REPAIR AND SERVICE MANUAL

TRACKER OFF ROAD™

LX6

699327-A
Issued August 2019

PRELIMINARY

For any questions about material in this manual, contact an authorized representative.

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

Steep hills allow the vehicles to move at faster speeds than speeds on a flat surface. To prevent the loss of vehicle control and possible injury, speeds must be controlled to the maximum level ground speed indicated in the GENERAL SPECIFICATIONS section. Apply the brake to control the speed.

If you operate the vehicle above the maximum specified speed, you can damage the drivetrain components. The damage caused by speeds more than the maximum specified can cause a loss of vehicle control, is abuse, and will not be covered under the warranty.

Refer to the TRANSPORTING VEHICLE section to learn how to tow or move the vehicle from one location to another location.

If the vehicle is used in a commercial environment, signs must be in position to inform of possible conditions that can be dangerous. Examples shown below.

NOTICES, CAUTIONS, WARNINGS AND DANGERS

Read the **NOTICES, CAUTIONS, WARNINGS** and **DANGERS.** The person who services a vehicle needs the mechanical skill and experience to see possible hazardous conditions. Incorrect service or repairs can cause damage to the vehicle or make the vehicle dangerous to operate.

NOTICE: A NOTICE indicates and describes information not related to personal injury.

⚠ CAUTION ***A CAUTION indicates a dangerous condition that can cause injury that is not life threatening.***

⚠ WARNING ***A WARNING indicates a dangerous condition that can cause death or serious injury.***

⚠ DANGER ***A DANGER indicates a dangerous condition that will cause death or serious injury.***

⚠ WARNING ***The battery posts, terminals and all related accessories contain lead and lead compounds. Wash your hands after contacting any of these components.***

REPAIR AND SERVICE MANUAL

TRACKER LX6, 72V

ELECTRIC POWERED UTILITY VEHICLE

MODEL YEAR 2020

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 specifications. Such modifications can cause serious personal injury or death. The manufacturer prohibits and disclaims responsibility for any such modifications or any other alteration which would adversely affect the safety of the vehicle.

The manufacturer reserves the right to incorporate engineering and design changes to products in this manual, without obligation to include these changes on units sold previously.

The information contained in this manual may be revised periodically by the manufacturer and therefore is subject to change without notice.

THE MANUFACTURER DISCLAIMS LIABILITY FOR ERRORS IN THIS MANUAL, and SPECIFICALLY DISCLAIMS LIABILITY FOR INCIDENTAL AND CONSEQUENTIAL DAMAGES resulting from the use of the information and materials in this manual.

These are the original instructions as defined by 2006/42/EC.

Dealer: 800-296-4804
Consumer: 877-394-6727

www.trackeroffroad.com

GENERAL INFORMATION

This vehicle has been designed and assembled in the United States of America (USA). The Standards and Specifications listed in the following text originate in the USA unless otherwise indicated.

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

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

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

BATTERY PROLONGED STORAGE

Batteries self-discharge over time. The rate of self-discharge varies depending on the ambient temperature, the age and condition of the battery.

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

For winter storage, the battery must be clean, fully charged and disconnected from any source of electrical drain.

BATTERY DISPOSAL

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

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Notes:

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

SAFETY INFORMATION

This manual contains recommended maintenance procedures from the manufacturer. Follow the procedures and fault isolation information to get the best service from the product. To decrease the risk of personal injury or property damage, read and follow all safety information and operational procedures in this manual.

GENERAL

Vehicles are used for different purposes, so it is not possible to know and inform of every possible occurrence. Be careful when you drive to prevent avoidable personal injury or damage to the vehicle. All users must read and obey this manual. Make sure to give special attention to the CAUTIONS, WARNINGS and DANGERS.

Anyone who operates the vehicle must read the entire owner's guide provided with the purchase of the vehicle, paying particular attention to the CAUTIONS, WARNINGS and DANGERS within.

For questions about this vehicle, contact your dealer.

The manufacturer has the right to change the design of the vehicle. There is no responsibility to make the changes on units purchased before design changes were made. The information in this manual can change without notice.

THE MANUFACTURER IS NOT LIABLE FOR ERRORS IN THIS MANUAL OR INCIDENTAL OR CONSEQUENTIAL DAMAGES THAT RESULT FROM THE USE OF THE MATERIAL IN THIS MANUAL.

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

These vehicles are for off-road use. They DO NOT meet the federal Motor Vehicle Safety Standards of the United States of America (USA) and are not for operation on the public streets.

Refer to the General Specifications section for capacity of the vehicle (See GENERAL SPECIFICATIONS on page 155).

Ensure all electrical accessories are grounded directly to the negative (-) battery post. **Never use the chassis or body as a ground connection.**

⚠WARNING ***Do not change the vehicle in any manner that changes the weight distribution, decreases stability, increases speed, or extends the necessary distance to stop more than the factory specification. Such changes can cause personal injury or death.***

Do not change the vehicle in any manner that changes the weight distribution, decreases stability, increases speed or extends the necessary distance to stop more than the factory specification. The manufacturer is not responsible for changes that cause the vehicle to be dangerous.

Do not allow anyone below the height of 59 inches (150 cm) to operate the vehicle.

Speed should be moderated by the environmental conditions, terrain, and common sense.

GENERAL OPERATION

ALWAYS:

- Use the vehicle responsibly and keep the vehicle in safe condition for operation.
- Read and obey all warnings and operation instruction labels on the vehicle.
- Follow all safety rules in the area where the vehicle is operated.
- When there is a risk of lightning, leave the vehicle and look for a safe location to wait until the lightning has stopped.
- Drive the vehicle only as fast as terrain and conditions allow.
- Apply the brake to control the speed on steep grades.
- Keep enough distance between vehicles.
- Decrease speed in wet areas.
- Be careful when you make sharp turns, or turns you are not familiar with.
- Be careful when you drive on loose terrain.
- Be careful when you operate the vehicle in a populated area.

SAFETY INFORMATION

MAINTENANCE

ALWAYS:

- Replace damaged or missing warning, caution or information labels.
- Service the vehicle according to the periodic service schedule in this manual.
- Make sure that approved and qualified personnel do all repairs.
- Follow the manufacturer's maintenance procedures.
- Use insulated tools within the battery area to prevent sparks or battery explosion.
- Use specified replacement parts. DO NOT use replacement parts of less quality.
- Use recommended tools.
- Make sure that tools and procedures not specified by the manufacturer will not be a safety risk to personnel or operation of the vehicle.
- Support the vehicle with wheel chocks and jack stands. NEVER get under a vehicle that is supported by a jack alone. Lift the vehicle according to the manufacturers instructions.
- Make sure you service the vehicle in an area away from open flame or sparks.
- Know that a vehicle in need of repair does not operate correctly and can be dangerous to operate.
- After making repairs or performing maintenance, test the vehicle in a safe area that is free from vehicle and person traffic.
- Make sure to record and keep all of the maintenance history of the vehicle.

VENTILATION

ALWAYS:

- Charge the vehicle in a well-ventilated area.
- Charge in an area free from flammable liquids and items.
- Charge the vehicle in an area that is free from flame or spark. Charge in an area that is a safe distance from gas water heaters and furnaces.
- Use a dedicated circuit for the battery charger. Do not plug other appliances into the receptacle when the charger is in operation.
- Operate the charger according to the charger manufacturers recommendations or applicable electrical code.

GENERAL INFORMATION AND ROUTINE MAINTENANCE

SERIAL NUMBER LABEL LOCATION

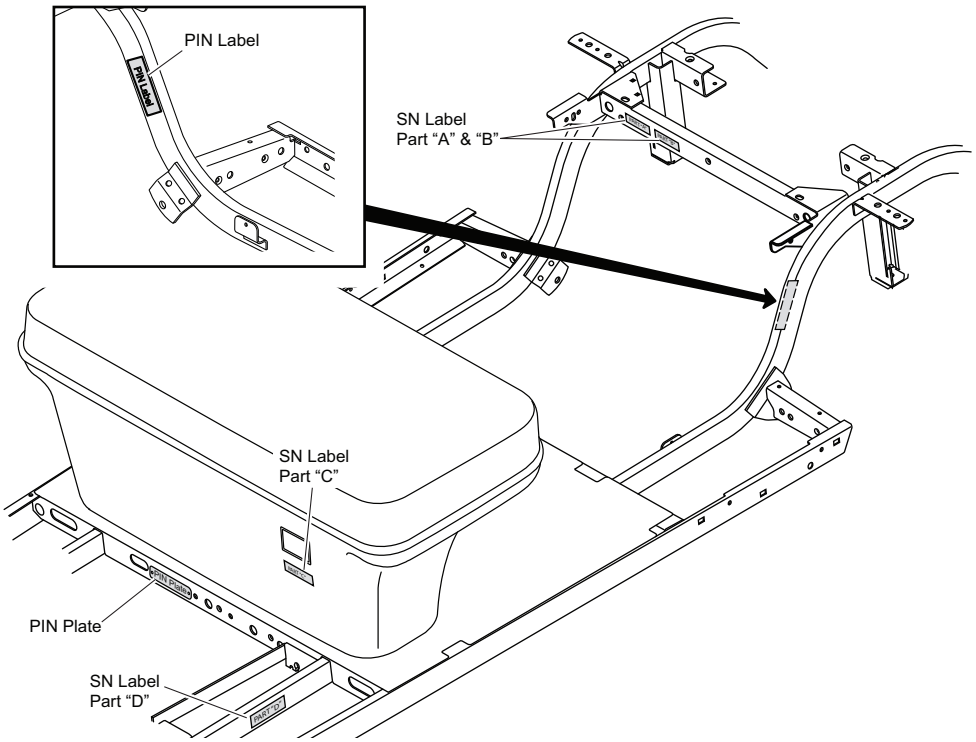


Fig. 1 Serial Number & PIN Label Locations

Serial number labels (with manufacture date code) and PIN plates are located in several locations. Part "A" and part "B" are located on the cross-member that spans the frame at the rear wheels. Part "C" is located under the charger receptacle. Part "D" is located on the frame rail below the driver's seat floorboard. The PIN plates are located on the inside of the frame rail at the driver's side rear wheel and on the frame cross-member below the front floorboard.(Ref Fig. 2) (Ref Fig. 1)

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.

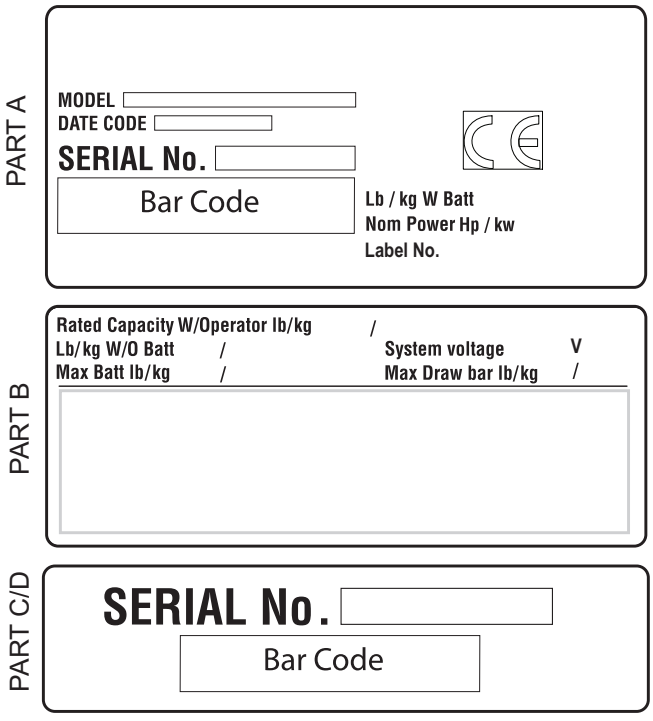


Fig. 2 Serial Number Labels

GENERAL INFORMATION AND ROUTINE MAINTENANCE

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

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).

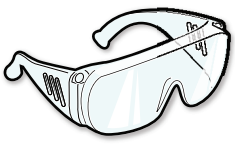
If the vehicle is to be transported at highway speeds, the sun top must be removed and the seat bottom secured (See SUN TOP on page 121). When transporting vehicle below highway speeds, check for tightness of hardware and cracks in sun top at mounting points. Always remove windshield when transporting (See SPILT WINDSHIELD on page 123). 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 and load plus 1000 lbs. (454 kg) (See GENERAL SPECIFICATIONS on page 155). 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. 3).

Vehicle batteries must be fully charged before initial use.

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. 3 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 provided it receives regular maintenance. Refer to the Periodic Service Schedule for appropriate service intervals (Ref Fig. 5). Refer to Lubrication Point for appropriate lubrication location (Ref Fig. 4).

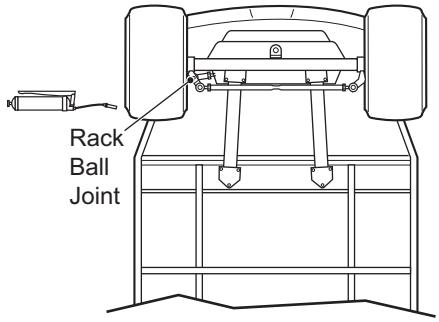


Fig. 4 Lubrication Points

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

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

REAR AXLE

The only maintenance required for the first five years is the periodic inspection of the lubricant level. The rear axle is provided with a lubricant level check/fill plug located on the bottom of the differential. Unless leakage is evident, the lubricant need to be only replaced after five years (See Replacing the Lubricant on page 111).

BRAKES

After the vehicle has been put into service, it is recommended that the brakes be checked daily by performing a brake test (See Periodic Brake Performance Test (PBPT) on page 97).

⚠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.***

TIRES

Tire condition should be inspected periodically (See SERVICE SCHEDULE on page 4). Inflation pressures should be checked when the tires are cool. Be sure to reinstall valve dust cap after checking or inflating (See WHEEL AND TIRE SERVICE on page 13).

LIGHT BULB REPLACEMENT

Refer to ELECTRICAL SYSTEM for information regarding light bulb replacement (See Halogen Headlight Bulb on page 79).

VEHICLE CLEANING AND CARE

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

It is important that proper techniques and cleaning materials be used. Using excessive water pressure may cause damage to seals, plastics, the electrical system, body finish or seat material. Do not use pressure in excess of 700 psi (4826 kPa) to wash vehicle.

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

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

The painted surfaces of the vehicle provide attractive appearance and durable protection. Frequent washing with lukewarm or cold water is the best method of preserving the 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 28432G**).
- Multi-purpose Battery Protectant formulated to form a long-term, flexible, non-tacky, dry coating that will not crack, peel, or flake over a wide temperature range (P/N 606312).
- Multi-purpose Hand Cleaner is an industrial strength cleaner containing no harsh solvents, yet gently lifts grease off hands. May be used with or without water (P/N 607636).
- Battery Maintenance Kit for complete battery cleaning and watering, with battery maintenance instructions (P/N 25587G01).
- Plexus plastic cleaner and polish removes minor scratches from windshield (P/N 606314).

SUN TOP AND WINDSHIELD

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

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

The sun top and windshield are designed for weather protection only.

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

GENERAL INFORMATION AND ROUTINE MAINTENANCE

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

SERVICE SCHEDULE

C - CHECK **C&A** - CHECK & ADJUST **CL** - CLEAN **R** - REPLACE

REMARKS	Before each use DAILY DAILY	WEEKLY	20 hrs MONTHLY	50 hrs QUARTERLY	125 hrs SEMI-ANNUAL	250 - 300 hrs ANNUAL	5 YEARS
Tires - Check pressure and inspect condition of tires & rims.	C	C	C	C	C	C	
Hardware - Check for loose or missing.	C	C	C	C	C	C	
Reverse Warning Indicator	C	C	C	C	C	C	
Overall Vehicle Condition	C	C	C	C	C	C	
Battery Pack - Check state of charge, condition, loose terminals, corrosion, hold down & hardware.	C	C	CL	CL	CL	CL	
Brake Pedal - Check for smooth operation	C	C	C	C	C	C	
Parking Brake - Check for correct hold capability.	C	C	C&A	C&A	C&A	C&A	
Accelerator - Check for smooth operation.	C	C	C	C	C	C	
Charger / Receptacle - Inspect charger connector and receptacle.	C	C	C	C	C	C	
Brakes - Conduct brake performance test; adjust if required.			C&A	C&A	C&A	C&A	
Wiring - Inspect for loose connections, broken or missing insulation.			C	C	C	C	
Direction Selector - Inspect attachment and mechanism.			C&A	C&A	C&A	C&A	
Steering Assembly - Check for excess play, loose or missing hardware.			C	C	C	C	
Tie Rods - Check for excess play, bent rods, loose or missing hardware.			C	C	C	C	
Front Axle - Check for damage to axle, loose or missing hardware.				C	C	C	
Rear Axle - Check fluid level, oil leakage, noise, loose or missing hardware.			C	C	C	C	
Parking Brake - Inspect linkage rods, latch arm and catch bracket.				C	C	C	
Parking Brake - Lubricate with light oil. Do not lubricate cables or brake latch.				C&A	C&A	C&A	
Rear Axle - Drain & replace fluid.							R
Rear Suspension - Inspect for shock oil leakage, worn bushings, loose or missing hardware.				C	C	C	
Front Suspension - Inspect for strut oil leakage, excessive play in hubs or kingpins, worn bushings, loose or missing hardware.				C	C	C	
Front Wheel Alignment - Inspect for unusual tire wear.				C&A	C&A	C&A	
Steering Assembly - Inspect bellows and pinion seal for damage and leakage.					C	C	
Rack End Ball Joint - Check for noise and loose or missing hardware.					C	C	

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

Fig. 5 Periodic Service Schedule

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

HARDWARE

Periodically the vehicle should be inspected for loose fasteners. Fasteners should be tightened in accordance with the Torque Specifications table (Ref Fig. 6).

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

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) 5.8	1 (2)	2 (3)	4 (6)	10 (14)	20 (27)	35 (47)	55 (76.4)			
Class 8.8 (Grade 5) 8.8	2 (3)	4 (6)	7 (10)	18 (24)	35 (47)	61 (83)	97 (131)			
Class 10.9 (Grade 8) 10.9	3 (4)	6 (8)	10 (14)	25 (34)	49 (66)	86 (117)	136 (184)			

Fig. 6 Torque Specifications

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

Notes:

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

SAFETY

NOTICES, CAUTIONS, WARNINGS AND DANGERS

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

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

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

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

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

IMPORTANT SAFETY WARNING

In any product, components will eventually fail to perform properly as the result of normal use, age, wear or abuse. It is virtually impossible to anticipate all possible component failures or the manner in which each component may fail.

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

Some components are heavy, spring loaded, highly corrosive, explosive, or may produce high amperage or reach high temperatures. Battery acid and hydrogen gas could result in serious bodily injury to the technician/mechanic and bystanders if not treated with the highest degree of 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 service before reading and understanding all notes, cautions and warnings in this manual.

When any maintenance procedure or inspection is performed, it is important to exercise caution 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 the 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 caution not to contact hot objects.

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

To prevent the possibility of motor disintegration, never operate the vehicle at full throttle for more than 4 - 5 seconds while the 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.

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

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.

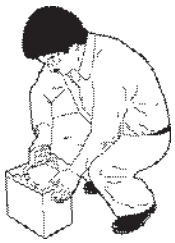
⚠ WARNING ***To prevent a battery explosion that could result in severe personal injury or death, keep all smoking materials, open flame or sparks away from the batteries.***

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

BATTERY REMOVAL & INSTALLATION

Tool List	Qty.
Insulated Wrench, 9/16"	1
Socket, 9/16"	1
Ratchet	1
Battery Carrier	1
Torque Wrench ft. lbs.	1

NOTICE: In the following text, there are references to removing/installing bolts etc. Additional hardware (nuts, washers etc.) that are removed must always be installed in its original position unless otherwise specified. Non-specified torques are as shown in torque table (See HARDWARE on page 5).

⚠ CAUTION ***Before any electrical service is performed, the key switch must be placed in the OFF position.***

If a power wire (battery, motor or controller) is disconnected for any reason on the vehicle, the key switch must be left in the OFF position for at least 30 seconds after the circuit is restored.

Turn the key switch to the OFF position and remove the key. 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 is neutralized on a regular basis, no corrosion to the battery racks or the 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 torque values below.

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.

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

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

Use caution when connecting 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**. Make sure that all battery terminals are installed with crimp up. Tighten the battery hold down hardware to the torque values below. Protect the battery terminals and battery cable terminals with a commercially available protective coating.

Item	Torque Specification
Terminal Post	7.5 - 9 ft. lbs. (10 - 12.5 Nm)
Hold Down	16 - 19 ft. lbs. (21.5 - 26 Nm)

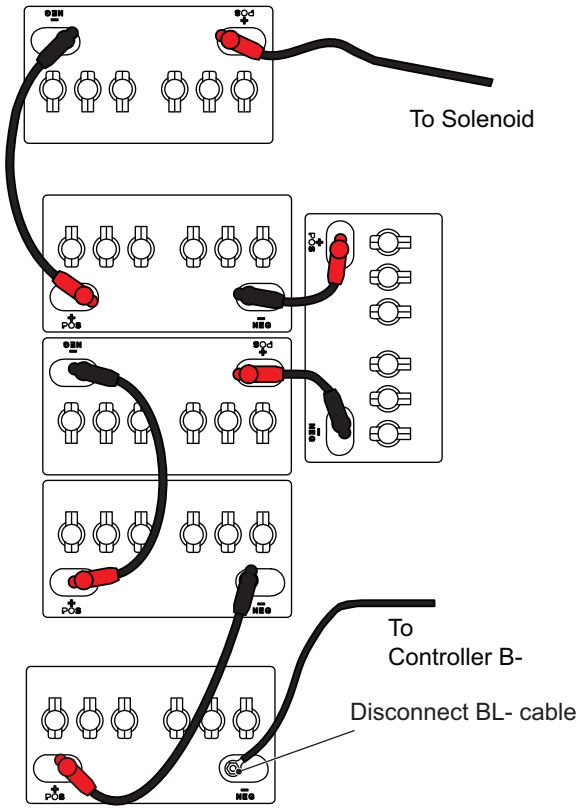


Fig. 1 Battery Connections

LIFTING THE VEHICLE

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

Some servicing operations may require the vehicle to be raised.

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

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

Entire Vehicle

1. Install wheel chocks in front and behind each front wheel (Ref Fig. 2).
2. Center the jack under the rear frame crossmember.
3. Raise the vehicle and locate a jack stand under the outer ends of the rear axle.
4. Lower the jack and test the stability of the vehicle on the two jack stands.

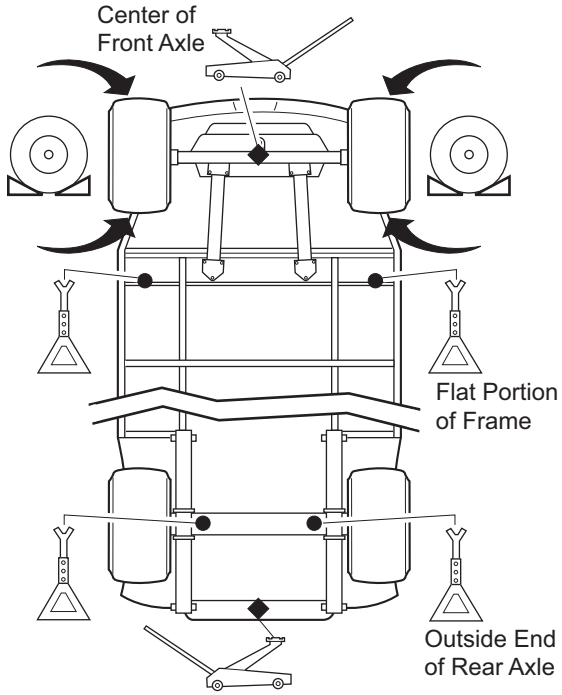


Fig. 2 Lifting the Vehicle

5. Place the jack at the center of the front axle.
6. Raise the vehicle and position the jack stands under the inner frame member as indicated.
7. Lower the jack and test the stability of the vehicle on the four jack stands.

Lower the vehicle by reversing the lifting sequence.

Front of Vehicle

1. Place the chocks in front and behind each rear wheel in order to stabilize the vehicle.
2. Place the jack at the center of the front axle (Ref Fig. 2).
3. Raise the vehicle and position the jack stands under the inner frame member as indicated.
4. Lower the jack and test the stability of the vehicle on the jack stands.

Lower the vehicle by reversing the lifting sequence.

Rear of Vehicle

1. Install wheel chocks in front and behind each front wheel (Ref Fig. 2).
2. Center the jack under the rear frame crossmember.
3. Raise the vehicle and locate a jack stand under the outer ends of the rear axle.
4. Lower the jack and test the stability of the vehicle on the jack stands.

Lower the vehicle by reversing the lifting sequence.

