSA
Speed Controller	250 Amp Solid State Controller
Drive Train	Motor Shaft Direct Drive
Transaxle	Differential with helical gears
Gear Selection	Dash Mounted Forward-Neutral-Reverse
Rear Axle Ratio	12.44:1

Performance	
Seating Capacity	2 Person
Dry Weight	557 lb (253 kg) (Withough Batteries)
Curb Weight	935 lb (424 kg) (Trojan T-875)
Vehicle load capacity	800 lb (360 kg)
Outside Clearance Circle	19.0 ft (5.8 m)
Speed (Level Ground)	19.0 mph (30.6 kph)
Towing Capacity	3 Golf Cars with Approved Permanent Tow Bar

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
Praking Brake	Self-compensating, single point engagement
Front Tires	Hold-in-One 18 x 8.50 - 8 (4 Ply Rated)
Rear Tires	Hold-in-One 18 x 8.50 - 8 (4 Ply Rated)

Body & Chassis	
Frame	Welded steel. Durashield™powder coat
Body & Finish	Injection modled TPO
Standard Color	Champagne

Noise & Vibration	
Noise	Sound pressure; continued A - weighted equal to 68 db(A)
Vibration, HAV	The average H/A Vibration Exposure is 4.5 m/s2 The uncertainty of measurement is 0.6.8 m/s2

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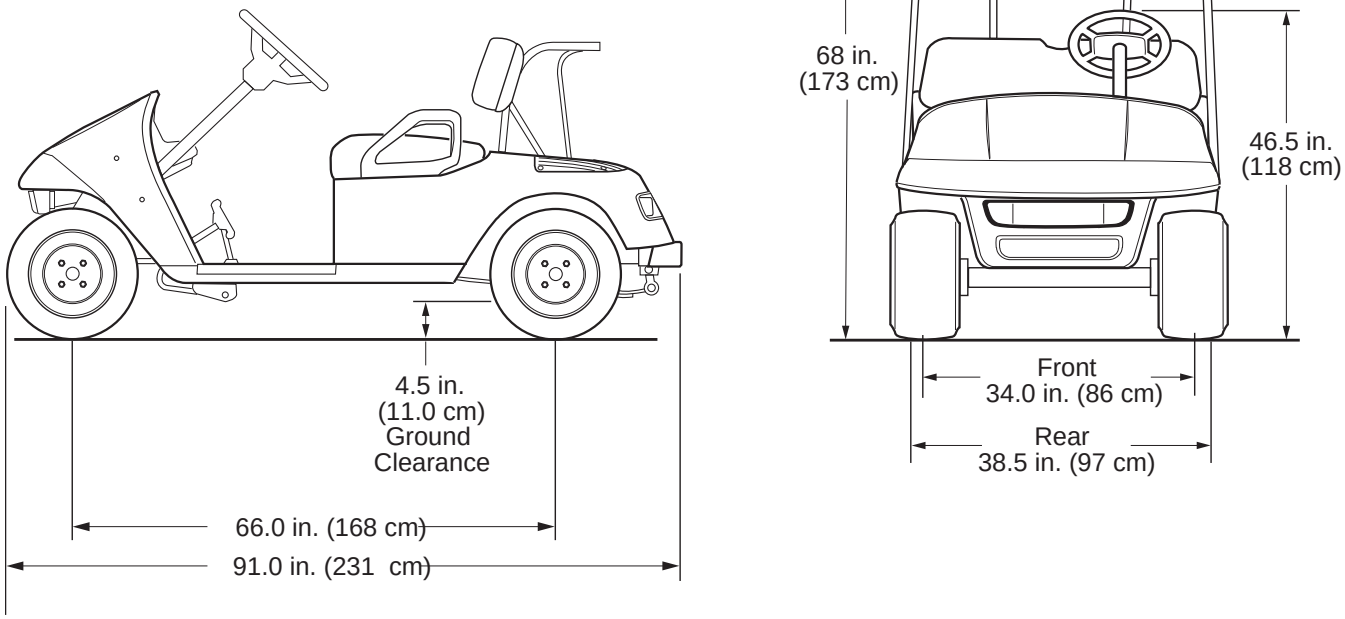