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

Notes:

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

Notes:

WHEELS AND TIRES

WHEEL AND TIRE SERVICE

Tools List	Qty.
Lug Wrench, 3/4"	1
Impact Wrench	1
Impact Socket, 3/4"	1
Torque Wrench, ft. lbs.	1

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

Tire condition should be inspected per the Periodic Service Schedule (See SERVICE SCHEDULE on page 4). 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 the inflation pressure rating on the tire sidewall.***

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

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

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

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

Tire inflation should be determined by the condition of the terrain. See **GENERAL SPECIFICATIONS** section for recommended tire inflation pressure (See GENERAL SPECIFICATIONS on page 155). For outdoor applications with major use on grassy areas, the following should be considered. On hard turf, it is desirable to have a **slightly** higher inflation pressure. On very soft turf, a lower pressure prevents tires from cutting into the turf. For vehicles being used on paved or hard surfaces, tire inflation pressure should be in the higher allowable range, but under no condition should inflation pressure be higher than recommended on tire sidewall. **All four tires** should have the same pressure for optimum handling characteristics. Be careful not to over inflate. Due to the low volume of these small tires, over inflation can occur in a matter of seconds. Be sure to install the valve dust cap after checking or inflating.

Tire Repair

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

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

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

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

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

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

Wheel Installation

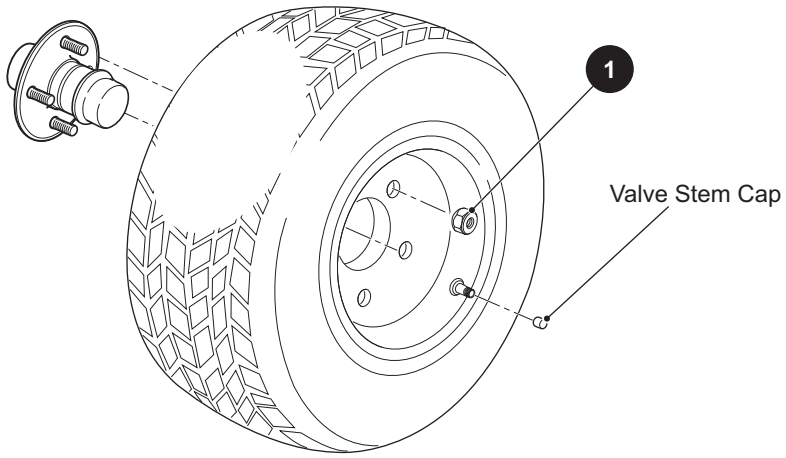
⚠ CAUTION ***Do not tighten lug nuts to more than 85 ft. lbs. (115 Nm) torque.***

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

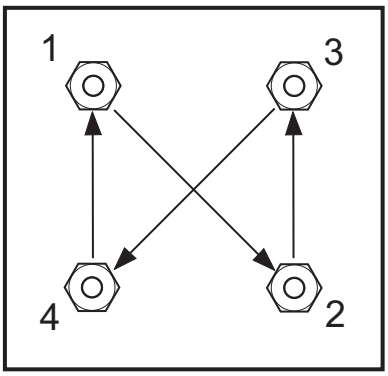
With the valve stem to the outside, mount the wheel onto the hub with lug nuts. Finger tighten lug nuts as shown. Then, tighten lug nuts to the torque values below in 20 ft. lbs. (30 Nm) increments following the same pattern.

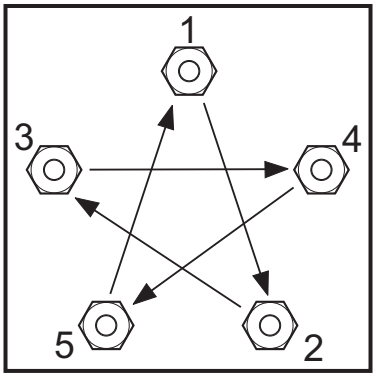
Item	Torque Specification
1	50 - 85 ft. lbs. (70 - 115 Nm)

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



Tire style may vary





'Cross Sequence'

Fig. 1 Wheel and Tire Installation

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

Notes:

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

Notes:

BODY

GENERAL

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 original positions unless otherwise specified. Non-specified torques are as shown in the table in GENERAL INFORMATION AND ROUTINE MAINTENANCE section.

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

It is important to use a sharp drill bit when removing the rivets on the side of the vehicle. Use extreme caution 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 an internal component. It is recommended that a protective piece of sheet metal be placed between the battery and the rivet as extra protection. Use of a drill depth stop will also 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. Some components are mounted with 'pop' rivets which require 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). Use caution when drilling to prevent the drill bit from being forced through and damaging 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 and to place a piece of protective sheet metal between the surface being drilled and components directly behind it.

BODY COMPONENT REPLACEMENT

Body components can be replaced by removing securing hardware, replacing the component and securing with hardware in same orientation.

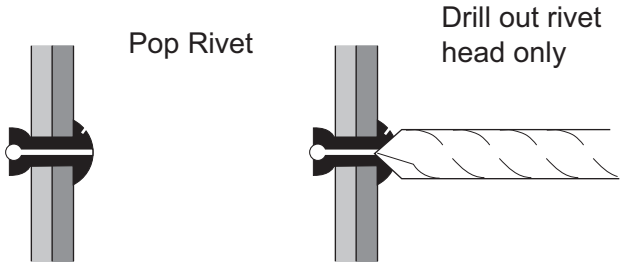


Fig. 1 Drill Out Metal Rivet

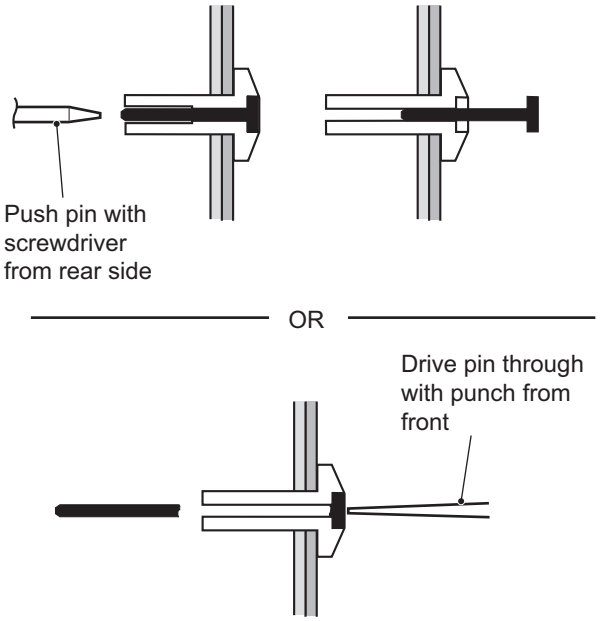


Fig. 2 Drive Rivet Removal

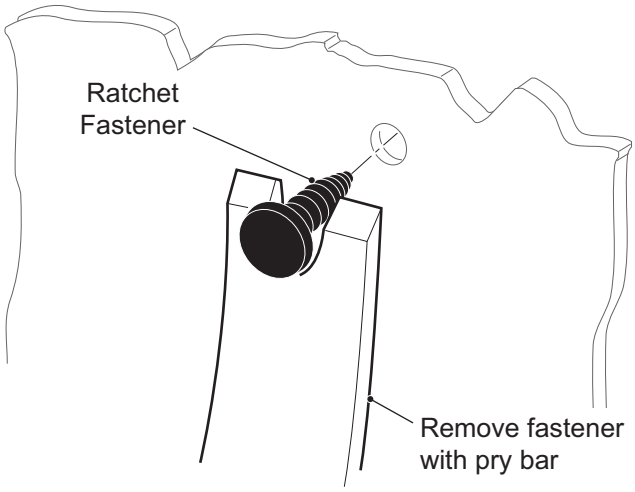


Fig. 3 Remove Ratchet Fastener

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

Rocker Panel

Tool List	Qty.
Wrench, 10 mm	1
Wrench, 3/8”	1
Socket, 10 mm	1
Socket, 3/8”	1
Ratchet	1
Bit Driver, T-30	1
Screwdriver, Phillips	1
Bit Driver	1
Drill	1
Drill Bit	1
Rivet Gun	1
Torque Wrench, in. lbs.	1

1. Drill out the rivet (3) securing the rear of the rocker panel (5) to the frame.
2. Remove the lock nut (6), washer (7), and screw (1) securing the front of the rocker panel (5) to the fender flare.
3. Remove the remaining lock nuts (4), spacers (8), and screws (2) securing the rocker panel (5) to the frame (Ref Fig. 4).

Be sure to retain the spacers (5) for reuse during assembly.

Assemble in the reverse order of removal using new rivets (3) and lock nuts (4, 6). Tighten the lock nuts (4, 6) to the torque values below.

Item	Torque Specification
4	45 - 55 in. lbs. (5 - 6.2 Nm)
6	18 - 20 in. lbs. (2 - 2.2 Nm)

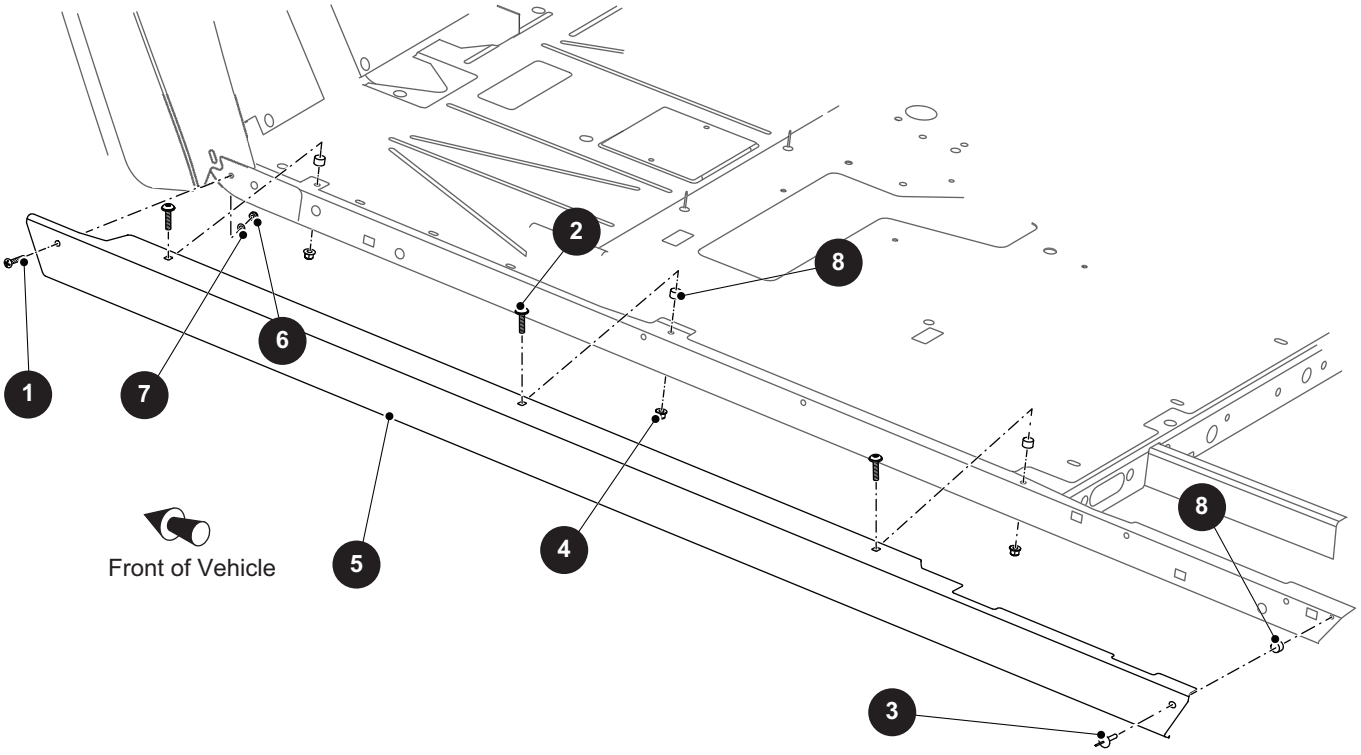


Fig. 4 Rocker Panel

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

Fender Flare

Tool List

Screwdriver, Phillips 1
Drill Bit 1
Drill 1
Rivet Gun 1

1. Remove the lock nut (6), washer (7), and screw (1) securing the front of the rocker panel (5) to the fender flare (Ref Fig. 4).
2. Drill out the rivets (9) securing the fender flare (10) to the cowl (Ref Fig. 5).

Assemble in the reverse order of removal using new rivets and lock nuts.

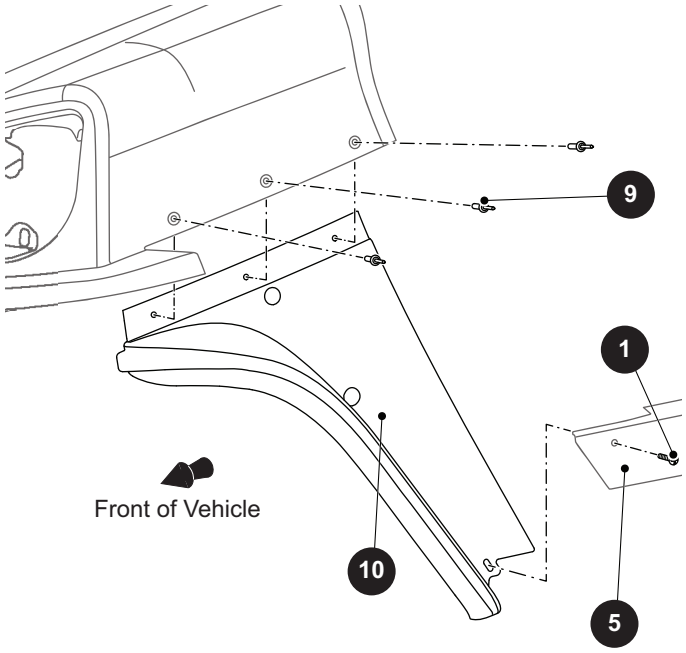


Fig. 5 Fender Flare

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

Cowl

Tool List	Qty.
Electric/air Drill	1
Drill Bit	1
Pop Rivet Tool	1
Pry Bar	1

1. Disconnect the headlights from the main harness (See Headlight Assembly on page 79).
2. Drill out the rivets securing the top of the fender flairs to each side of the cowl (See Fender Flare on page 19).
3. Drill out the rivets (12) securing the top of the instrument panel (15) to the cowl (20) (Ref Fig. 6).
4. A small, non-marring pry bar may be necessary to pry the cowl from beneath the instrument panel.

Assemble in the reverse order of removal using new rivets.

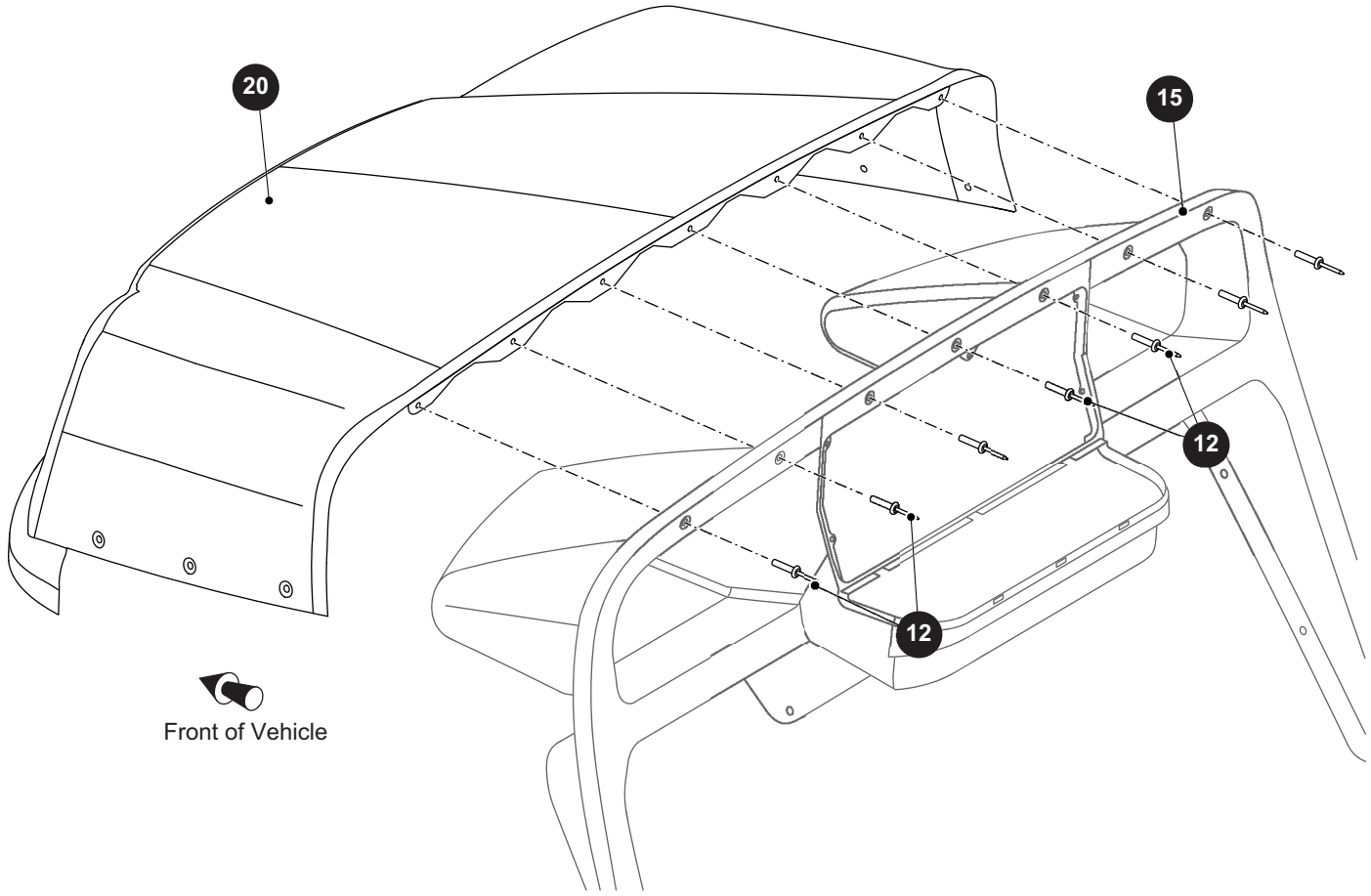


Fig. 6 Cowl

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

Control Panel

Tool List **Qty.**

Screwdriver, Phillips 1

Pry Bar 1

1. Remove the screws (11) securing the top of the control panel (10) to the instrument panel (15) (Ref Fig. 7).
2. Pull the top of the control panel out and up. A small pry bar may be necessary.
3. Disconnect the electrical accessories from the main harness.

Assemble in the reverse order of removal.

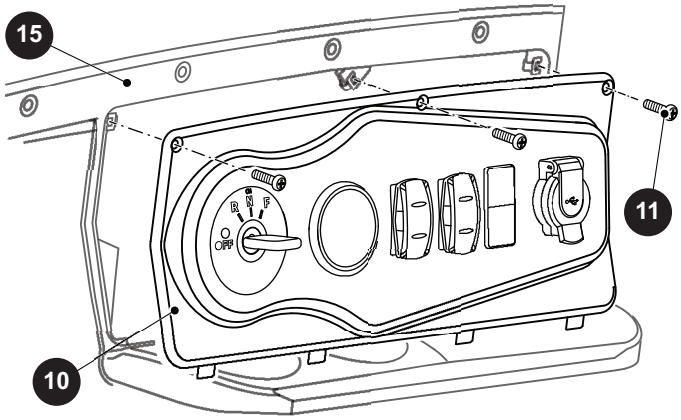


Fig. 7 Control Panel

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

Instrument Panel

Tool List	Qty.
Insulated Wrench, 9/16"	1
Drill	1
Drill Bit	1
Rivet Gun	1

NOTICE: It is necessary to remove either the cowl or gauge panel to remove the instrument panel. It it not necessary to remove both.

⚠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. New safety labels are available from the Service Parts Department at no cost.***

1. Disconnect the battery cable at the negative (-) battery terminal.
2. Remove the control panel (See Control Panel on page 21).
3. Disconnect the push on connectors to the reverse buzzer (See Reverse Buzzer on page 82).
4. Pull the front of the floor mat up to expose the rivets.
5. Drill out the rivets (12) securing the cowl (20) to the top of the instrument panel (15) (See Cowl on page 20).
6. Drill out the rivets (13) securing the instrument panel to the floor.
7. Retain the trim pieces (16) for assembly.

Assemble in the reverse order of removal using new rivets. If the instrument panel is to be replaced, be sure to remove the reverse buzzer to install on the new instrument panel and make sure a new safety label is applied to the new instrument panel.

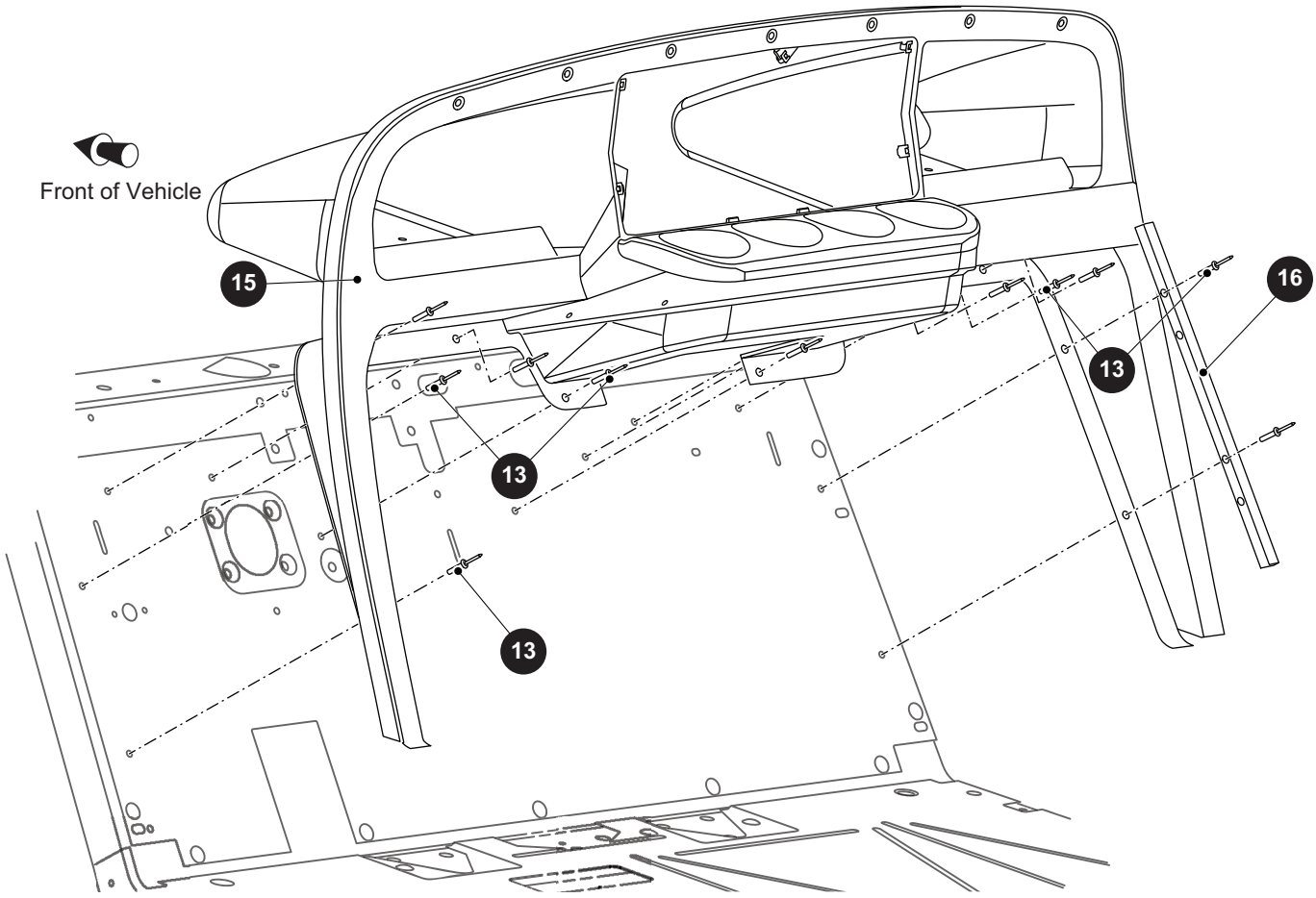


Fig. 8 Instrument Panel

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

Front Fascia and Mounting Bracket

Tool List	Qty.
Wrench, 3/8”	1
Socket, 3/8”	1
Ratchet	1
Pry Bar	1
Torque Wrench, ft. lbs.	1

NOTICE: It is not necessary to remove the fascia to replace any other body components.

1. Remove the cowl (See Cowl on page 20).
2. Disconnect the electrical connections to the horn (See Horn on page 83).
3. Remove the ratchet rivets (22) securing the sides of the fascia (25) to mounting bracket (19) (Ref Fig. 9).
4. Remove the bolts (17) and washers (18) securing the fascia to the frame and set the horn to the side.
5. Remove the bolts (21) securing the mounting bracket to the frame.

Assemble in the reverse order of removal using new ratchet rivets. Tighten the bolts (17, 21) to the torque values below.

Item	Torque Specification
17, 21	6 - 8 ft. lbs. (8 - 11 Nm)

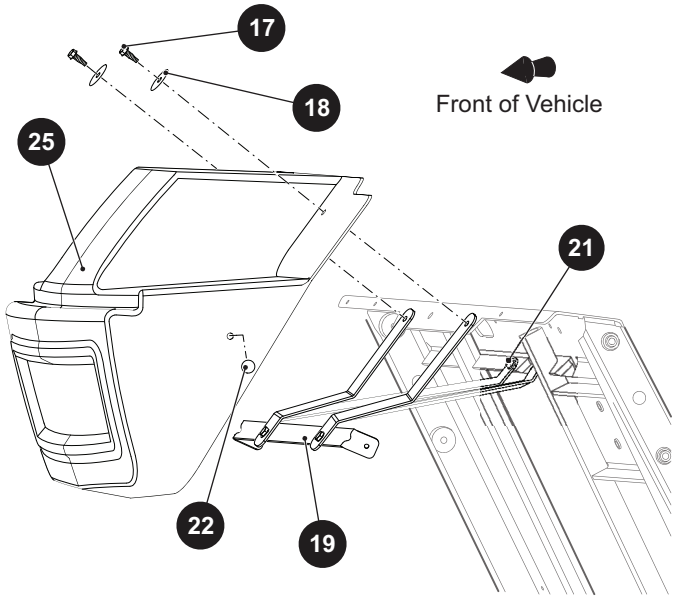


Fig. 9 Fascia

Seat Back

Tool List	Qty.
Wrench, 7/16”	1
Socket, 7/16”	1
Ratchet	1
Torque Wrench, in. lbs.	1

Remove the bolts (23) securing the hand grip (24) and seat back (30) to the seat back support (26) (Ref Fig. 10).

Assemble in the reverse order of removal.

Tighten the bolts to the torque values below.

The procedure is the same for the front facing rear seat and flip seat except that there is no hand grip.

Item	Torque Specification
23	45 - 55 in. lbs. (5 - 6.2 Nm)

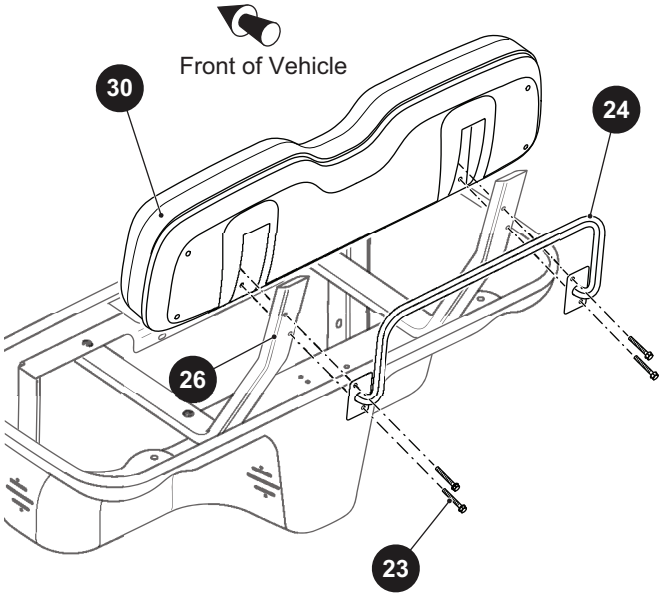


Fig. 10 Seat Back

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

Front Seat and Seat Frame

Tool List	Qty.
Floor Jack	1
Jack stands	4
Wrench, 1/2"	2
Socket, 1/2”	1
Ratchet	1
Drill	1
Drill Bit, 3/16"	1
Rivet Gun	1
Torque Wrench, ft. lbs.	1

1. Remove the seat bottom.
2. Remove the seat back.
3. Disconnect the wiring from the charging port (14).
4. Remove the on-board charger.
5. Drill out the rivets (39) securing the seat frame to the front of the seat pod and discard the washers (37, 38) (Ref Fig. 11).
6. Remove the lock nuts (29), bolts (27), and washers (28) securing the seat back supports (26) to the seat frame.
7. Lift and support the vehicle (See LIFTING THE VEHICLE on page 9).
8. Remove the lock nuts (36), spacers (33, 34) and washers (32) securing the seat frame (35) and seat pod (40) to the frame.

Assemble in the reverse order of removal using new lock nuts (29, 36), rivets (39), and washers (37, 38). Tighten the lock nuts to the torque values below.

Item	Torque Specification
29, 36	14 - 18 ft. lbs. (19 - 24 Nm)

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

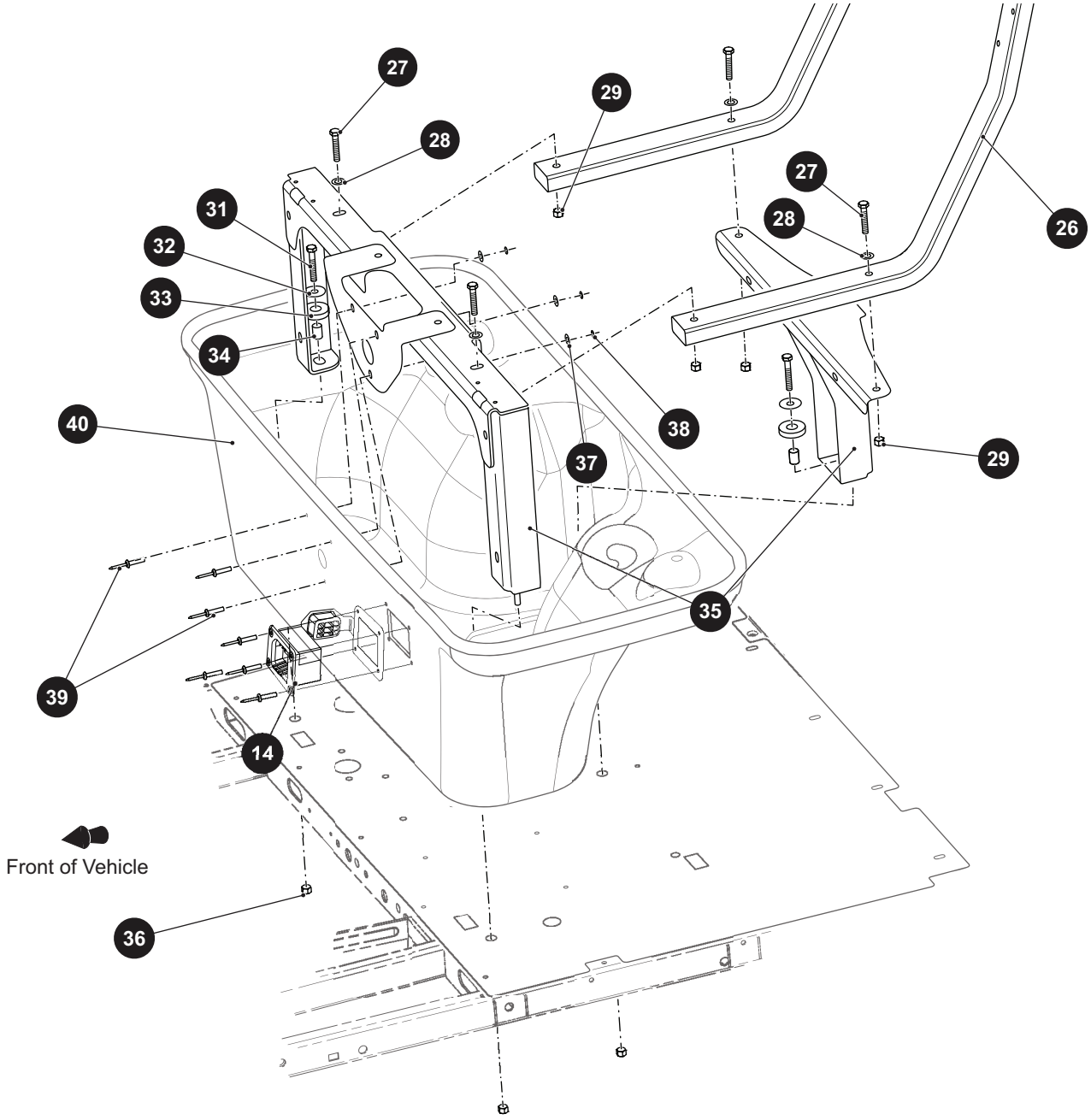


Fig. 11 Front Seat Pod and Frame

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

Flip Seat, Seat Back Support, and Footrest

Tool List	Qty.
Wrench, 7/16”	1
Wrench, 9/16”	2
Socket, 7/16”	1
Socket, 9/16”	1
Ratchet	1
Screwdriver, Phillips	1
Torque Wrench, ft. lbs.	1

1. Remove the sun top (if equipped) (See SUN TOP on page 121)
2. Remove the seat back (See Seat Back on page 23).
3. Remove the lock nuts (51), washers (49), and screws (48) securing the flip seat (45) to the seat frame (50).
4. Remove the lock nuts (47), washers (46), and bolts (44) securing the hand rails (55) to the foot rest (60).
5. Remove the lock nuts (41), washers (42) and bolts (43) securing the hand rails to the seat frame.
6. Remove the lock nuts (54), washers (53), and bolts (52) securing the seat frame to the seat back support (65).
7. Remove the lock nuts (58), washers (57), and bolts (56) securing the seat frame to the seat frame support (63).
8. Remove the lock nuts (62), washers (61), and bolts (59) securing the seat frame support to the vehicle frame.
9. Remove the bolts (64) securing the seat back support to the vehicle frame.
10. Remove the lock nuts (68), washers (67), and bolts (66) securing the footrest to the vehicle frame.

Assemble in the reverse order of removal using new lock nuts.

Tighten the lock nuts to the torque values below.

Item	Torque Specification
51	8 - 10 ft. lbs. (11 - 13.5 Nm)
(41, 47, 54, 58, 62, 68)	21 - 25 ft. lbs. (28.5 - 34 Nm)

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

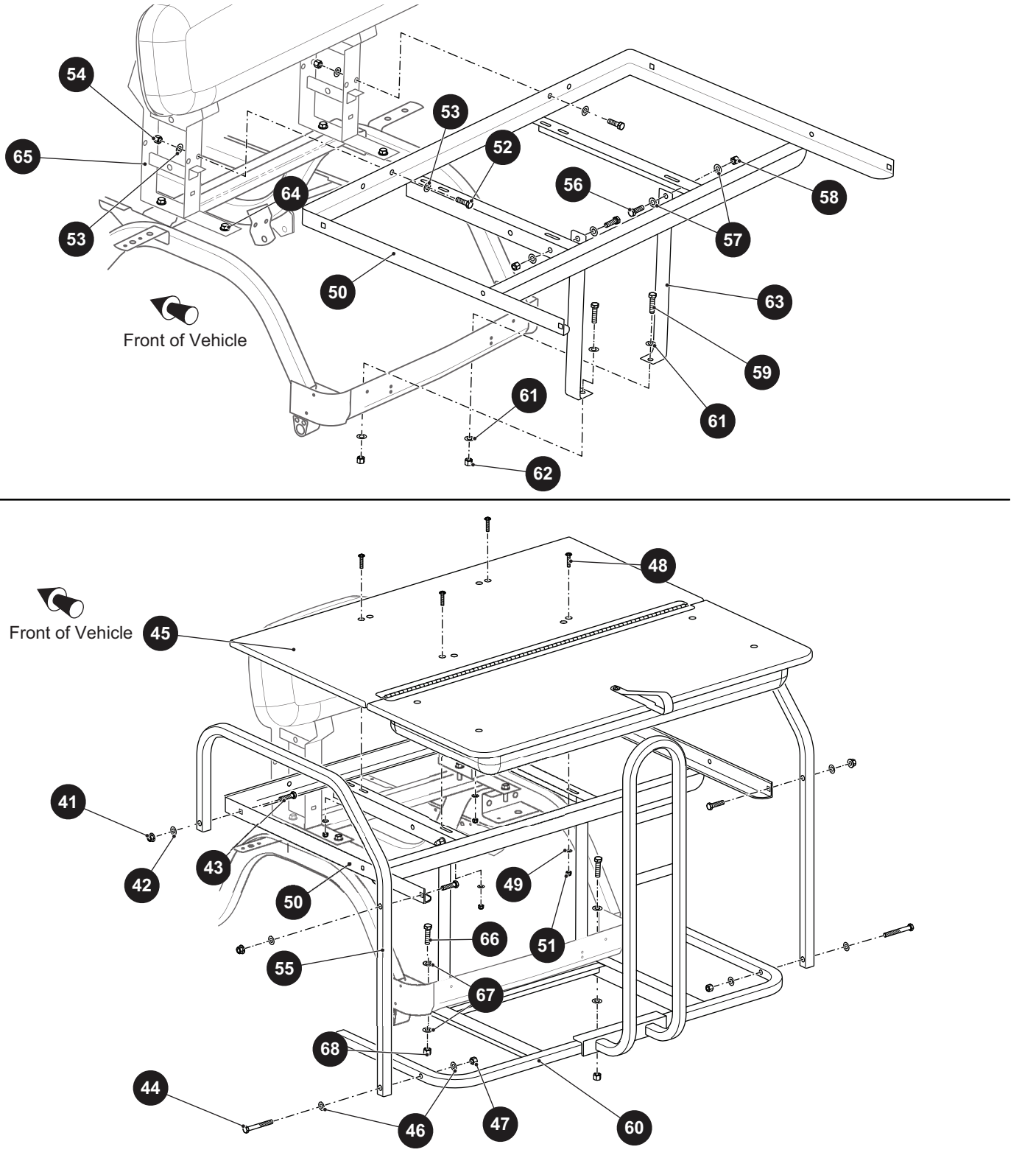


Fig. 12 Flip Seat

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

Truck Bed and Bed Support

Tool List	Qty.
Wrench, 5/16"	1
Wrench, 7/16”	1
Wrench, 1/2"	1
Wrench, 9/16"	1
Socket, 5/16”	1
Socket, 7/16”	1
Socket, 1/2”	1
Socket, 9/16”	1
Ratchet	1
Torque Wrench, in. lbs.	1
Torque Wrench, ft. lbs.	1

⚠WARNING ***The truck bed is heavy and awkward to handle. To prevent possible personal injury, it is strongly recommended that it is fully disassembled or use a team lift if removing the bed complete.***

1. Remove the sun top (if equipped) (See SUN TOP on page 125)
2. Remove the screws (84) securing the sides (80) of the bed to the bed frame (75) (Ref Fig. 13).
3. Unlatch and lift the bed.
4. If the deck (90) is damaged, remove the lock nuts (82) and screws (81) securing the deck of the bed to the bed frame.
5. If the latch (85) is damaged remove the screws (86) securing it to the bed frame.
6. Remove the lock nuts (71), washers (72), and bolts (69) securing the bed frame to the seat support (65).
7. Inspect the bushings (83), and replace them if necessary.
8. Inspect the bumpers (78) and replace them if necessary by removing the lock nuts (79) securing them to the seat support.
9. Remove the seat back (See Seat Back on page 23).
10. Re move the lock nuts (76), washers (74), and bolts (73) securing the seat support to the support brackets (70).
11. Remove the bolts (77) securing the seat support to the frame.
12. Remove the lock nuts (89), washers (87), and bolts (88) securing the support brackets to the frame.

Assembly is in the reverse order of removal using new lock nuts.

Tighten all hardware to the torque settings below.

Item	Torque Specification
84	4 - 5 ft. lbs. (5.5 - 6.7 Nm)
82	8 - 10 ft. lbs. (11 - 13.5 Nm)
71	17 - 21 ft. lbs. (23 - 28.5 Nm)
76, 77, 79, 89	21 - 25 ft. lbs. (28.5 - 34 Nm)
86	30 - 40 in. lbs. (3.4 - 4.5 Nm)

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

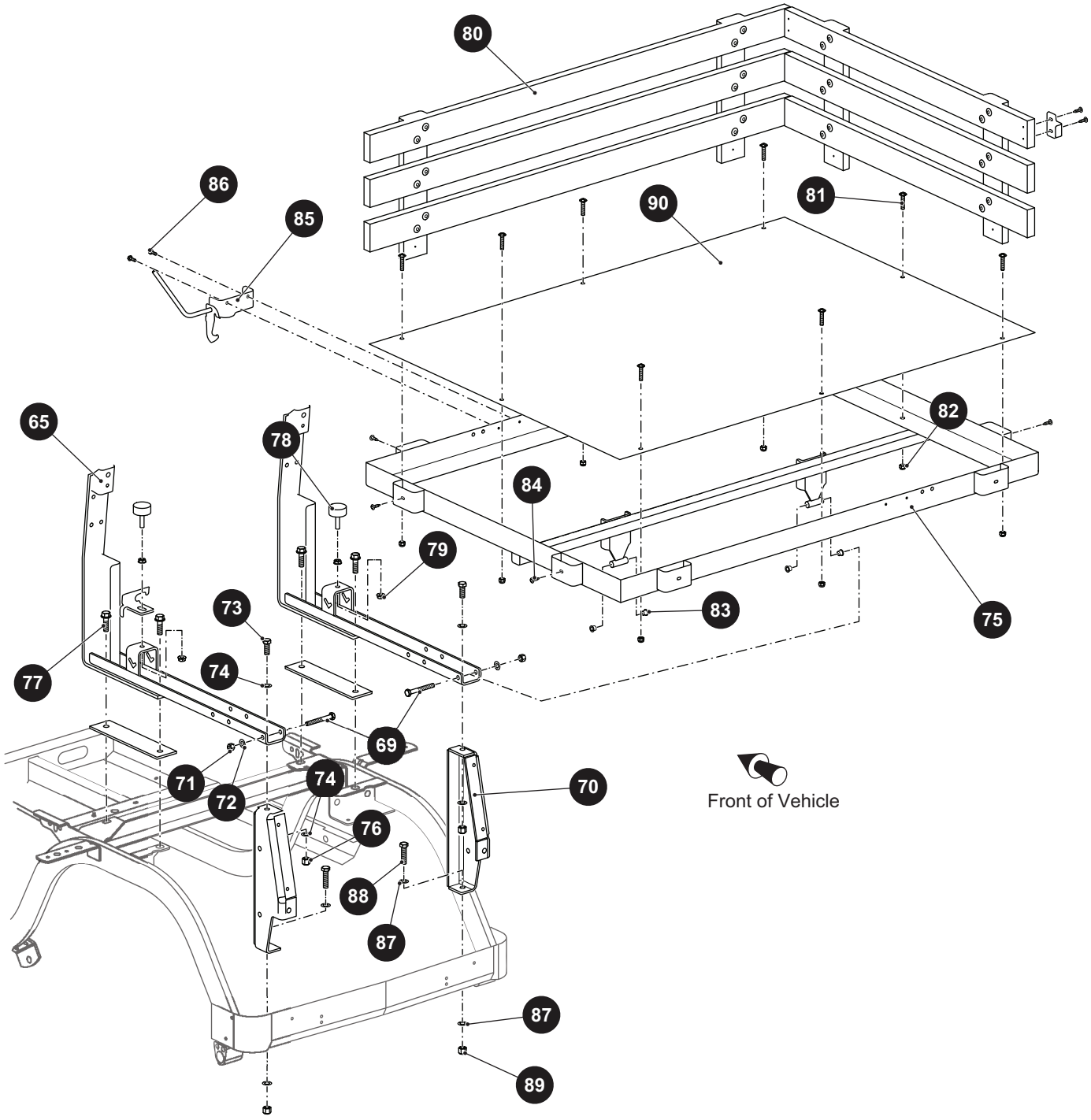


Fig. 13 Truck Bed

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

Rear Body

Tool List	Qty.
Torx Bit, T-20	1
Bit Driver	1
Pin Punch	1
Drill Bit	1
Drill	1
Pry Bar	1
Rivet Gun	1
Torque Wrench, in. lbs.	1

⚠WARNING ***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 the 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.***

1. Remove the sun top (if equipped) (See SUN TOP on page 121).
2. Remove the truck bed or flip seat (See Truck Bed and Bed Support on page 28) (See Flip Seat, Seat Back Support, and Footrest on page 26).
3. Remove the screws (91) securing the access panel (95) to the rear body (100) (Ref Fig. 14).
4. Disconnect the wire harness from the taillights (if equipped).
5. Remove the rocker panels and pull back the floor mat (See Rocker Panel on page 18).
6. Drill out the rivets (93) securing the rear body to the frame.
7. Drill out the rivets (92) securing the front of the rear body to the floor.
8. Pry out the ratchet rivets (94) securing the top of the rear body to the frame.
9. Remove the drive rivets (96) securing the rear of the rear body to the frame.

Assembly is in the reverse order of removal using new rivets.The drive rivets (96) can be reused as long as they were not damaged during removal.

Tighten the screws (91) to the torque value shown below.

Item	Torque Specification
91	5 - 7 in. lbs. (.5 - .8 Nm)

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

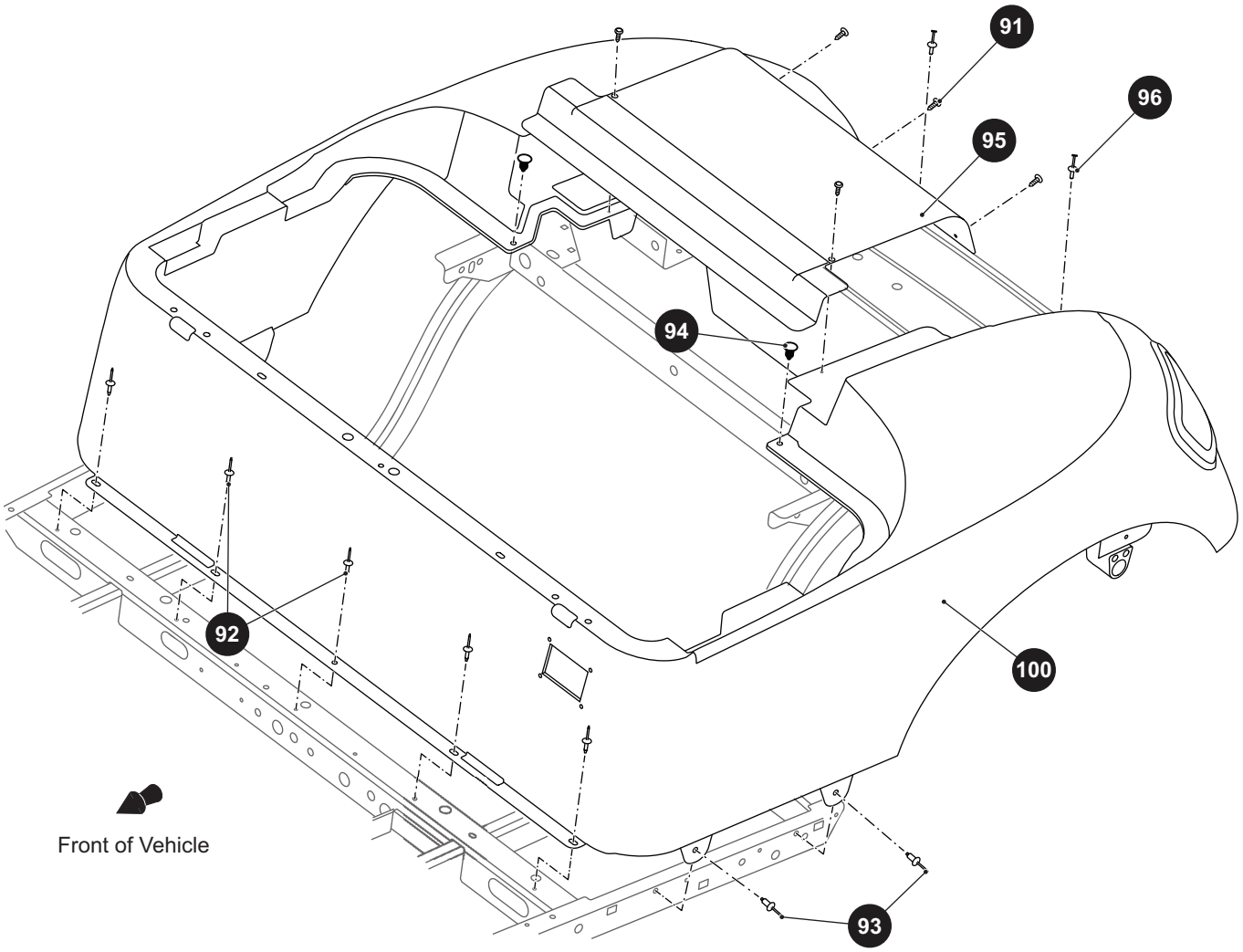


Fig. 14 Rear Body

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

PAINTING

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

⚠ WARNING ***All painting must be done in an area with adequate ventilation to safely disperse harmful vapors.***

Wear eye protection and a respirator, following manufacturer's instructions to protect from overspray and airborne mist.