Fig. 1 Vehicle Dimensions

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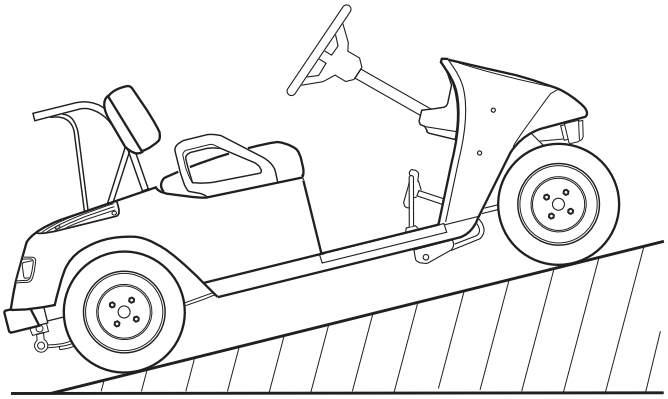
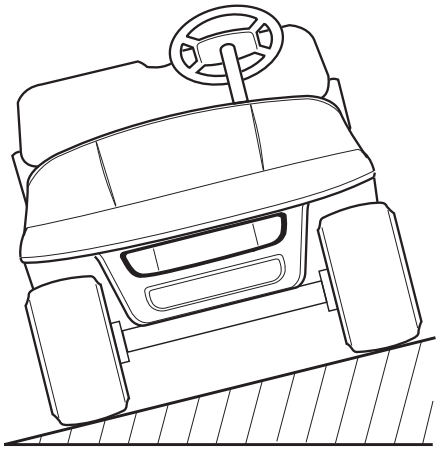