⚠ CAUTION ***Provide protection from overspray to vehicle and surrounding area.***

Minor Scratches

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

1. Thoroughly clean the surface to be repaired with alcohol and dry.
2. Touch up damaged area with sequential coats (two coats minimum recommended, allowing 30 - 45 minutes between coats, increasing to 45 - 60 minutes in higher humidity) using brush on touch-up paint, until a coating layer is visible slightly above the surface of the part.
3. Use 400 grit "wet" sand paper to blend the touch up area level with the rest of the part being repaired. Use a polishing compound (3M Finesse or automotive grade) to renew the gloss and to further blend and transition the newly painted surface.
4. Clean with alcohol and dry.
5. (Optional but recommended) Follow this process with a clear coat to renew and protect the depth of the finish.
6. Wax or polish with a Carnauba base product available at any automotive parts distributor.

Larger Scratches

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

1. Thoroughly clean the surface to be repaired with alcohol and dry.
2. Mask the area to be painted (common masking tape is adequate) prior to repair and use aerosol type touch-up paint.
3. Apply spray touch up paint in light even overlapping strokes. Multiple coats may be applied to provide adequate coverage and finish. Always remember to shake the can for a minimum of one minute to mix the paint and achieve the best color match.
4. After painting, allow to dry overnight. Smooth the mask lines using 400 grit "wet" sand paper to blend touch up area level with the rest of the part being repaired.
5. Use a polishing compound (3M Finesse or automotive grade) to renew the gloss and to further blend and transition the newly painted surface.
6. Clean with alcohol and dry.
7. (Optional but recommended) Follow this process with a clear coat to renew and protect depth of finish.
8. Wax or polish with a 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.

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

Notes:

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

Notes:

FRONT SUSPENSION, STEERING & AXLE

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 (See HARDWARE on page 5).

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

Be sure to use only the recommended lubricants. Maintain correct adjustment of the front bearings and repack 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 (See SERVICE SCHEDULE on page 4).

Lubrication

Tool List **Qty.**

Grease Gun 1
Shop Towels .....AR

Grease the rack ball joint (1). Wipe off old grease and dirt from the grease fitting and do not use more than three pumps of grease in any grease fitting. Wipe off any grease that is forced out of rubber boot (Ref Fig. 1).

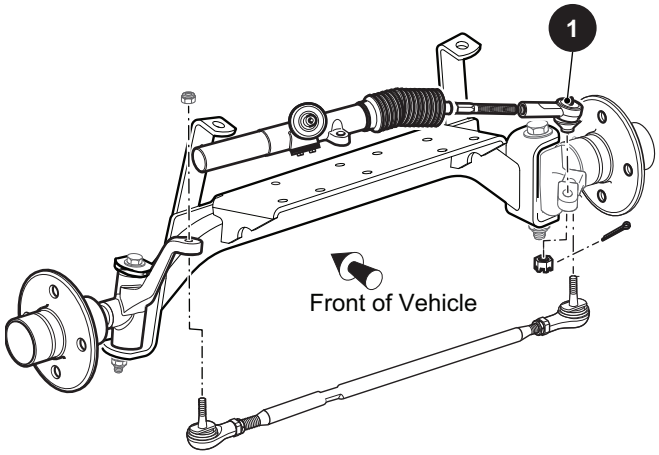


Fig. 1 Lubrication Points

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

Wheel Bearing and King Pin Bushing inspection

WARNING ***To prevent possible injury or death resulting from a vehicle falling from a jack, follow the lifting procedure. Be sure vehicle is on a firm and level surface (See LIFTING THE VEHICLE on page 9).***

Never get under a vehicle while it is supported by a jack. Use jack stands and test the stability of the vehicle on stands before beginning any repair procedure. Always place chocks in front and behind wheels not being raised. Use extreme care since the vehicle is extremely unstable during the lifting process.

Lift the front of the vehicle and support on jack stands (See LIFTING THE VEHICLE on page 9). Rotate the front wheel and feel for any roughness. While holding the spindle with one hand, grasp the bottom of the tire with the other hand and rock the tire back and forth on the spindle.

NOTICE: Some minor rocking movement of tire is normal.

If excess movement is detected, the wheel bearing may require repacking and adjusting or replacement (See Wheel Bearing Packing on page 35) (See Wheel Bearing Adjustment on page 36) (See Wheel Bearing and Race Replacement on page 40).

If excess movement is detected and the wheel bearing is in good condition a worn spindle bearing is indicated. The spindle bearings can not be replaced, the spindle with bearings installed is available through service parts (See Spindle Replacement on page 46).

Wheel Bearing Packing

Tool List **Qty.**

Grease Gun 1
Bearing Packer (Recommended).....1

Remove the hub from the spindle and disassemble (See Hub Replacement on page 40).

Clean all bearings, the grease seal and hub in solvent and dry thoroughly. Inspect for signs of damage. Pitting or a blue coloration of the rollers will indicate a failed or failing bearing. If the roller portion of the bearing is to be replaced, the race must also be replaced (See Wheel Bearing and Race Replacement on page 40).

The front wheel bearings are tapered roller type and must be packed with grease at installation or any time the bearing is removed for inspection. It is recommended that a bearing packer attached to a grease gun be used; however, manual packing is acceptable if done correctly. To pack a bearing manually requires that a dab of grease be placed in the palm of the hand and the bearing be dipped in the grease. Force the grease up through and around all of the rollers until the entire bearing is saturated in grease.

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

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

Wheel Bearing Adjustment

Tool List	Qty.
Socket, 1 1/2”	1
Lug Wrench, 3/4”	1
Ratchet	1
Pliers, Needle Nose	1
Torque wrench, ft. lbs.	1
Torque wrench, in. lbs.	1

1. If performing a wheel bearing adjustment only, lift and support front of vehicle (See LIFTING THE VEHICLE on page 9).
2. Remove the cotter pin (2) and loosen the castellated nut (3).
3. If performing a wheel bearing adjustment as part of another procedure, make sure the wheel is mounted to the hub hand tight with lug nuts (4) and the hub is loosely retained on the spindle (5) with the castellated nut (Ref Fig. 2).
4. Seat the bearings by rotating the wheel while tightening the castellated nut until slight resistance is felt.
5. Rotate the wheel 2 - 3 more turns to displace excess grease. If required, tighten the 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.
6. 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.
7. Bend the cotter pin (2) against the flats of the castellated nut (3).
8. If completing a wheel bearing adjustment as part of another procedure, tighten the front wheels (See Wheel Installation on page 13).

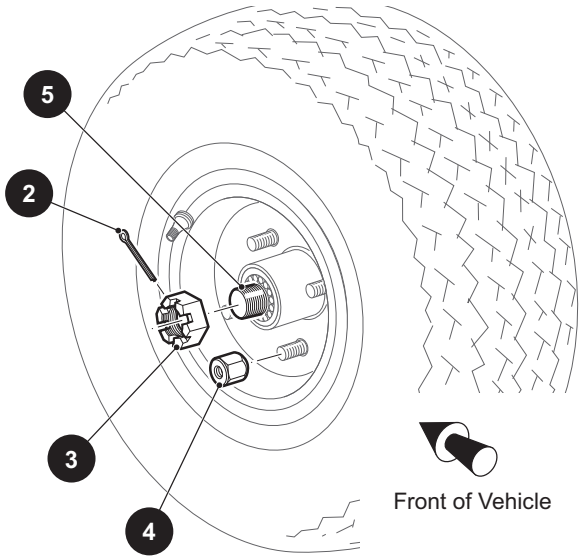


Fig. 2 Bearing Adjustment

Wheel Alignment

Tool List	Qty.
Wrench, 3/4”	1
Wrench, 1/2”	1
Wrench, 14mm	1
Crowfoot Socket, 3/4”	1
Socket, 13 mm	1
Ratchet	1
Tape Measure	1
Chalk	1
Torque Wrench, ft. lbs.	1

1. Lift and support the front of the vehicle (See LIFTING THE VEHICLE on page 9).
2. Confirm the alignment of the front springs.
3. Rotate each wheel and scribe a chalk line around the circumference of the tire at the center of the tread pattern.
4. Lower the 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.
5. Measure the distance between the chalk lines at both the front and the rear of the tires (Ref Fig. 3).
6. The measurement taken at the front of the tires should be 0" - 1/8” (0 - 3 mm) less than the rear.

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

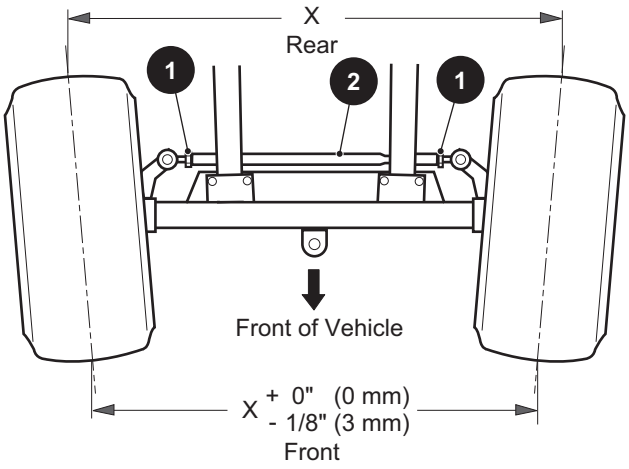


Fig. 3 Wheel Alignment

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

The tie rod has different threads on each end. It is adjusted in the same manner as a turnbuckle. The end with the flat area on the threaded tube has left hand threads (clockwise to loosen) while the end without the flat has conventional right hand threads (counter-clockwise to loosen).

7. To adjust the wheel alignment, loosen the tie rod jam nuts (1) and turn the tie rod (2) until the correct alignment is achieved.
8. Tighten the jam nuts to the torque values below.

Test drive the vehicle and confirm the steering wheel is correctly centered. If it is not centered, proceed below.

1. Remove the bolt connecting the intermediate shaft to the steering shaft and center the steering wheel (Ref Fig. 4).
2. Reconnect the intermediate shaft and tighten the bolt to the torque values below.

Item	Torque Specification
Jam Nut	36 - 40 ft. lbs. (49 - 54 Nm)
6	13 - 18 ft. lbs (18-24 Nm)

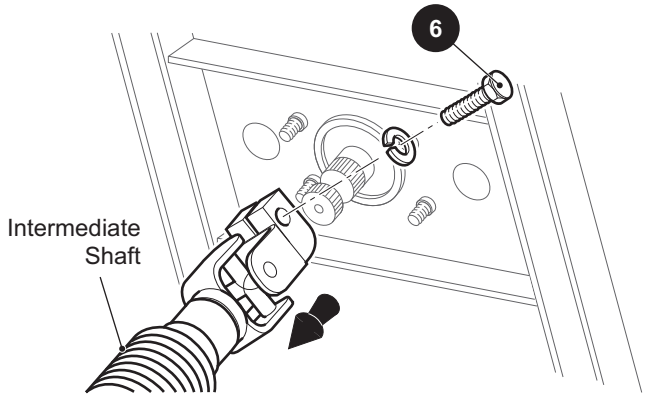


Fig. 4 Disconnect Intermediate Shaft to Center Steering Wheel

FRONT SUSPENSION

Front Shock Absorber Replacement

Tool List	Qty.
Wrench, 1/4”	1
Wrench, 9/16”	1
Floor Jack	1
Jack Stands	2
Wheel Chocks	4

1. Lift and support the vehicle (See LIFTING THE VEHICLE on page 9).
2. Remove the nut (1) from the bottom of the shock absorber (2) at the front axle (3) (Ref Fig. 5).
3. Compress the shock absorber to clear the mounting bracket.
4. Remove the nut from the top of the shock absorber at the frame.
5. Remove the shock absorber.

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

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

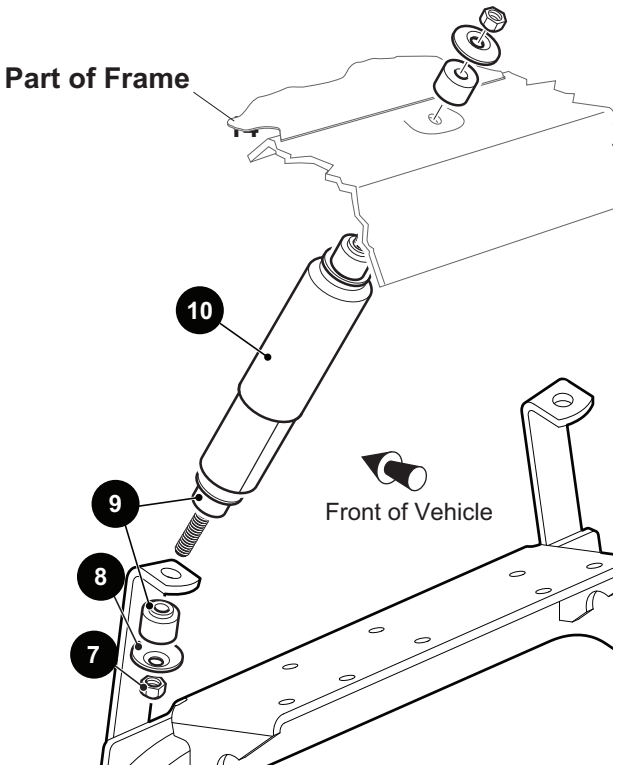


Fig. 5 Shock Absorber

Front Spring Replacement

Tool List	Qty.
Floor Jack	1
Jack Stands	4
Ratchet	1
Socket, 3/4”	1
Socket, 5/8”	1
Wrench, 5/8”	1
Torque Wrench ft. lbs	1
Tape Measure	1

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

The following procedure will replace one spring at a time.

1. Lift and support front of vehicle (See LIFTING THE VEHICLE on page 9)
2. Remove the front wheels.

To detach the driver side spring (20):

3. Fully loosen the two lock nuts (16) on the bellows end of the rack and pinion unit (15) until only one thread is engaged (Ref Fig. 6).
4. Remove the lock nut (19) and washers (14) from the long bolt (47). The rack and pinion unit (15) is now loose.
5. Remove the 1-5/8” long bolts (18) and lock nuts (12) securing the front of the driver side spring (20) to the axle.
6. Hold the nut (21) with a wrench and loosen the long bolt (47). Note the location of the washer (22) and thread the long bolt out as far as possible to remove the washer, nut and spacer (23).
7. Remove the long bolt (47) and spring plate (26) from the axle and spring (20).
8. Pull the upper driver side of the floor mat out of the plastic trim retainer and away from the floor.
9. Remove the lock nuts (27), bolts (29), and spring plate (31) securing the rear of the spring (20) to the vehicle frame.

⚠ 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 installed in its original location (Ref Fig. 6).***

Assemble in the reverse order of removal:

- Make sure to install the long bolt (47), spring plate (26), spacer (23), nut (21) and washer (22) in their original locations.
- Use new lock nuts (16, 19, 27) and wait to torque the hardware until after both springs are aligned.

To detach passenger side spring (25):

1. Remove the lock nuts (11), bolts (17), and spring plate (26) securing the front of the passenger side leaf spring (25) to the axle (Ref Fig. 6).
2. Pull the upper passenger side of the floor mat out of the plastic trim retainer and away from the floor.
3. Remove the lock nuts (28), bolts (24), and spring plate (32) securing the rear of the spring (25) to the vehicle frame.

Assemble in the reverse order of removal using new lock nuts (11, 28).

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 the wheel alignment any time the front-end components are replaced or adjusted.

After installation:

1. Measure the distance from the center bolt (29) at the rear of the left spring to the center bolt (17) at the front of the right spring (Ref Fig. 6).
2. Measure the distance from the center bolt (24) at the rear of the right spring to the center bolt (47) at the front of the left spring.

The two measurements must be equal.

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

3. Tighten the spring hardware (11, 12, 27, 28) first and the rack and pinion unit hardware (16, 19) next. Tighten all hardware to the torque values below.
4. Replace the upper portion of the floor mat in the plastic trim retainers.
5. Install the front wheels (See Wheel Installation on page 13) and lower the vehicle.
6. Check the front wheel alignment and adjust if necessary (See Wheel Alignment on page 36).

Item	Torque Specification
11, 12, 16, 19, 27 28	35 - 50 ft. lbs. (47 - 67 Nm)

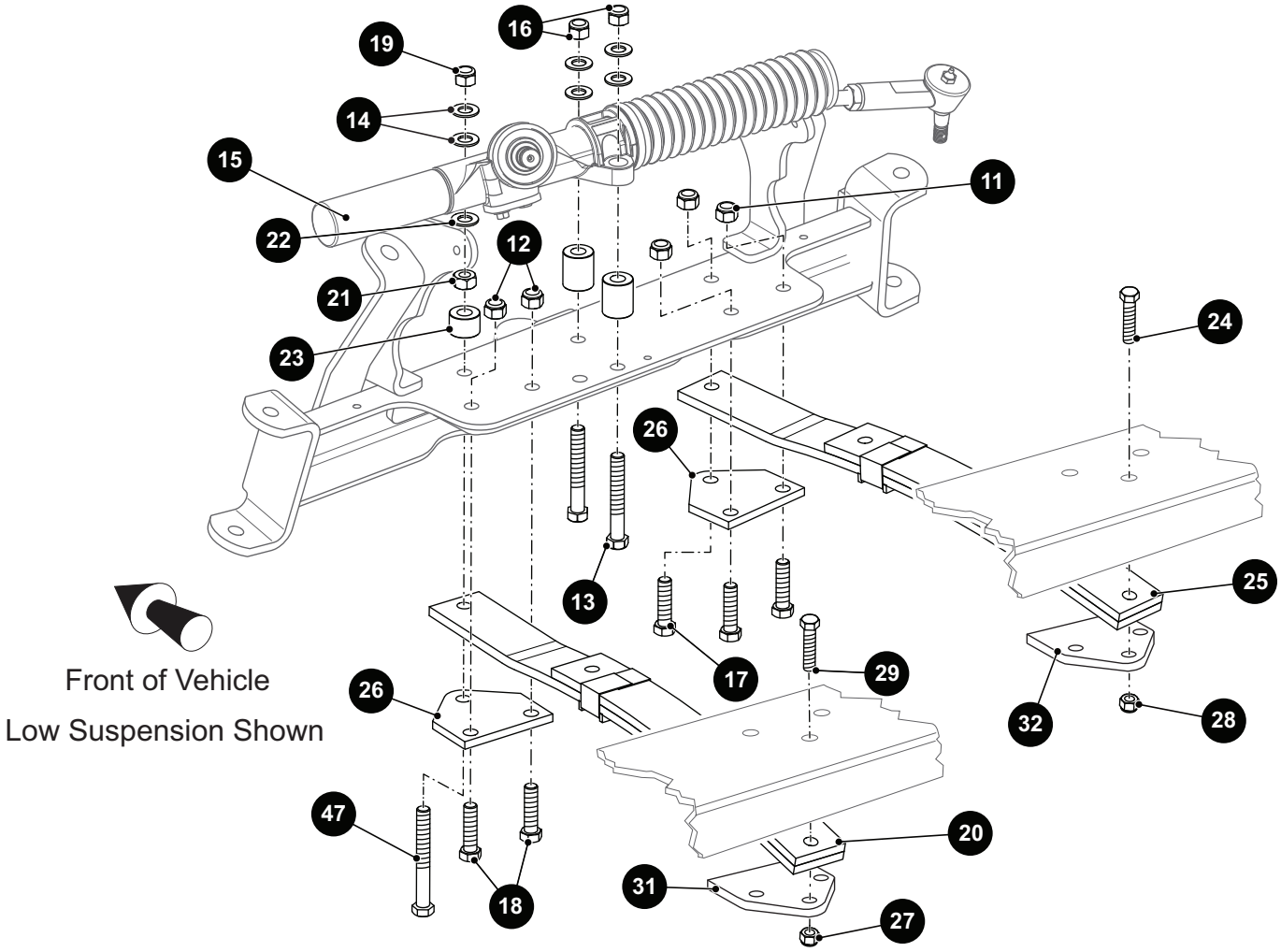


Fig. 6 Leaf Springs

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

Hub Replacement

Tool List	Qty.
Socket, 3/4”	1
Ratchet	1
Straight Blade Screwdriver	1
Ball Peen Hammer	1
Needle Nose Pliers	1
Socket, 1 1/2”	1
Wheel Bearing Grease	AR
Seal Driver	1

1. Lift and support the front of the vehicle and remove the front wheel(s) (See LIFTING THE VEHICLE on page 9).
2. Remove the cotter pin (37) and castellated nut (38) (Ref Fig. 8).
3. While holding the outer wheel bearing (34) in place, slide the hub (30) from the spindle (35).
4. Clean the spindle and new hub thoroughly with solvent.
5. Pack the new bearings with grease (See Wheel Bearing Packing on page 35).
6. Apply a light coat of grease to the inner race and place the inner wheel bearing (33) in the new hub.
7. Orient the new grease seal (36) so that the flange side of the seal is facing into the bore.
8. Tap gently into place until the seal is flush with the end of the hub.
9. Lubricate the lips of the seal and spindle with grease (Ref Fig. 7).

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

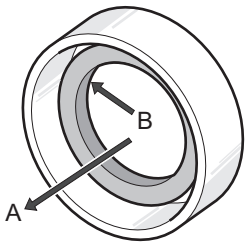


Fig. 7 Seal Installation

10. Place the new hub (30) onto the spindle (35) 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.
11. Install the outer wheel bearing (34) and secure the hub (30) loosely with the castellated nut (37).
12. Place the wheel onto the hub and hand tighten the lug nuts.

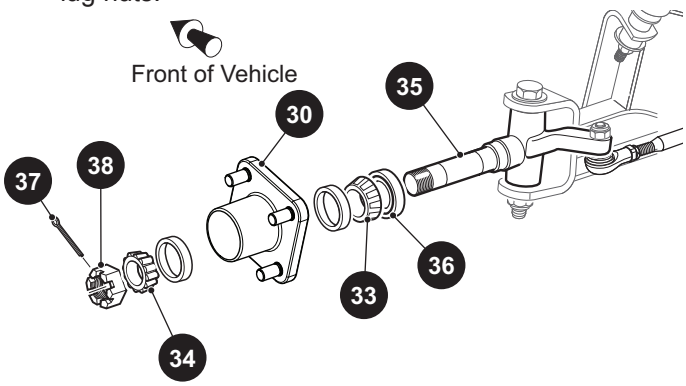


Fig. 8 Hub Replacement

13. Adjust the bearing (See Wheel Bearing Adjustment on page 36).

Wheel Bearing and Race Replacement

Tool List	Qty.
Arbor Press	1
Bearing Driver	1
Non-Ferrous Punch	1
Ball Peen Hammer	1

1. Lift and support the front of the vehicle and remove the front wheel(s) (See LIFTING THE VEHICLE on page 9).
2. Remove the hub (30) from the spindle (See Hub Replacement on page 40).
3. Remove the grease seal (36) and inner wheel bearing (33).
4. Use an arbor press and bearing driver to press out the bearing races.
5. If an arbor press is not available, tap the bearing race using a hammer and a soft non-ferrous punch through the other side of hub. Tap the race in a circular pattern while moving from side to side to avoid damaging the bore of the hub.
6. Clean the outer wheel bearing (34), inner wheel bearing (33) and hub in solvent and dry thoroughly.
7. Inspect for signs of damage. Pitting or a blue coloration of the rollers indicates a failed or failing bearing. If the roller portion of the bearing is to be replaced, the race must also be replaced.
8. Make sure the bore of the hub (30) is clean and place the new race (39) over the bore of the hub.
9. Press the new race into the hub using an arbor press and a bearing driver.
10. If an arbor press is not available, evenly tap with a hammer and a bearing driver to drive race fully into the bore.

11. Repeat on the other side of the hub.
12. Clean the spindle (35) and pack the new bearings with grease (See Wheel Bearing Packing on page 35).

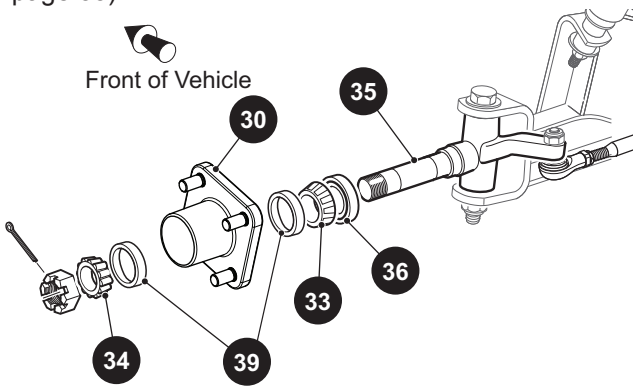


Fig. 9 Wheel Bearing Replacement

13. Install the inner wheel bearing (33) and new grease seal in the hub.
14. Mount the hub to the spindle (See Hub Replacement on page 40).
15. Adjust the bearing (See Wheel Bearing Adjustment on page 36).
16. Lower the vehicle and tighten the front wheel(s) (See Wheel Installation on page 13).

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

STEERING

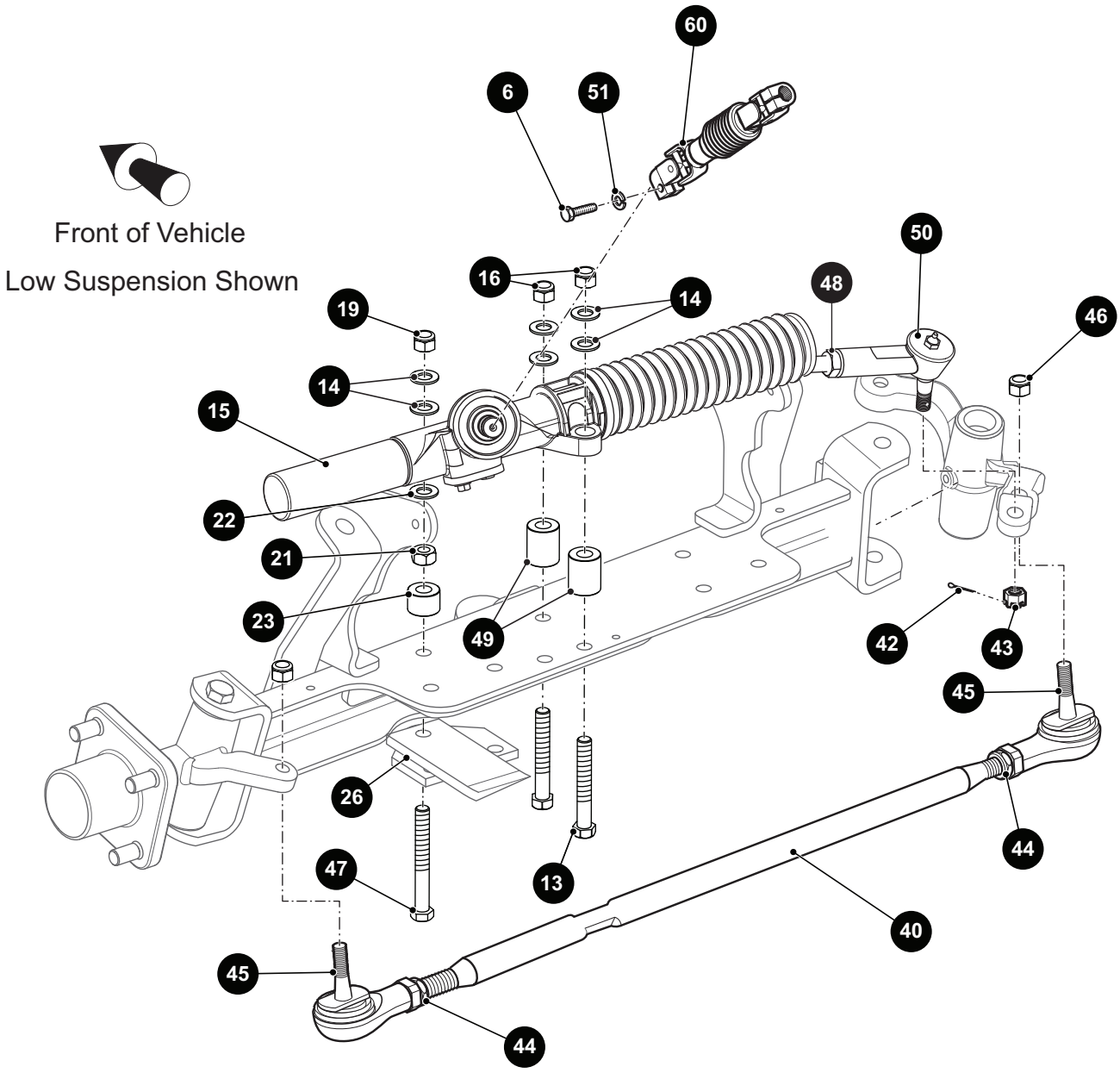


Fig. 10 Steering Components

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

Rack Ball Joint Replacement

Tool List	Qty.
Wrench, 11/16”	1
Wrench, 3/4”	1
Socket, 11/16”	1
Crow’s Foot Socket, 3/4”	1
Pliers, Needle Nose	1
Wire Ties	2
Ball Joint Separator	1
Plastic Faced Hammer	1
Tape Measure	1
Torque Wrench, ft. lbs.	1

1. Loosen the passenger side front wheel and lift and support the front of the vehicle (See LIFTING THE VEHICLE on page 9).
2. Remove the passenger side front wheel and turn the steering wheel fully to the left.
3. Remove the cotter pin (42) and loosen the castellated nut (43) until the rack ball joint (50) threads are protected (Ref Fig. 10).
4. Using a ball joint separator as a lever, apply pressure to the ball joint and tap the nut with a plastic faced hammer to release the ball joint from the passenger side spindle arm.
5. Remove the castellated nut (43) from the ball joint (50).
6. Remove the ball joint (50) from the spindle arm.
7. Cut away the wire ties (53, 52) from the bellows (65) and pull the bellows back to expose the threads on the rack extension (55) (Ref Fig. 13).
8. Measure the amount of threads exposed from the jam nut.

NOTICE: To install new the rack ball joint close to its correct position, measure the amount of threads exposed from jam nut (Ref Fig. 11).

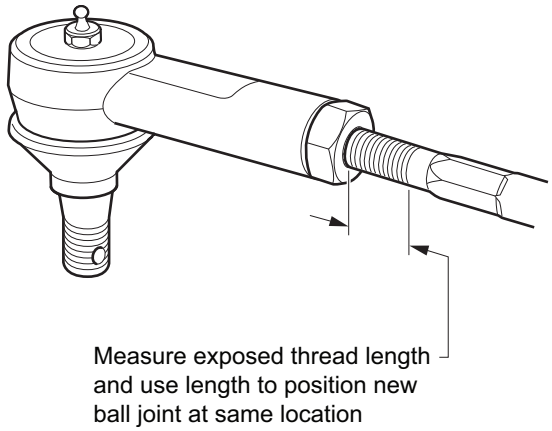


Fig. 11 Rack Ball Joint Installation

9. Loosen the jam nut (48) and remove the rack ball (50) joint from the rack extension (55).
10. Inspect the bellows for cracks and replace if necessary (See Bellows Replacement on page 44).
11. Using the measurement made earlier, thread the jam nut (48) and the new rack ball (50) joint to the previous location on the rack extension (55) and set the jam nut (48) hand tight.
12. Attach the rack ball joint (50) to the spindle arm.
13. Tighten the castellated nut (43) to the torque values listed below and continue to tighten as needed to insert a new cotter pin (42). 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. 32).***

14. Check for proper rack extension-to-rack and pinion unit clearance before tightening the jam nut (48) to the torque settings listed below (See Checking/Adjusting Rack Extension-to-Rack and Pinion Unit Clearance on page 48).
15. Install the passenger side front wheel and lower the vehicle (See Wheel Installation on page 13).
16. Check the front wheel alignment and adjust if necessary (See Wheel Alignment on page 36).

Item	Torque Specification
43	36 ft. lbs. (50 Nm)
48	35 - 45 ft. lbs (47 - 61 Nm)

Tie Rod End Inspection/Replacement

Tool List	Qty.
Tape Measure	1
Wrench, 9/16”	1
Wrench, 11/16”	1
Wrench, 3/4”	1
Socket, 11/16”	1
Crow’s Foot Socket, 3/4”	1
Needle Nose Pliers	1
Ball Joint Separator	1
Plastic Faced Hammer	1
Torque Wrench, ft. lbs.	1

1. Grasp the tie rod (40) at the ball joints (45) and check for any vertical motion which would indicate a worn condition and require replacement (Ref Fig. 10).
2. Lift and support the front of the vehicle and remove the front wheel(s) (See LIFTING THE VEHICLE on page 9).

3. To install the new tie rod ball joint close to its correct position, measure the exposed thread length from the jam nut (Ref Fig. 12).

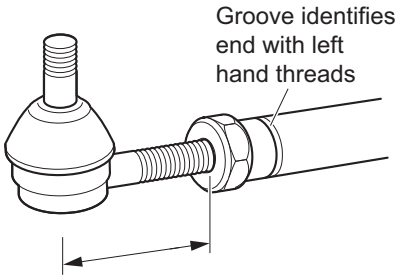


Fig. 12 Tie Rod Replacement

4. Loosen the jam nut (44) at the threaded tube (40).

NOTICE: To hold the threaded tube while loosening jam nut, use a wrench on the center, flat section of tube (Ref Fig. 25).

The tie rod has opposite threads on each end. It is adjusted similar to a turnbuckle. The end with the flat area on the threaded tube has left hand threads (clockwise to loosen) while the end without the flat has conventional right hand threads (counter-clockwise to loosen).

5. Remove the lock nut (46) until tie rod ball joint (45) threads are protected.
6. Using a ball joint separator as a lever, apply pressure to the ball joint and tap the nut with a plastic faced hammer to release the tie rod from the spindle arm.
7. Remove the lock nut to drop the tie rod from the spindle arm.
8. Unscrew the tie rod ball joint and jam nut from threaded tube.
9. Thread on the new jam nut and then, using the measurement made earlier, screw the ball joint to the previous location in the threaded tube.
10. Set the jam nut hand tight.

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

11. Attach the tie rod to the spindle.
12. Tighten the lock nut (46) to the torque values below.
13. Tighten the jam nut (44) to the torque values below.
14. Install the front wheel(s) and lower the vehicle (See Wheel Installation on page 13).
15. A worn tie rod is likely to have caused incorrect wheel alignment. Check the front wheel alignment and adjust if necessary (See Wheel Alignment on page 36).

Item	Torque Specification
44, 46	35 - 50 ft. lbs (47- 67 Nm)

Bellows Replacement

Tool List	Qty.
Needle Nose Pliers	1
Wrench, 11/16”	1
Wrench, 3/4”	1
Socket, 11/16”	1
Crow’s Foot Socket, 3/4”	1
Ball Joint Separator	1
Plastic Faced Hammer	1
Tape Measure	1
Wire Cutters	1
Wire Ties	2
Torque Wrench, ft. lbs.	1

1. Loosen the passenger side front wheel and lift and support the front of the vehicle (See LIFTING THE VEHICLE on page 9).
2. Remove the passenger side front wheel and turn the steering wheel fully to the left.
3. Remove the rack ball joint (50) and jam nut (48) from the rack extension (55) (See Rack Ball Joint Replacement on page 43).
4. Cut the wire ties (53, 52) and slide the bellows (65) off of the rack extension (Ref Fig. 13).
5. Install a new bellows aligning the small end over the groove in the rack extension and secure it with a new wire tie (53).
6. Leave the large end of the bellows loose until the rack the extension-to-rack and pinion unit clearance is checked or adjusted.

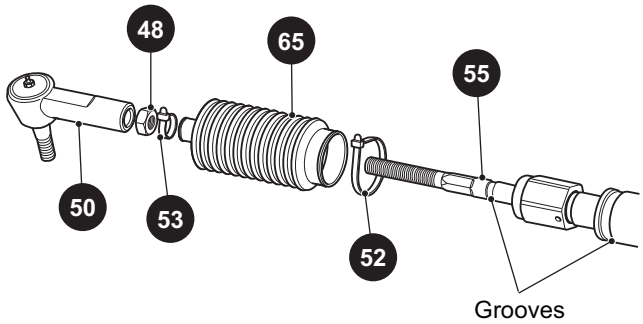


Fig. 13 Bellows Replacement

7. Install the jam nut (48) and rack ball joint (50) on the rack extension (55) and reattach it to the spindle arm.

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

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

8. Check for proper rack extension-to-rack and pinion unit clearance before tightening the jam nut (48) to the torque values below (See Checking/Adjusting Rack Extension-to-Rack and Pinion Unit Clearance on page 48).
9. Secure the large end of the bellows with a new wire tie (52).
10. Install the passenger side front wheel and lower the vehicle (See Wheel Installation on page 13).
11. Check the front wheel alignment and adjust if necessary (See Wheel Alignment on page 36).

Item	Torque Specification
48	35 - 45 ft. lbs. (47 - 61 Nm)
6	155 -215 in. lbs (18-24 Nm)

Rack and Pinion Unit Replacement

Tool List	Qty.
Wrench, 13 mm	1
Wrench, 5/8"	1
Wrench, 11/16"	1
Socket, 13 mm	1
Wrench, 5/8"	1
Wrench, 11/16"	1
Ratchet	1
Needle Nose Pliers	1
Ball Joint Separator	1
Plastic Faced Hammer	1
Torque Wrench, ft. lbs.	1
Torque Wrench, in. lbs	1

1. Loosen the front wheels and lift and support the front of the vehicle (See LIFTING THE VEHICLE on page 9).
2. Remove the front wheels.
3. Remove the bolt (6) and washer (51) securing the intermediate shaft (60) to the rack and pinion unit (15) (Ref Fig. 10).
4. Remove the cotter pin (42) and loosen the castellated nut (43) until the rack ball joint (50) threads are protected.
5. Using a ball joint separator as a lever, apply pressure to the ball joint and tap the nut with a plastic faced hammer to release the ball joint from the passenger side spindle arm.
6. Remove the lock nut from the ball joint and the ball joint from the spindle arm.
7. Remove the lock nuts (16, 19), bolts (13, 47), washers (14), and spacers (49) securing the rack and pinion unit to the front axle.

Assemble in the reverse order of removal using new lock nuts.

Tighten all the hardware to the torque values below. Continue tightening the castellated nut as needed to insert a new cotter pin. Maximum torque is 50 ft. lbs. (70 Nm).

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

8. Set the proper rack extension-to-rack and pinion unit clearance (See Checking/Adjusting Rack Extension-to-Rack and Pinion Unit Clearance on page 48).
9. Install the front wheels and lower the vehicle (See Wheel Installation on page 13).
10. Check the front wheel alignment and adjust if necessary (See Wheel Alignment on page 36).

Item	Torque Specification
16	35 - 50 in. lbs. (47 - 67 Nm)
43	36 ft. lbs. (50 Nm)
6	13 - 18 ft. lbs (18 - 24 Nm)

Pinion Seal Replacement

Tool List	Qty.
Vice	1
Straight Blade Screwdriver, Small	1
Ball Peen Hammer	1
Sandpaper, 600 Grit	AR
Shop Towel	AR
Wheel Bearing Grease	AR
Socket, 1 1/2"	1

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

1. Remove the rack and pinion unit from the vehicle (See Rack and Pinion Unit Replacement on page 45).
2. Anchor in a vice by clamping on the mounting ears of the rack and pinion unit.
3. Slide a small straight blade screwdriver between the lip of the seal and the pinion and pry the top portion of the seal up to remove (Ref Fig. 14).

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

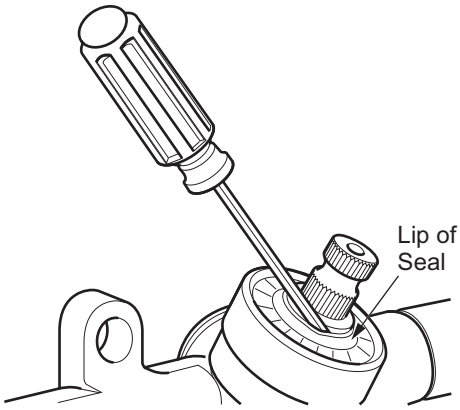


Fig. 14 Pinion Seal Replacement

4. Check the outer pinion surface for roughness and sand lightly if needed.

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

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

5. Place the seal over the pinion and tap it carefully with a socket and hammer to start the seal straight into the bore. Drive the seal fully into the bore until it seats and wipe it clean of any excess grease.
6. Attach the rack and pinion unit to the front axle (See Rack and Pinion Unit Replacement on page 45).

Spindle Replacement

Tool List	Qty.
Wrench, 11/16”	1
Wrench, 3/4”	1
Socket, 11/16”	1
Socket, 3/4”	1
Ratchet	1
Pliers, Needle Nose	1
Ball Joint Separator	1
Plastic Faced Hammer	1
Torque Wrench, ft. lbs.	1

⚠ CAUTION ***The spindle bearings are designed to be lube-free. Lubrication attracts dirt and will ruin the bearings. Do not apply grease to the spindle bearings.***

1. Loosen the front wheel and lift and support the front of the vehicle (See Wheel Installation on page 13).
2. Remove the front wheel.
3. Loosen the lock nut (46) until the tie rod ball joint (45) threads are protected (Ref Fig. 15).
4. Using a ball joint separator as a lever, apply pressure to the ball joint and tap the nut with a plastic faced hammer to release the tie rod from the spindle arm (70).
5. Remove the nut from the tie rod and the tie rod from the spindle arm.
6. If removing the passenger side spindle, repeat the previous step for the rack ball joint.
7. Remove the lock nut (56), washer (57), and bolt (59).
8. Remove the spindle (70) from the axle.
9. Remove the thrust washer (61) and the king pin tube (62) from the spindle.

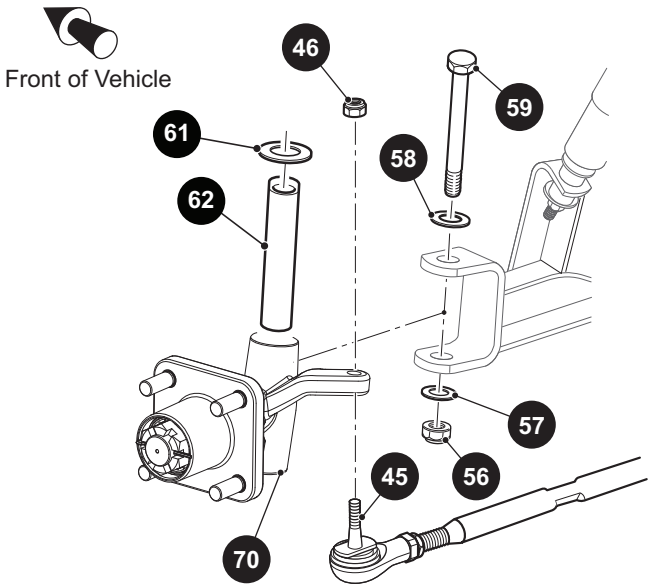


Fig. 15 Spindle Replacement

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

Assemble in the reverse order of removal using new lock nuts.

1. Tighten all hardware to the torque values below.
2. Check that the spindle turns freely on the king pin tube after tightening.
3. Install the front wheels and lower the vehicle (See Wheel Installation on page 13).
4. Check the front wheel alignment and adjust if necessary (See Wheel Alignment on page 36).

Item	Torque Specification
56	56 - 70 ft. lbs. (75 - 95 Nm)
46	35 -50 ft. lbs (47 - 67 Nm)

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

Front Axle Replacement

Tool List	Qty.
Socket, 9/16”	1
Socket, 5/8”	1
Socket, 3/4”	1
Wrench, 1/4”	1
Wrench, 9/16”	1
Wrench, 5/8”	1
Wrench, 11/16”	1
Wrench, 3/4”	1
Ratchet	1
Plastic Faced Hammer	1
Shop Towels	AR
Wire	AR
Torque Wrench, ft. lbs.	1

1. Loosen the front wheels.
2. Lift and support the front of the vehicle (See LIFTING THE VEHICLE on page 9).
3. Remove the front wheels (See Wheel Installation on page 13).
4. Remove the shock absorbers (See Front Shock Absorber Replacement on page 37).
5. Remove the driver side spindle (See Spindle Replacement on page 46).
6. Wrap a towel around the spindle and set the spindle aside.
7. Repeat at the passenger side letting the rack ball joint (50) rest on the front spring to support the spindle.

⚠ WARNING ***To prevent possible injury from falling steering components, secure the rack and pinion unit (15) to the front springs with a 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.

8. Remove the bolt (6) and washer (51) securing the intermediate shaft (60) to the rack and pinion unit (15).
9. Remove the lock nuts (16, 19), bolts (13, 47), and washers (14) securing the rack and pinion unit (15) to the front axle (Ref Fig. 10).
10. Move the rack and pinion unit back to rest on top of the front springs.
11. Secure the rack and pinion unit to the spring with a wire to prevent the intermediate shaft from pulling apart.
12. Remove the lock nuts (11), bolts (17), and spring plate (26) securing the passenger side spring to the axle (Ref Fig. 6).
13. At the long bolt (47) securing the front of the left spring. Note the location of the washer (22) and remove it from end of bolt.
14. Remove the lock nuts (21), hex nut (21), spacer (23), bolts (47, 18) and spring plate (26) securing the driver side spring to the axle.

⚠ 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 installed in its original location.***

Assemble in the reverse order of removal using new lock nuts. All hardware must be installed in its original location. Tighten the shock absorber mounting hardware until the rubber bushings expand to the diameter of the washers. Tighten all other hardware to the torque values below.

Check the front wheel alignment and adjust if necessary (See Wheel Alignment on page 36).

Item	Torque Specification
16, 19, 21	35 - 50 ft. lbs. (47 - 67 Nm)
43	36 ft. lbs (50 Nm)
56	56 - 70 ft. lbs. (75 - 95 Nm)

Rack and Pinion Unit Disassembly and Inspection

Tool List	Qty.
Vice	1
Socket, 3/8”	1
Wrench, 11/16”	1
Wrench, 3/4”	1
Ratchet	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, 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 the rack and pinion unit in a vice by the mounting ears only. The rack and pinion unit is made of aluminum and can be damaged if held otherwise.***

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

1. Remove the rack and pinion unit from vehicle (See Rack and Pinion Unit Replacement on page 45).
2. Anchor in a vice by clamping on the mounting ears of the unit.
3. Remove the screws (63) securing the tensioner assembly (62) in the rack and pinion unit.
4. Remove the tensioner assembly (62) to relieve pressure on the rack (75) and pinion (80).
5. Loosen the jam nut (48) and remove the rack ball joint (50) from the rack extension (55).
6. Cut the wire ties (53, 52) securing the bellows (65) and slide the bellows off the rack extension.
7. Pull the rack gear (75) from the unit.
8. Remove the pinion seal (67) (See Pinion Seal Replacement on page 45).
9. Remove the internal retaining ring (61) from rack and pinion unit.
10. Pull out the pinion gear (80) and ball bearing (64) as an assembly.

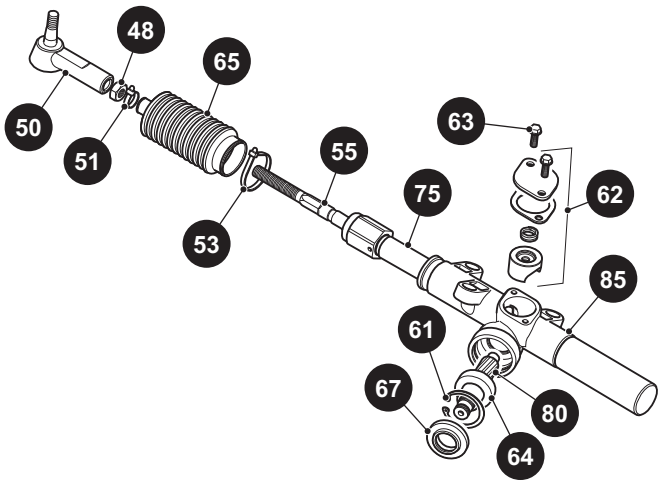


Fig. 16 Rack and Pinion Unit Disassembly

11. Clean the rack (75), pinion (80), and housing (85).
12. Inspect the 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.
13. If the rack and pinion pass inspection, clean them, the tensioner, and the housing thoroughly and lubricate for assembly. Use the grease specified in the tool list.
14. Install the pinion gear (80) and ball bearing (64) assembly in the reverse order of removal, making sure to lubricate the pinion seal lip prior to installing seal (See Pinion Seal Replacement on page 45).
15. Insert the rack gear (75) into the rack and pinion unit. Turn the pinion gear (80) clockwise to help pull the rack in if necessary.
16. Install the bellows (65) and secure to the rack extension (55) with a wire tie (51). **Do not** secure the large end of bellows to the rack and pinion unit until instructed to do so after setting the proper rack extension-to-rack and pinion unit clearance.
17. Install the tensioner (62) and tighten the bolts (63) to the torque values below.
18. Thread the jam nut (48) and rack ball joint (50) to the original location on the rack extension and set the jam nut hand tight.
19. Install the rack and pinion unit on the vehicle (See Rack and Pinion Unit Replacement on page 45).

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

20. Set the proper rack extension-to-rack and pinion unit clearance (See Checking/Adjusting Rack Extension-to-Rack and Pinion Unit Clearance on page 48).

Item	Torque Specification
48	35 - 45 ft. lbs (47 - 61 Nm)
13	100 - 120 in. lbs (11.25 - 13.5 Nm)

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

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

1. Turn the steering wheel fully to the right.
2. The rear spindle arm on the passenger side **must rest against** the front axle (Ref Fig. 17). If it does not, all adjustment is made at the rack ball joint (50) (Ref Fig. 16).