RECOMMENDED MAX RAMP
25% GRADE or 14^{o}MAX



RECOMMENDED MAX SIDE TILT
25% GRADE or 14^{o}MAX

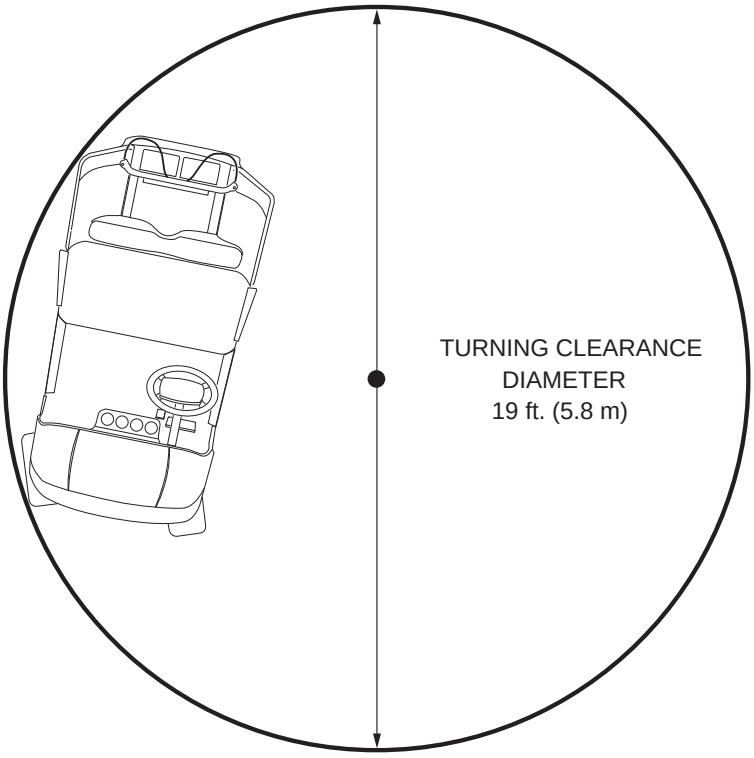


Fig. 2 Vehicle dimensions, Incline Specifications and Turning Clearance Diameter

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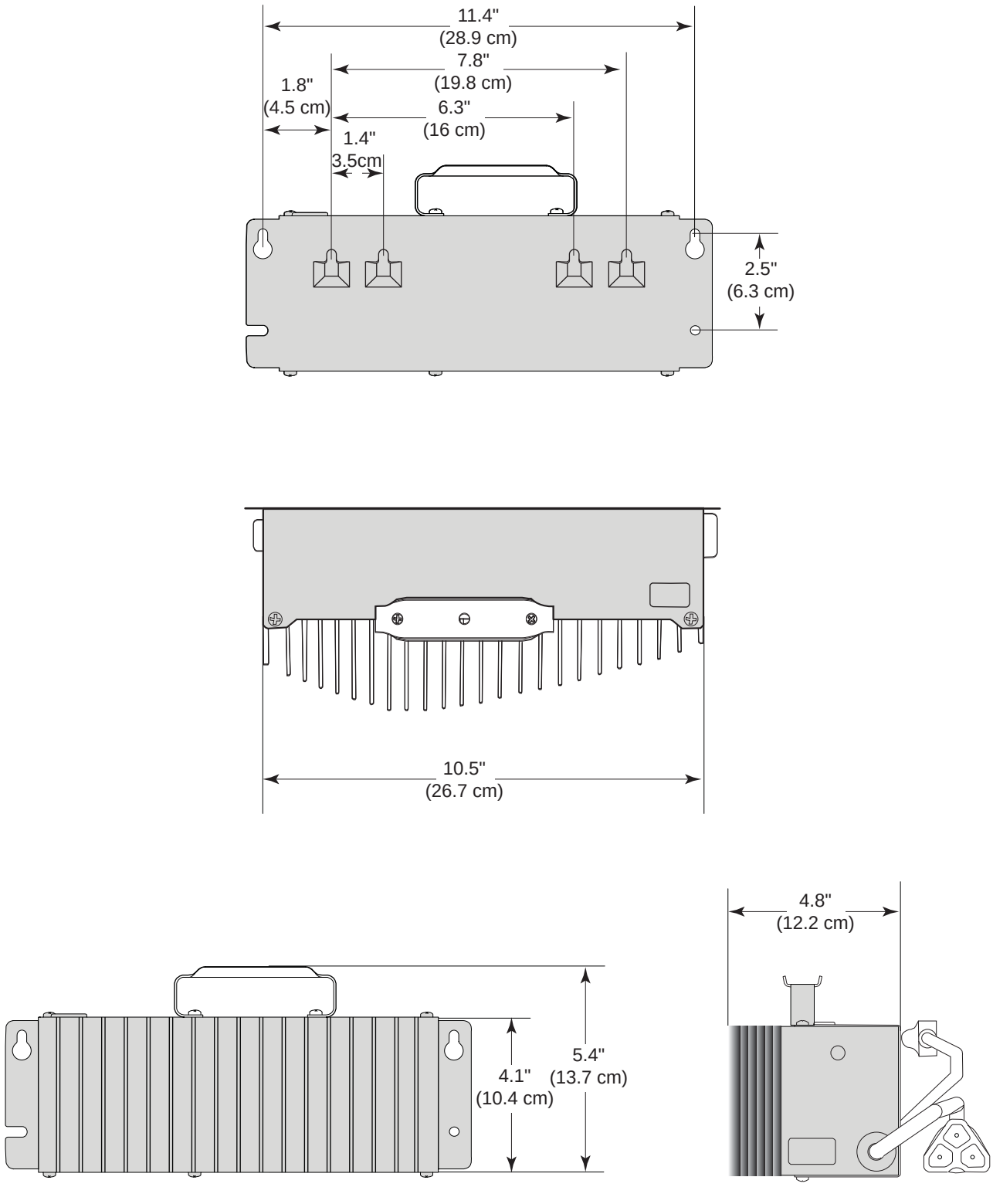

Fig. 3 Battery Charger Dimensions

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NOTICE

Read the following warnings before attempting to operate the vehicle:

⚠ WARNING

To prevent personal injury or death, observe the following:

When vehicle is to be left unattended, engage park brake, move direction selector to neutral, turn key to 'OFF' position and remove key.

Drive vehicle only as fast as terrain and safety considerations allow. Consider the terrain and traffic conditions. Consider environmental factors which effect the terrain and the ability to control the vehicle.

Avoid driving fast down hill. Sudden stops or change of direction may result in a loss of control. Use service brake to control speed when traveling down an incline.

Use extra care and reduced speed when driving on poor surfaces, such as loose dirt, wet grass, gravel, etc.

All travel should be directly up or down hills.

Use extra care when driving the vehicle across an incline.

Stay in designated areas and avoid steep slopes. Use the park brake whenever the vehicle is parked.

Keep feet, legs, hands and arms inside vehicle at all times.

Avoid extremely rough terrain.

Check area behind the vehicle before operating in reverse.

Make sure the direction selector is in correct position before attempting to start the vehicle.

Slow down before and during turns. All turns should be executed at reduced speed.

Always bring vehicle to a complete stop before shifting the direction selector.

See GENERAL SPECIFICATIONS for vehicle load and seating capacity.

NOTICE

Read and understand the following text and warnings before attempting to service vehicle:

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

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

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

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

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

⚠ WARNING

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

Be sure no loose clothing or hair can contact moving parts.

Use care not to touch hot objects.

Raise rear of vehicle and support on jack stands before attempting to run or adjust powertrain.

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

Hydrogen gas is formed when charging batteries. Do not charge batteries without adequate ventilation.

Do not permit open flame or anyone to smoke in an area that is being used for charging batteries. A concentration of 4% hydrogen gas or more is explosive.

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TO CONTACT US...
North America:

Technical Assistance & Warranty	Phone: 1-800-774-3946, FAX: 1-800-448-8124
Service Parts	Phone: 1-888-GET-E-Z-GO (1-888-438-3946), FAX: 1-800-752-6175
International:	Phone: 001-706-798-4311, FAX: 001-706-771-4609

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