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

3. Loosen the jam nut (48) at the rack ball joint and use a wrench to thread the shaft of the rack extension (55) further into rack ball joint. This will provide more travel for the steering wheel to be turned to the right.

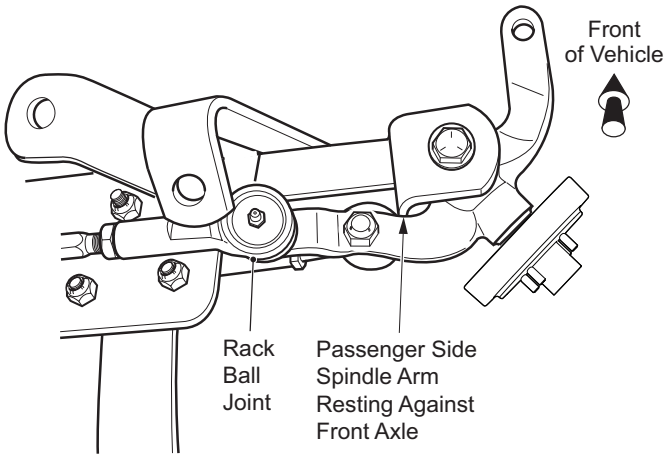


Fig. 17 Spindle Contact with Front Axle

4. With the spindle arm resting against front axle, cut the wire tie (52) securing the bellows (65) to the rack and pinion unit.
5. Slide the bellows away from the rack and pinion unit to see the large hex of the rack extension.
6. An 1/8” gap should exist between the large hex and the end of the rack and pinion unit (Ref Fig. 18).

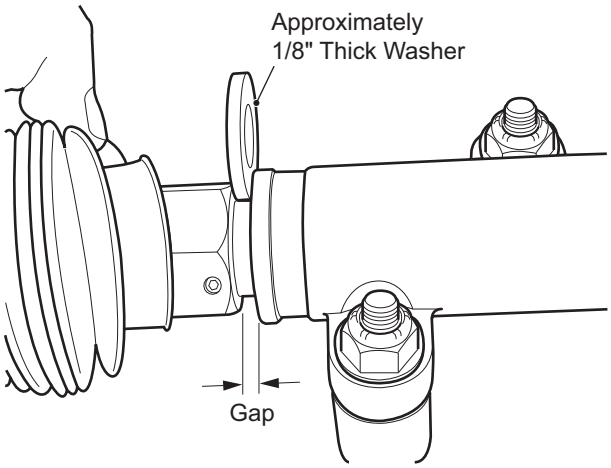


Fig. 18 Checking Gap

7. Adjust, using an 1/8” thick washer as a gauge, by turning the shaft of the rack extension with a wrench to create the 1/8” gap.
8. Tighten the jam nut (48) to the torque values below.
9. Secure the bellows to the rack and pinion unit with a new wire tie (52).

Item	Torque Specification
48	35 - 45 ft. lbs (47 - 61 Nm)

Steering Wheel Replacement

Tool List **Qty.**

Socket, 15/16”.....1
Ratchet.....1
Plastic Faced Hammer.....1
Ball Peen Hammer.....1
Anti-seize Compound.....1
Torque Wrench, ft. lbs.....1

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

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

1. From the front side of the steering wheel (90), pull straight up on the bottom of the steering wheel cover (95) to release the two bottom retaining tabs.
2. Using a thumb for leverage as shown, reach from behind the steering wheel with fingertips to first pull down, and then push up to release the two top steering wheel cover retaining tabs (Ref Fig. 19).

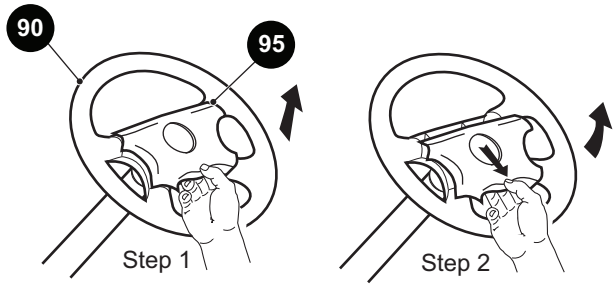


Fig. 19 Steering wheel cover Removal

3. Loosen the steering wheel retaining nut (68) two to three turns until the threads on the steering column shaft are protected (Ref Fig. 20).
4. Apply upward pressure to the steering wheel. Place a plastic faced hammer against the steering wheel nut and strike a plastic faced hammer sharply with a ball peen hammer.

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

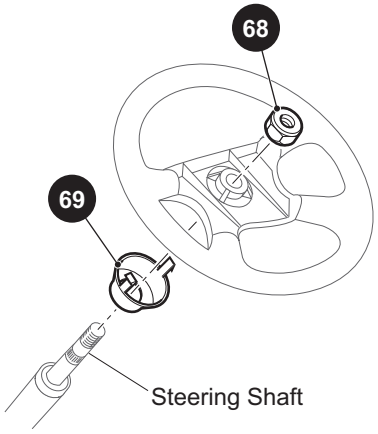


Fig. 20 Steering Wheel Replacement

⚠ 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.***

5. When the steering wheel is loose, remove the retaining nut (68) and remove the steering wheel (90).
6. Prior to replacement, assemble the replacement steering wheel by aligning the retaining tabs on the rear collar hub (69) with the slots in the back of the steering wheel (Ref Fig. 20).
7. Squeeze the tabs to allow insertion of the hub. **Do not force**. Squeeze the hub on top and bottom to fully seat.
8. Lightly coat the splines of the steering shaft with a commercially available anti-seize compound.
9. With the vehicle wheels in the straight ahead position, align the steering wheel on the steering shaft and slide the wheel onto the shaft.
10. Tighten the steering wheel nut (68) to the torque values below.
11. Inspect the four retaining tabs on the clipboard (5) for white stress lines. If stress lines are present, replace the clipboard with a new one.
12. Install by carefully pressing, first the top two, then the bottom two retaining tabs into the matching slots in the steering wheel.

Item	Torque Specification
68	15 - 20 ft. lbs (20 - 27 Nm)

Steering Shaft and Column Replacement

Tool List	Qty.
Wrench, 13 mm	1
Wrench, 9/16”	1
Socket, 13 mm	1
Socket, 9/16”	1
Socket, 15/16”	1
Ratchet	1
Snap Ring Pliers	1
Bearing Separator	1
Gear Puller	1
Arbor Press	1
Bearing Driver Set	1
Torque Wrench, ft. lbs.	1
Wheel Bearing Grease	AR

1. Remove the steering wheel (See Steering Wheel Replacement on page 49).
2. Loosen the front wheels and lift and support the front of the vehicle (See LIFTING THE VEHICLE on page 9).
3. Remove the front wheels.
4. Remove the bolt (6) and washer (49) securing the intermediate shaft (60) to the steering shaft (105).
5. Remove the four bolts (82) and washers (83) that secure the steering column (100) to the chassis and remove the column.
6. Remove the large retaining ring (87) on the bottom end of the column and pull the shaft (105) and bearing (86) out as an assembly.
7. Slide the wave washer (89) out the bottom end of the steering column (100) and retain for reuse during assembly.
8. Remove the small retaining ring (88) and press the bearing from the steering shaft.
9. Press the new bearing onto the shaft until it seats against the shoulder.
10. With the small retaining ring oriented with the arch up, slide the ring onto the shaft as far as possible using snap ring pliers (Ref Fig. 22).
11. Use fingers to seat the retaining ring fully into the groove.
12. Slide the wave washer into the base of the steering column.
13. Apply wheel bearing grease to the lip of the seal in the bushing (81) at the top of the column and press the steering shaft and bearing assembly into the column base.
14. Secure with the large retaining ring (87), making sure it is fully seated in the groove of the column.
15. Place the steering column on the vehicle and tighten the four column bolts (82) to the torque values below.

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

16. Tighten the bolt (6) securing the intermediate shaft (60) to the steering shaft (105) to the torque values below (Ref Fig. 21).
17. Install the front wheel(s) and lower vehicle (See Wheel Installation on page 13).
18. Install the steering wheel (See Steering Wheel Replacement on page 49).

Item	Torque Specification
Jam Nut	45 - 55 in. lbs. (5 - 6 Nm)
6	155 -215 in. lbs (18-24 Nm)

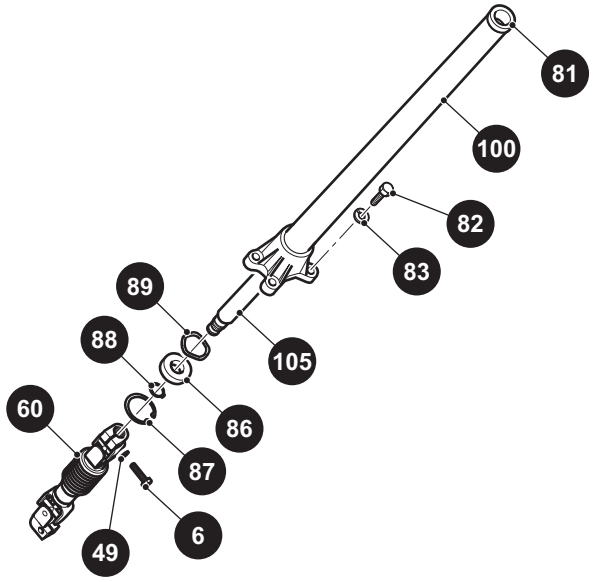


Fig. 21 Steering Shaft and Column

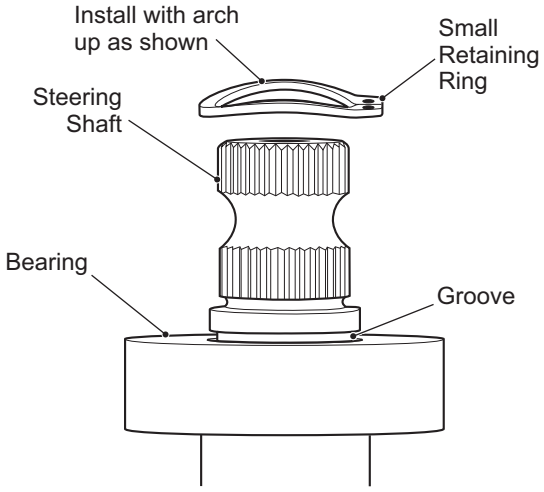


Fig. 22 Small Retaining Ring Orientation

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

Notes:

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

BATTERIES AND BATTERY CHARGER

SAFETY

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

⚠WARNING ***To prevent a 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 keyswitch is in the off position and all electrical accessories are disabled before servicing the vehicle.

Never disconnect an active circuit 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 caution not to tip the batteries when removing or installing them; spilled electrolyte can cause burns to skin and damage to the vehicle.

The electrolyte in a battery is an acid solution which can cause severe burns to the skin and eyes. Treat all electrolyte contact 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 then flushed with clean water (Ref Fig. 7).

Overfilling a battery can result in electrolyte being expelled from the battery during the charge cycle. Expelled electrolyte can cause damage to the vehicle and storage facility.

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

Use insulated wrenches 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 able to produce electricity as the result of a chemical reaction. This chemical reaction releases stored chemical energy in the form of electrical energy. The chemical reaction occurs faster in warm conditions and slower in cold conditions. Temperature is important when conducting tests on a battery. Test results must be corrected to compensate for temperature differences.

As a battery ages, it still may perform adequately, but 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.

BATTERIES AND BATTERY CHARGER

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

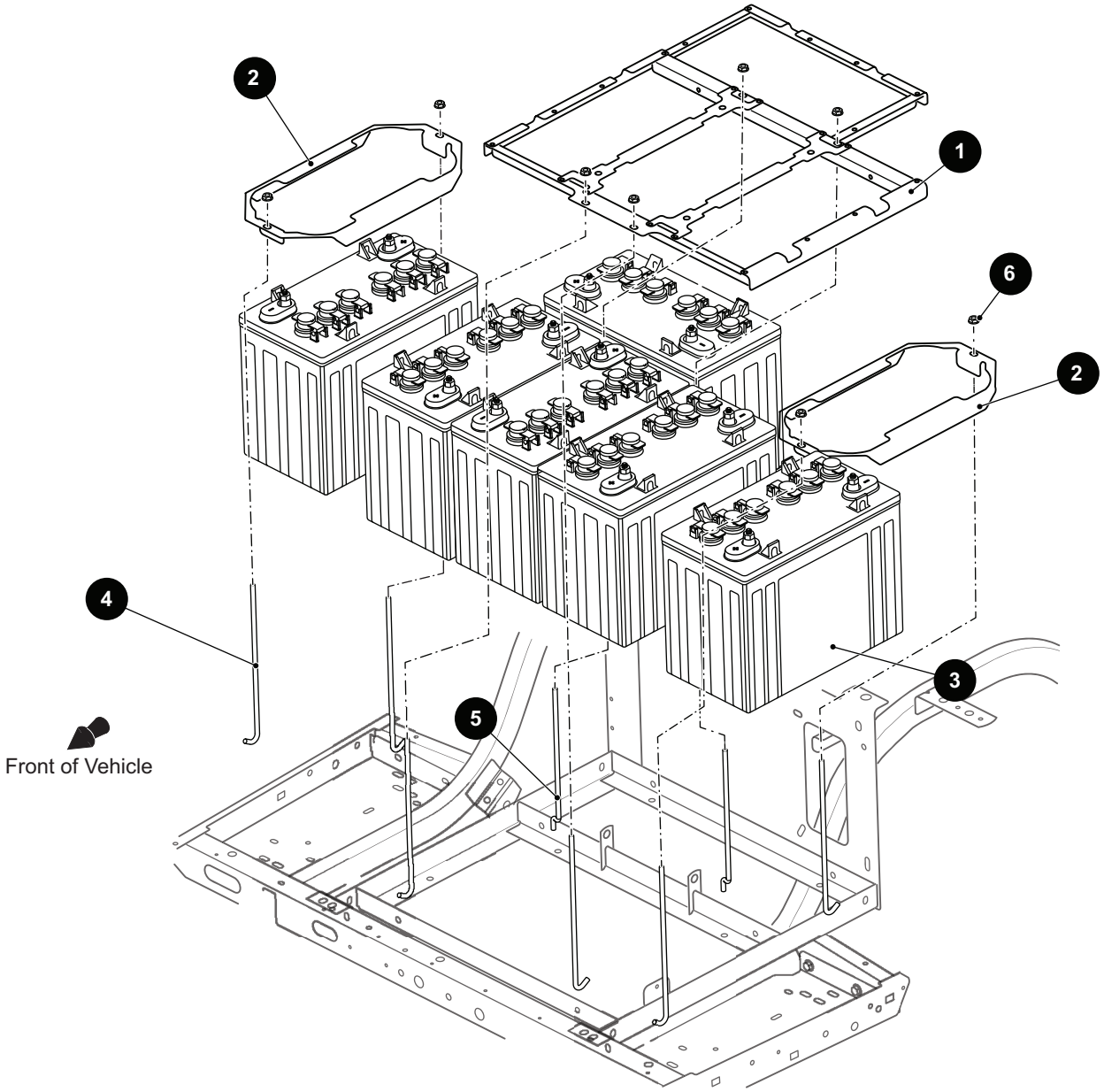


Fig. 1 Battery System

Batteries Removal

Tool List	Qty.
Insulated Wrench, 1/2”	1
Insulated Wrench, 9/16”	1
Insulated Socket, 1/2”,	1
Insulated Socket, 9/16”	1
Ratchet	1
Battery Carrier	1
Torque Wrench, ft. lbs.	1
Torque Wrench, in. lbs.	1
Putty Knife	1
Wire Brush	1
Terminal Spreader	1

NOTICE: Hardware that is removed must always be installed in its original position unless otherwise specified. If torque values are not specified, refer to the Torque Specifications table (See TORQUE SPECIFICATIONS on page 5).

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

⚠ WARNING ***Use insulated wrenches 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.***

Make sure that the key switch is in the OFF position and remove the key from vehicle. Make sure all electrical accessories are deactivated.

1. Remove the negative (-) cable (11).
2. Remove the positive (+) cable (8).
3. Remove the nuts (6) and hold down bolts (4) from the battery hold downs (2) and battery bracket (1).
4. Remove the batteries (3) using a battery carrier (Ref Fig. 1).
5. Remove all corrosion from the terminals and hardware with a putty knife and wire brush.
6. Wash the area with a solution of sodium bicarbonate (baking soda) and water and thoroughly dry.
7. Apply a corrosion resistant paint to the battery racks and surrounding area.

Battery Installation

1. Place the batteries (3) in the battery racks.
2. Install the battery hold downs (2) and battery bracket (1) with the hold down bolts (4).
3. Tighten the lock nuts (6) to torque values below, tight enough to prevent movement of the battery but not tight enough to cause distortion of the battery cases.
4. Inspect all wires and terminals.
5. Clean any corrosion from the battery terminals or the wire terminals with a solution of sodium bicarbonate (baking soda) and a wire brush.
6. Connect the battery wires as shown (Ref Fig. 2). Be sure that all battery terminals are installed with the crimp upward.
7. Tighten the battery terminal hardware to the torque values below.

Item	Torque Specification
Lock Nut (6)	16 - 19 ft. lbs. (22 - 26 Nm)
Battery Terminal Hardware	90 - 110 in. lbs. (10 - 12 Nm)

⚠ CAUTION ***Do not overtighten the battery terminal clamps. This will cause a "mushroom" effect on the battery post, preventing the terminal nut from being properly tightened. Protect the battery terminals and battery wire terminals with a commercially available protective coating.***

⚠ WARNING ***Aerosol containers of battery protector spray must be used with extreme caution. Insulate the metal container to prevent the can from contacting any battery terminals which could result in an explosion.***

After installing the batteries, coat terminals with a commercially available terminal protector spray.

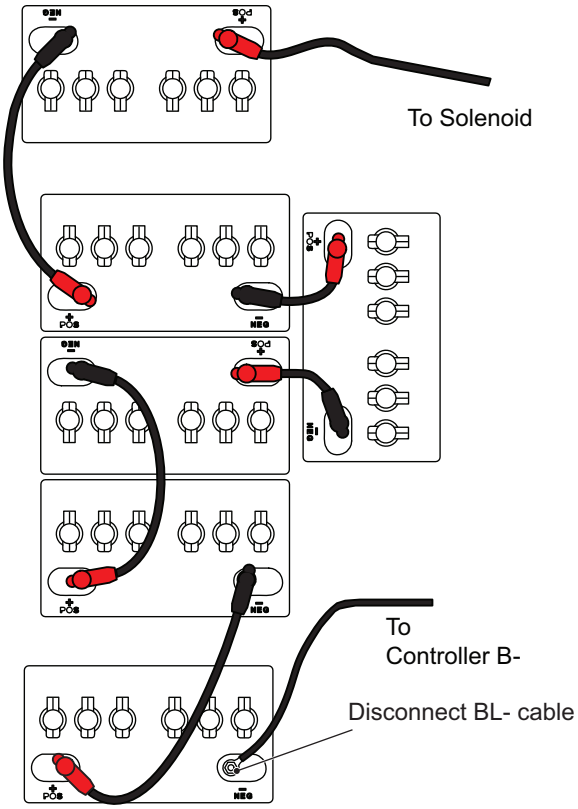


Fig. 2 Battery Connections

BATTERIES AND BATTERY CHARGER

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

BATTERY MAINTENANCE

Tool List	Qty.
Insulated Wrench, 9/16”	1
Battery Carrier	1
Hydrometer	1
Battery Maintenance Kit P/N 25587G01	1
Battery Protective Spray	1
Torque Wrench, in.lbs	1
Insulated Socket, 9/16”	1
Ratchet	1

At Each Charging Cycle

Before charging the batteries, inspect the battery charger connector and vehicle receptacle housing for dirt or debris. Clean with compressed air if necessary.

Charge the batteries after each day of use.

Monthly

- Inspect all wiring for fraying, loose terminals, corrosion, and worn or missing insulation.
- Check that the electrolyte level is correct and add suitable water as required.
- Clean the batteries and wire terminals.
- Tighten the battery terminal nuts to 90 - 110 in. lbs. (10.2 - 12.4 Nm).
- Spray the battery terminals with a commercially available battery protective spray.
- Install all terminal covers.

Temperature Affects Battery Capacity

The battery storage capacity is affected by the temperature. The colder the temperature, the less energy the battery is able to store. As the temperature increases, so does the storage capacity of the battery (Ref Fig. 3).

The ideal battery temperature for deep cycle batteries is 77°F (25°C). At 32°F (0°C), the storage capacity of the battery will be reduced by 20%, meaning the vehicle will not travel as far in cold weather as it will in warm weather.

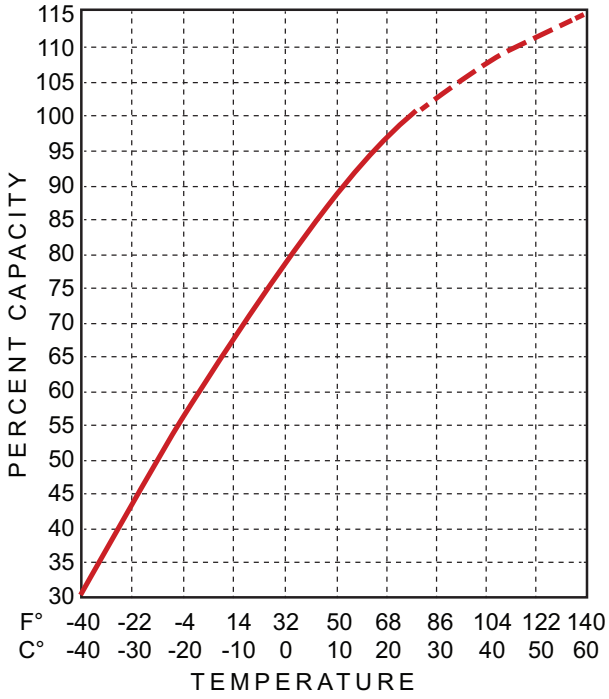
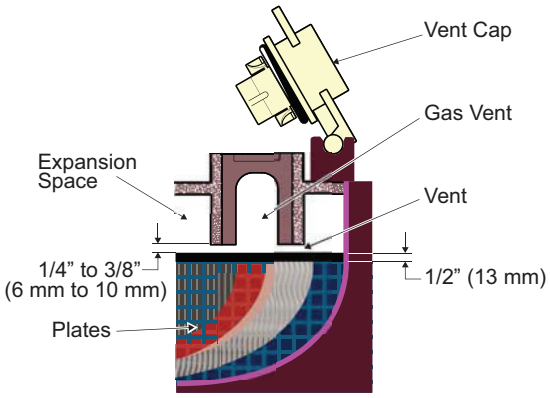


Fig. 3 Temperature Effects

Electrolyte Level and Water

The correct level of the electrolyte is 1/2” (13 mm) above the plates in each cell (Ref Fig. 4).

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. Any portion of the plates that become exposed to air will be irreparably damaged. Too much water will force electrolyte out of the battery due to gassing and the increase in electrolyte volume that results from the charging cycle.



Electrolyte level should be at least 1/2” (13mm) above the plates and 1/4” to 3/8” (6 to 10 mm) below vent.

Fig. 4 Correct Electrolyte Level

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

⚠ WARNING ***Do not overfill the batteries. The charging cycle will increase electrolyte volume and force it out of the battery and damage surrounding components.***

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 the electrolyte 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. 5).

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. 5 Water Purity Table

Even if the water is colorless, odorless, tasteless and suitable for drinking, it should be analyzed to see that it does not exceed the impurity levels specified in the water purity table (Fig. 5).

Automatic watering devices such as the one included in the Battery Maintenance Kit (P/N 25587G01) can be used with an approved water source (Ref Fig. 6). These watering devices are fast and accurate to use and maintain the correct electrolyte level within the battery cells.

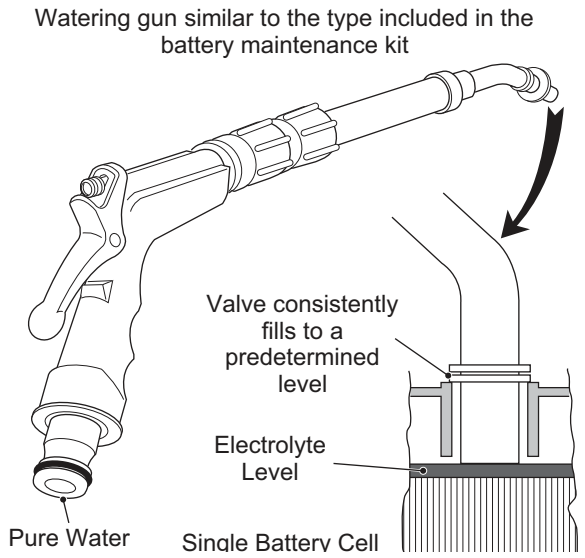


Fig. 6 Automatic Watering Gun

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 exterior 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 transfer acid from the top of the batteries to another area of the vehicle or storage facility, where it will attack the structure or floor. After spraying down the batteries, a conductive residue will remain on the batteries which 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 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. 7). In addition to the batteries, spray all metal components adjacent to the batteries with the sodium bicarbonate (baking soda) solution.

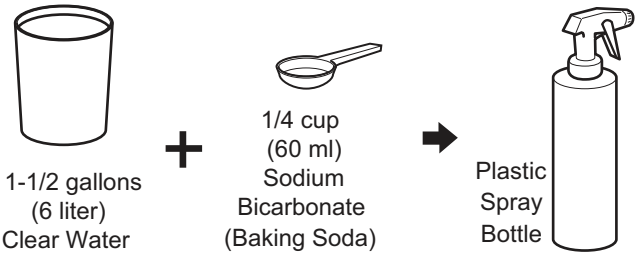


Fig. 7 Preparing Acid Neutralizing Solution

Leave the solution on the batteries for a minimum of three minutes. Use a soft bristle brush or cloth to clean the tops of the batteries to remove any residue that could cause the self discharge of the battery. Rinse the entire area with low pressure clear water. All items required for complete battery cleaning and watering are included in the Battery Maintenance Kit (P/N 25587G01).

Cleaning should be done once a month or more often under extreme conditions.

Prolonged Storage

Prior to prolonged storage, the battery charger, controller, and all other electronic devices must be disconnected. Otherwise, they will contribute to the premature discharge of batteries.

The batteries need to be maintained to prevent discharge during periods of storage.

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 0.002 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 (usually less than 20 days), it should be recharged. If a battery is left in a discharged state, sulfating takes place on and within the plates. Sulfating will cause permanent damage to the battery. To prevent damage, the battery should be recharged. A hydrometer (P/N 50900G1) can be used to determine the specific gravity, and therefore the state of charge of a battery.

In cold conditions, the battery must be fully charged to prevent the possibility of freezing (Fig. 8). 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.

Disconnect the charger connector from the vehicle receptacle.

Clean the batteries and neutralize and remove all deposits from the battery case to prevent self discharge. The batteries should be tested or recharged at thirty day minimum intervals.

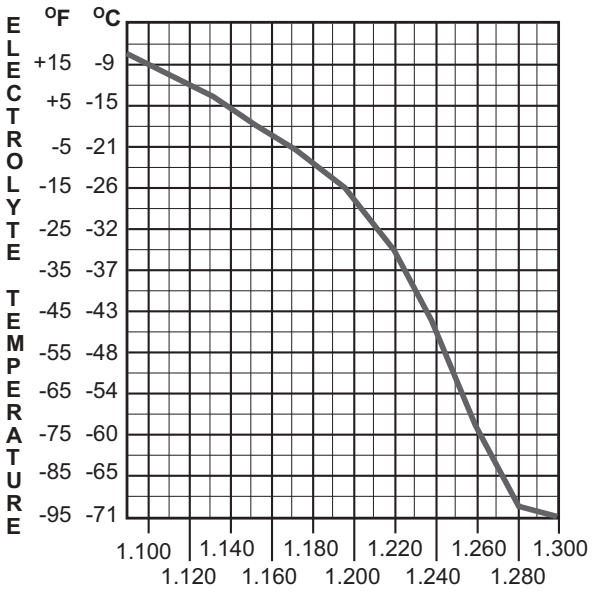


Fig. 8 Freezing Point of Electrolyte

Battery Charging

The battery charger is designed to fully charge the battery set. Some automatic battery chargers contain an electronic module that can not activate if the batteries are severely deep cycled. Automatic chargers will determine the correct duration of charge to the battery set and will shut off automatically when the battery set is fully charged. Always refer to the manufacturer's instructions of the specific charger used.

Before charging, the following should be observed:

⚠ CAUTION ***Do not overfill the batteries. The charging cycle will increase electrolyte volume and force it out of the battery and damage surrounding components.***

- The electrolyte level in all cells must be at the recommended level and the plates covered (See Electrolyte Level and Water on page 56).
- Charging must be done 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 must be in good condition and free from dirt or debris.
- The charger connector must be fully inserted into the vehicle receptacle.
- The charger connector and cord set must be protected from damage and located in an area to prevent injury resulting from personnel running over or tripping over the cord set.

- The charger is automatically turned off during the connect/disconnect cycle. Therefore, no electrical arc is generated at the DC plug/receptacle contacts.

NOTICE: In some portable chargers, an audible rattle is present in the body of the charger DC plug. This rattle is caused by an internal magnet 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 charging receptacle.

AC Voltage

The battery charger output is directly related to the input voltage. If the vehicle routinely receives an incomplete charge in a normally adequate time period, low AC voltage could be the problem. Consult the electrical provider.

FAULT TESTING

Fault testing is done for two distinct reasons:

- 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.
- Determine why a particular vehicle does not perform adequately. Performance problems can cause a vehicle to operate slowly or be incapable of operating for the time required.

A new battery must **mature** before it will develop its maximum capacity. Maturing can take up to 100 charge/discharge cycles. After the maturing phase, as the battery ages, its capacity diminishes. The only way to determine the capacity of a battery is to perform a load test using a discharge machine following the 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 problematic cell or cells are identified, the suspect battery can be removed and replaced. At this point there is nothing that can be done to save the battery. The individual battery should be replaced with a good battery of the same brand, type, and approximate age.

Hydrometer

A hydrometer (P/N 50900G1) is used to test the state of charge of a battery cell (Ref Fig. 9). 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 a battery explosion that could result in severe personal injury or death. Never insert a metal thermometer into a battery. Use a hydrometer with a built in thermometer that is designed for testing batteries.***

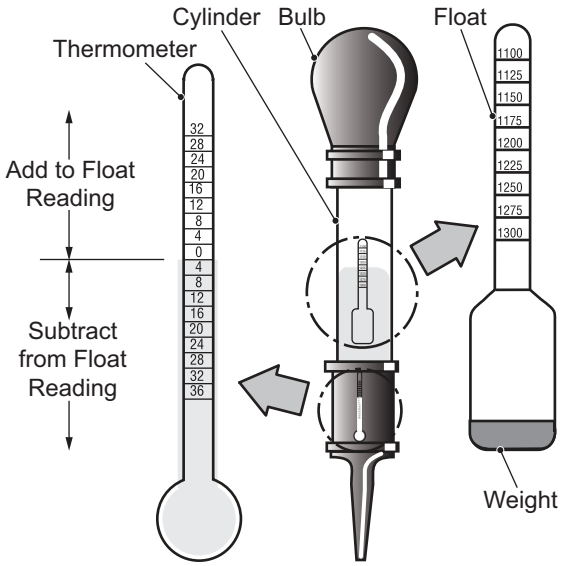


Fig. 9 Hydrometer

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 vehicle 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. A discharged battery will read in the 1.140 range.

NOTICE: Do not perform a hydrometer test on a battery that has just been filled. The battery must go through at least one charge and discharge cycle in order to allow the water to adequately mix with the electrolyte.

The temperature of the electrolyte is important. 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.

BATTERIES AND BATTERY CHARGER

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

⚠ WARNING ***The electrolyte in a battery is an acid solution which can cause severe burns to the skin and eyes. Treat all electrolyte contact 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 using a hydrometer to test the electrolyte solution.

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 then flushed with water (Ref Fig. 7).

Using Hydrometer

1. Draw the electrolyte into the hydrometer several times to permit the thermometer to adjust to the electrolyte temperature and note the reading.
2. Examine the color of the electrolyte. A brown or gray color indicates a problem with the battery and indicates the battery is nearing the end of its life.
3. 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.
4. Hold the hydrometer in a vertical position at eye level and note the reading where the electrolyte meets the scale on the float.
5. 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. 10).
6. Test each cell and note the readings (corrected to 80° F or 27° C). A variation of fifty points between any two cell readings (example 1.250 - 1.200) indicates a problem with the low reading cell(s). As a battery ages the specific gravity of the electrolyte will decrease at full charge. This is not a reason to replace the battery, providing all cells are within fifty points of each other.

Since the hydrometer test is in response to a vehicle showing 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.

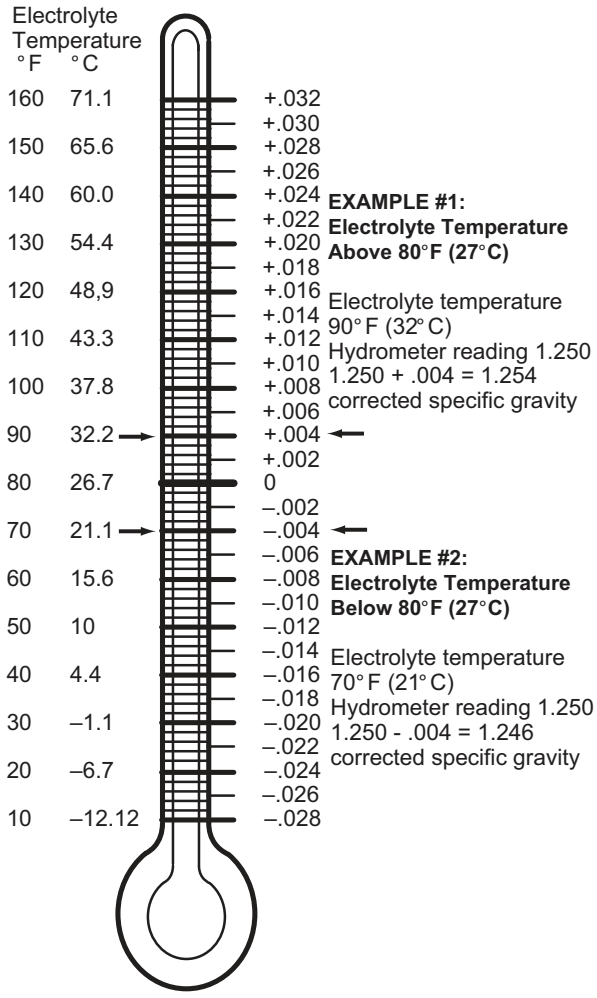


Fig. 10 Hydrometer Temperature Correction

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

BATTERY CHARGER

Charger Description

The battery charger supplied with the vehicle is a Delta-Q Technologies QuiQ 72V charger. It is a fully automatic battery charger and is designed specifically for charging electric vehicle batteries. Use the charger on 72V battery systems only.

Instructions are printed on the charger for daily reference. A manual provided by the charger manufacturer is shipped with the charger.

For information regarding the battery charger, including charging instructions, LED display explanations, fault testing, and ordering replacement parts, refer to the charger manual or contact the manufacturer directly (See BATTERY CHARGER USER'S GUIDE on page 139).

Portable Charger Installation

⚠WARNING ***Use charger only on 72 volt battery systems. Other usage can cause personal injury and damage.***

Lead acid batteries can 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 of the battery manufacturer's specific precautions such as recommended rates of charge and removing or not removing cell caps while charging.

⚠ DANGER ***Risk of electric shock. Connect the 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 the risk of electric shock – do not use ground adapters or modify the plug. Do not touch the uninsulated portion of output connector or an uninsulated battery terminal. Disconnect the DC supply before making or breaking the connections to the battery while charging.***

Do not open or disassemble the charger.

Do not operate the charger if the AC supply cord is damaged or if the charger has received a sharp blow, been dropped, or is otherwise damaged in any way. Refer all repair work to qualified personnel.

The charger is 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 above the ground to permit maximum air flow around and underneath the charger. For optimum performance and the shortest charge times, put the charger in an area with adequate ventilation. The charger should also be installed in an area that will be relatively free of dirt, mud, or dust. Accumulations within the charger vents will reduce their heat dissipating qualities.

The status display of the charger must be visible to the user.

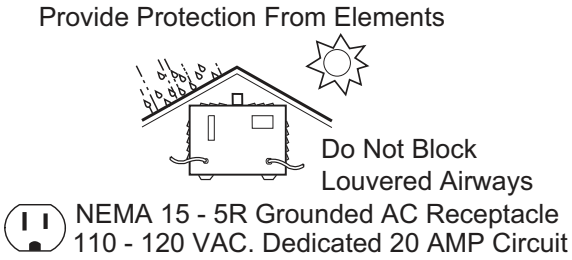


Fig. 11 Charger Installation

The charger can remain connected to 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 connected. The charger will automatically stop when the batteries are fully charged, and the DC plug can be removed from the vehicle.

NOTICE: Routing the DC cord through the steering wheel when charging the batteries, serves as a good reminder to store the cord out of the way when charging is complete. The DC plug can be damaged by driving over or catching the cord on the vehicle when driving away.

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

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

Notes:

ELECTRONIC SPEED CONTROL

PERFORMANCE

NOTICE: The vehicle will operate only when the key-switch is in the ON position. The vehicle's top speed is sensed and regulated directly by the controller and the feature to slow the vehicle when the accelerator pedal is up is mild.

Speed Control

⚠WARNING ***To prevent the possibility of loss of control that could cause severe injury or death, use the service brake to control the speed. The speed control system is not a substitute for the service brake.***

Speed control system vehicles are equipped with a regenerative motor control system.

Example: If all of the following events occur:

- the vehicle is being driven down a slope
- the vehicle attempts to exceed the specified top speed with the accelerator pedal pressed **or** released

the regenerative brake will limit the speed of the vehicle to the specified top speed but the warning beeper will **not** activate. When the regenerative braking system is activated by this sequence of occurrences, the motor generates power which is returned to the batteries.

If the operator attempts to override the electronic brake by moving the key switch to another position, the vehicle will slow **rapidly** until it reaches the speed of approximately 2 mph (3 kph).

Pedal-Up Braking

Pedal-up braking is regenerative braking that occurs when the accelerator pedal is released while the vehicle is moving.

Example: If all of the following events occur:

- the vehicle is being driven down a slope
- the accelerator pedal is released

the pedal-up braking decreases speed until the vehicle stops or the accelerator pedal is applied.The warning beeper will **not** activate. When pedal-up braking is activated by this sequence of occurrences, the motor generates power which is returned to the batteries.

Walk-Away Feature

Walk-Away limits the movement of the vehicle without driver input, decreases vehicle speed to 2 mph (3 kph), and activates an alarm.

Example: If all of the following events occur:

- the vehicle is stopped for more than 2 seconds
- the accelerator pedal is released for more than one second
- the vehicle begins to move at more than 2 mph (3 kph)

the Walk-Away feature limits the speed to approximately 2 mph (3 kph) and the warning beeper activates. When the accelerator pedal is pressed, the walk-away feature and warning beeper stops and normal vehicle operation continues.

Anti-Roll Back Feature

Anti-Roll Back, like Walk-Away, limits reverse motion of the vehicle down a slope to less than 2 mph (3 kph). See 'Walk-Away Feature' above. An alarm will not be activated should the Anti-Roll Back feature engage.

Anti-Stall Feature

Anti-Stall protection prevents motor damage if the vehicle is stalled against an object or on a hill.

Example: If all of the following events occur:

- the system senses that the accelerator pedal is pressed (power applied to motor)
- the motor is stopped long enough that additional time can cause damage to the motor.

the Anti-Stall feature will interrupt power to the motor. This brief interruption will permit the vehicle to roll backwards slightly before again stopping in the stalled condition. To restore power to the motor, power cycle the keyswitch to the OFF position and back to the ON position.

High Pedal Disable Feature

High pedal disable prevents acceleration of the vehicle if the key switch is in the ON position while the accelerator pedal is pressed.

Diagnostic Mode Feature

Diagnostic Mode helps with fault testing.

With some electrical system failures, the Diagnostic Mode feature defaults to a mode that allows the vehicle to operate at a decreased speed.

This feature allows the vehicle to be driven back to the storage facility for problem diagnosis.

The technician can put the controller in diagnostic mode and the controller will report the likely failure.

ELECTRONIC SPEED CONTROL

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

OPERATION

With the key switch in the OFF position:

- the controller is deactivated
- the electronic braking system is deactivated allowing the vehicle to roll freely
- the reverse warning beeper is deactivated

With the key switch in ON position:

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

NOTICE: 72 volt vehicles operate only with the keyswitch in the ON position.

If all of the following events occur with the keyswitch in the ON position

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

the Walk-Away feature will limit speed to approximately 2 mph (3 kph) and the warning beeper activates. When the accelerator pedal is pressed, the electronic braking and warning beeper is overridden and normal vehicle operation resumes.

⚠WARNING ***To prevent the possibility of loss of control that could cause severe injury or death, always use the service brake to control speed. The controller system is not a substitute for the service brake.***

If all of the following events occur with the key switch in the ON position

- the vehicle is being driven down a slope
- the vehicle speed exceeds the designed speed with the accelerator pedal pressed **or** released

the regenerative brake will limit the speed of the vehicle to the designed speed range (the warning beeper will **not** sound). When the electronic braking system is activated by this sequence of events, the motor generates power which is returned to the batteries. 72 volt models are equipped with a regenerative motor control system.

The speed of the motor 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 reduce the speed of the vehicle through regenerative braking.

If the operator attempts to override the regenerative brake 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 system is a low power consumption unit but it will drain the vehicle batteries over a period of time. If the vehicle is to be stored for a prolonged period of time, the controller should be disconnected from the batteries by setting the key switch to the OFF position.

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:

1. Remove the rocker panel.
2. Lift the floor mat.
3. Remove the access cover from the floor (Ref Fig. 1).
4. The ITS and plunger are accessed by removing the four screws and top cover from the enclosed pedal box.

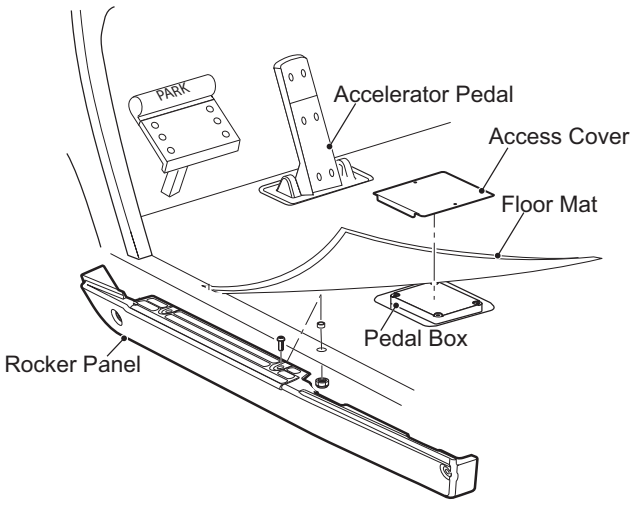


Fig. 1 Access to Pedal Box

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

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.

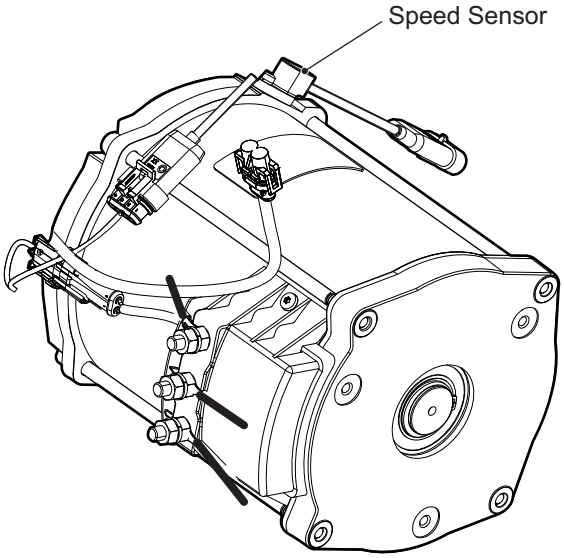


Fig. 2 Speed Sensor

Controller

The controller is a solid state unit that activates a solenoid and controls the function of the vehicle by responding to inputs from the ITS and motor speed sensor. The controller and solenoid are located under the front facing rear seat on the rear-driver side of the under seat compartment.

The pedal box and the speed sensor are connected to the controller through a 35-pin connector on the controller.

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.

GENERAL FAULT TESTING

Testing

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

A series of blinks will indicate the fault code (one, two, three, four or five followed by a pause and one, two, three, four or five more blinks). By reading the decal attached near the controller, or by reading the Diagnostic Mode Fault Code chart, the likely fault, symptom(s), and corrective action to be taken can be found (See LED Fault Code Chart on page 133).

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

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

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

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

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

For static tests, raise the rear wheels of the vehicle and support the vehicle on jack stands. Test the vehicle stability before proceeding (See LIFTING THE VEHICLE on page 9).

Place the keyswitch in the F position. Press the accelerator pedal until the micro switch in the pedal box activates causing the solenoid mounted to the controller to make an audible click. If the solenoid does not click, test the batteries (See Testing Battery Voltage on page 83).

INDUCTIVE THROTTLE SENSOR (ITS) TESTING AND REPLACEMENT

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

1. Lift and support the vehicle (See LIFTING THE VEHICLE on page 9).
2. Remove the driver side rocker panel insert and pull the floormat forward to expose the metal cover to the pedal box.
3. Remove the metal cover and remove the four screws securing the plastic cover to the pedal box (Ref Fig. 3).

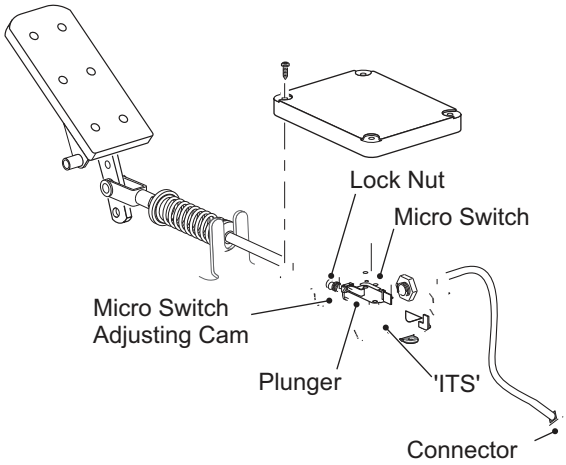


Fig. 3 ITS and Plunger

4. With the DVOM set to volts, probe the white wire at the ITS with the positive (+) probe and attach the negative (-) probe to the negative (-) battery terminal.
5. Place the keyswitch in the F.
6. Press 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 caution not to overtighten the nuts which could strip the plastic studs while tightening the nuts enough to prevent movement of the ITS.***

7. Carefully remove the two wires that attach to the ITS and carefully remove the nuts securing the ITS to the plastic pedal box studs.
8. Install a new ITS being careful to align the ITS and not to overtighten the retaining nuts.
9. Attach the wiring.
10. 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.
11. If the plunger needs adjustment, loosen the lock nut at the accelerator yoke and rotate the plunger until the desired dimension is achieved.
12. Firmly tighten the jam nut.
13. Replace the plastic cover and press it firmly into place before tightening the cover screws.
14. Replace the metal cover, floormat and rocker panel insert.

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

Notes:

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

Notes:

MOTOR

GENERAL

⚠ CAUTION ***Do not use the accelerator and motor to hold the vehicle on a hill. Leaving the motor in a stalled condition for more than 3-4 seconds can cause permanent damage.***

Disassembly of the motor is not recommended.

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

⚠ WARNING ***Disconnect the negative (-) battery cable with an insulated wrench before removing wires from the motor. A short-circuit of the motor wires can cause an explosion.***

Motor Removal

Tool List	Qty.
Wrench, 10mm	1
Insulated Wrench, 9/16”	1
Chalk or Paint Pen	1
Socket, 10mm	1
Ratchet	1
Torque Wrench, in. lbs.	1

1. Use an insulated wrench to disconnect the negative (-) battery cable from the battery (Ref Fig. 1).
2. Mark both the axle and motor housings to help with realignment during assembly of the motor to rear axle (Ref Fig. 2).
3. Disconnect the motor wires from terminals U, V, and W (12) (Ref Fig. 3) (Ref Fig. 4).

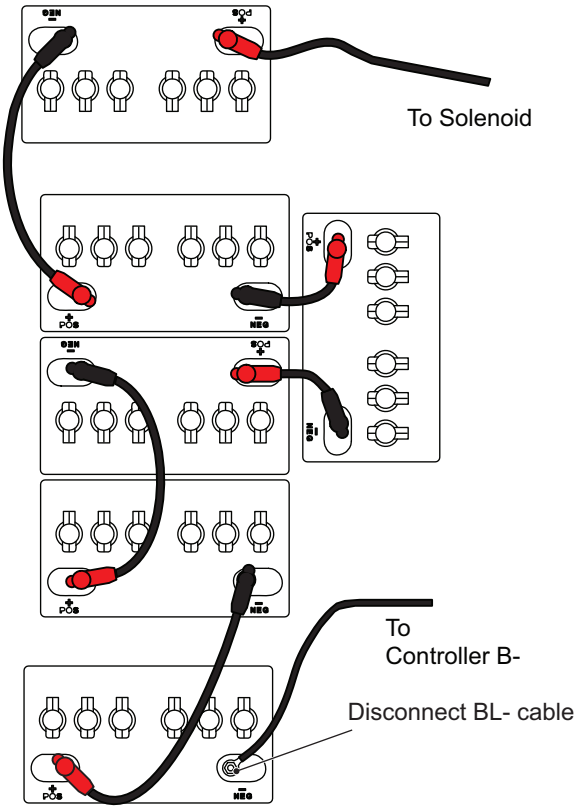


Fig. 1 Disconnect Battery Cable

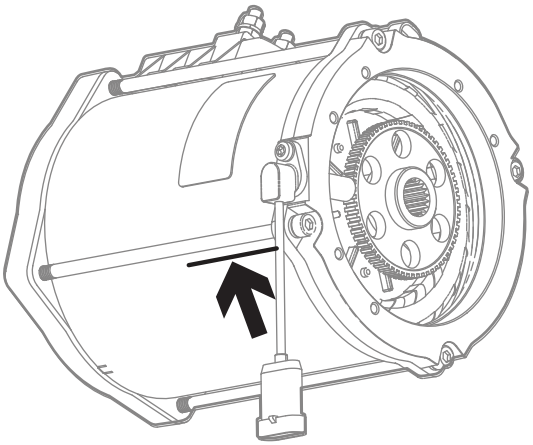


Fig. 2 Mark Axle and Motor

⚠ CAUTION ***Do not damage the splines when removing and installing the motor to the rear axle housing.***

4. Disconnect the speed sensor (8) and temperature sensor (9). (Ref Fig. 3).

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

5. Remove the bolts (11) securing the motor (1) to the axle housing, and carefully slide the motor straight out from the axle splines.
6. Clean the motor coupler with compressed air and use a scraper to remove any rust deposits.

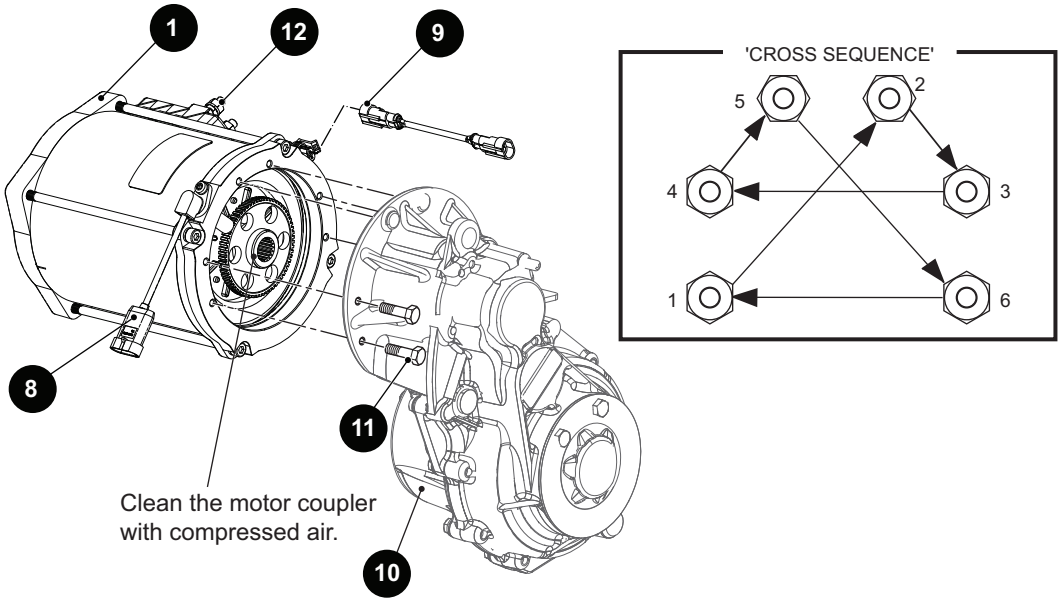


Fig. 3 Motor Components

Motor Installation

Assemble in the reverse order of removal.

1. Apply a small quantity of molybdenum grease or a generous amount of silver grade anti-seize grease to the female part of the spline.
2. Carefully align the motor spline with the input shaft of the axle. Align the orientation marks and install the mounting hardware.
3. Finger tighten the bolts (11) in a ‘cross sequence’ (Ref Fig. 3), then tighten in 25 in. lbs. (2.82 Nm) increments of torque using the same ‘cross sequence’ pattern.
4. Reconnect the temperature sensor (9) and speed sensor (8) wiring harnesses.
5. Reconnect the U, V, and W terminals (12) (Ref Fig. 3) (Ref Fig. 4).

Tighten all hardware to the torque values below

Item	Torque Specification
11	72 - 78 in. lbs. (8 - 9 Nm)

MOTOR WIRING

Motor Terminal	Wire Marker	From
U	U	Controller "U"
V	V	Controller "V"
W	W	Controller "W"

Fig. 4 Motor Wiring

MOTOR TESTS

The armature and motor housing are not available as individual parts. The Curtis handheld can show specific motor faults (See CURTIS CONTROLLER on page 128). The motor can also be tested using a DVOM (See AC Motor Bench Test on page 151). Additionally, 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 should be replaced.

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

Notes:

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

Notes:

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

ELECTRICAL SYSTEM

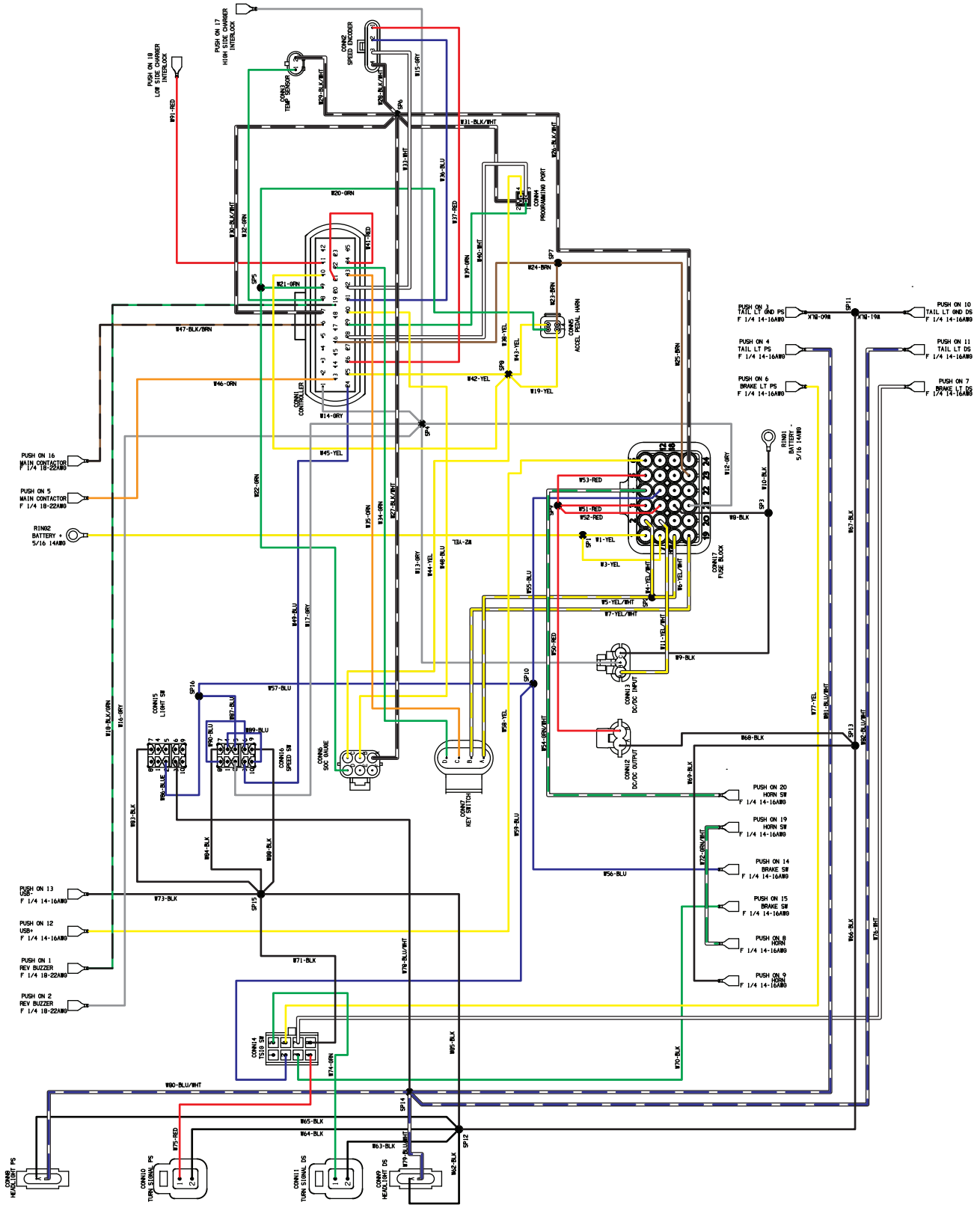


Fig. 1 Wiring Diagram

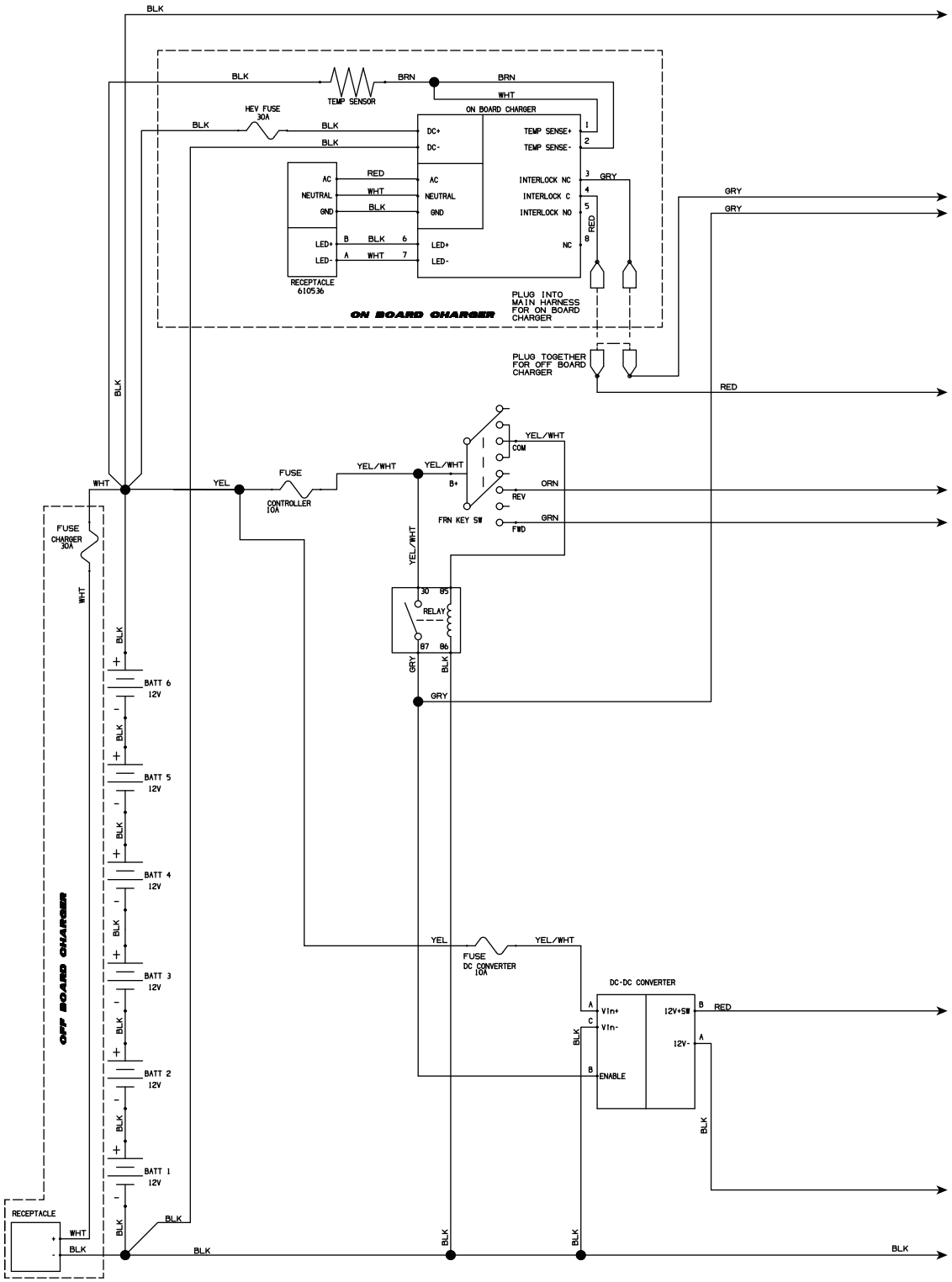


Fig. 2 Electrical Schematic

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

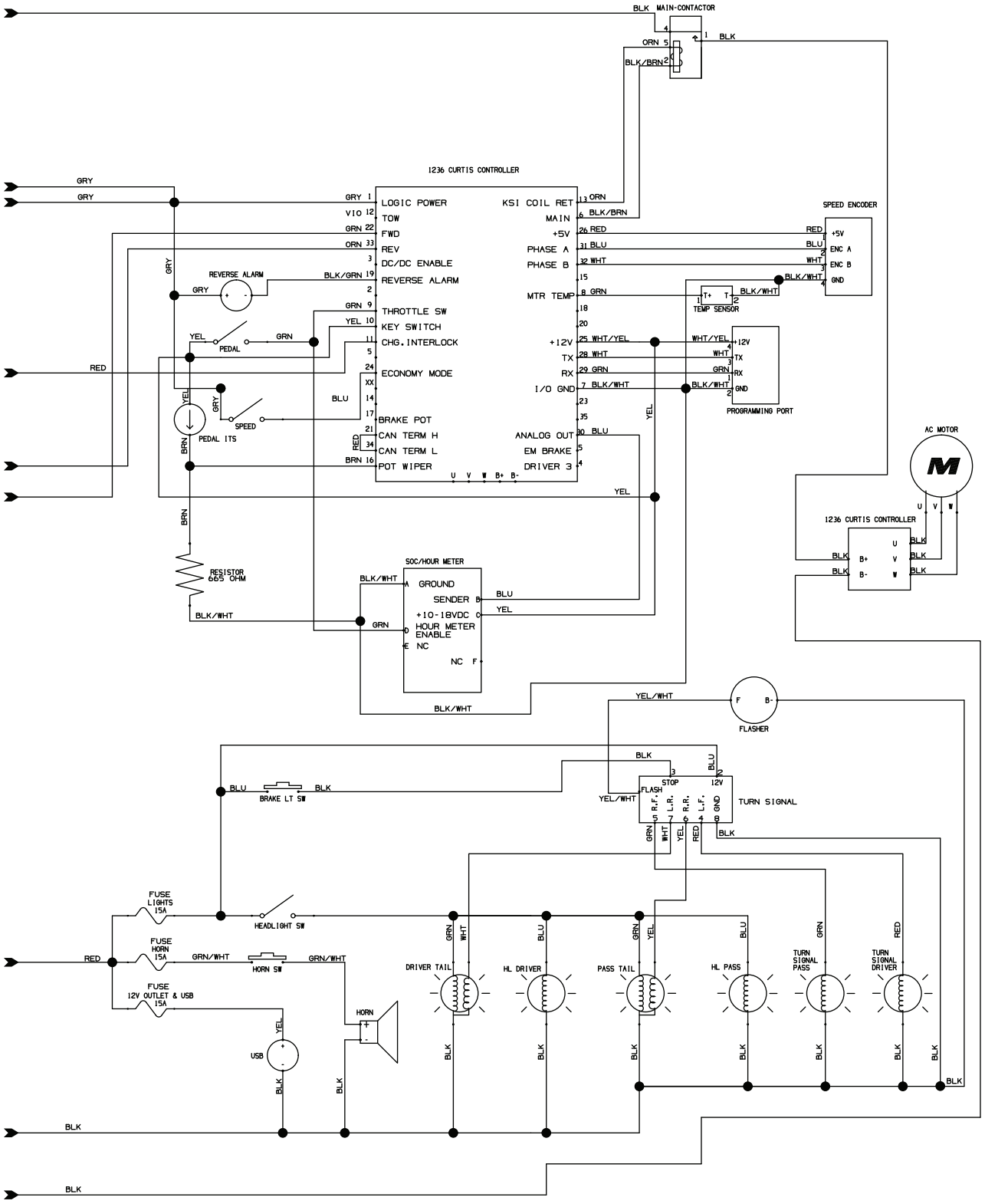


Fig. 3 Electrical Schematic (Continued)

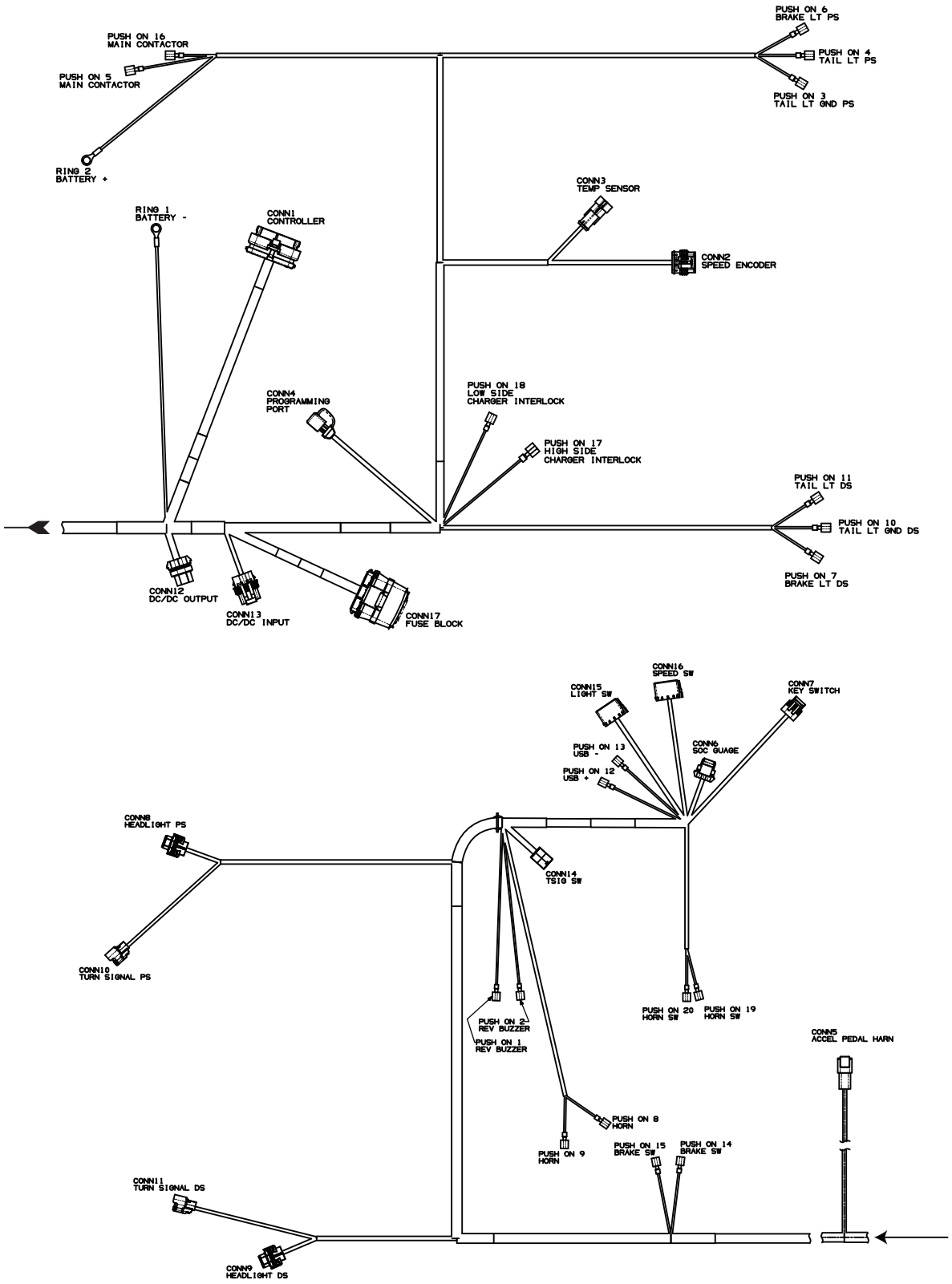


Fig. 4 Harness Overview

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

VOLTAGE TESTING FOR BATTERIES

⚠ WARNING ***Hydrogen gas formed during battery charging is explosive.***

Avoid any electrical spark or open flame near the batteries.

NOTICE: If the temperature of the battery or the ambient temperature is below 60° F (15.55° C), the capacity of the battery will be reduced, and it will require more time to charge.

Voltage on a cold battery increases faster, therefore reducing the charging rate.

Fully charge new batteries or batteries that have been in storage before testing or installing in the vehicle.

⚠ CAUTION ***Do not over charge the batteries.***

Use a Digital Volt Ohm Meter (DVOM) to check the battery.

Attach the negative (-) lead of the DVOM to the ground terminal of the battery. Attach the positive (+) lead to the positive battery terminal. The voltage reading obtained should be 12 volts or above. If the reading is below 12 volts, the battery needs to be charged and the specific gravity of the electrolyte checked with a hydrometer (See Using Hydrometer on page 60).

MAIN HARNESS

Power Supply

Tool List **Qty.**

DVOM..... 1

1. Check for loose or bare wires.
   a. Check for loose wires at each terminal connection and for worn insulation or bare wires touching the frame.

⚠ CAUTION ***Bare wires can cause a short-circuit.***

NOTICE: If any DVOM readings indicate a faulty wire, check the condition of the terminals and wire junction. A faulty wire must be replaced. (See Faulty Wire Replacement on page 78)

2. Check the condition of the 72V batteries set.
   a. Check for adequate battery volts (nominal 12 VDC) by setting the DVOM to 30 VDC range and place the red probe (+) on the battery post with the white (WHT) wire attached.
   b. Place the black probe (-) on the battery post with the black wire attached.
   c. A reading of 11 VDC or greater indicates adequate battery condition.
   d. No reading indicates:
      - a poor connection between the probes and the battery terminals or
      - a faulty DVOM
   e. A voltage reading below 11 volts indicates poor battery condition and that the vehicle should be recharged before proceeding with the test.

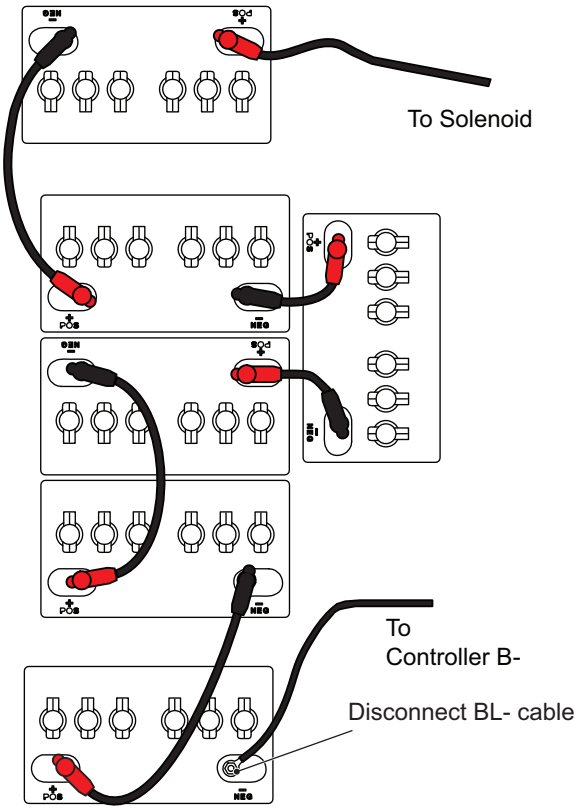


Fig. 5 72V Battery Set Connections

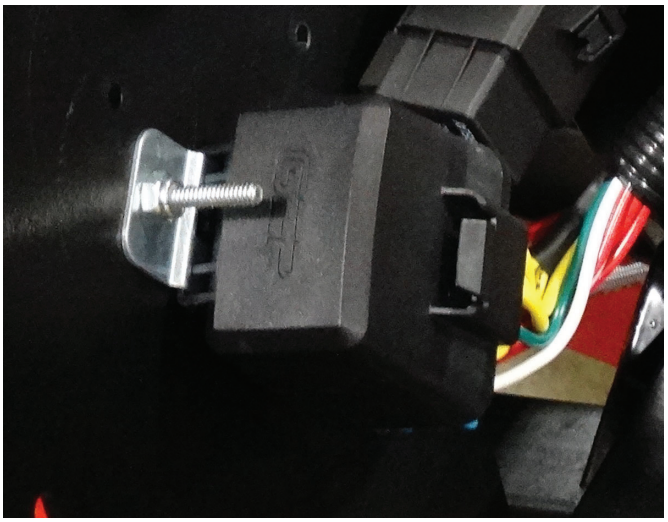
NOTICE: Due to the resistance of the wires involved within the harness, voltage readings can be slightly lower than battery voltage. A reading of 1 volt below battery voltage is acceptable.

3. Check the power wire.
   a. Attach the black probe (-) to the battery post with the black wire attached.
   b. Attach the red probe (+) to the power (white) wire terminal at the fuse block.
   c. A reading of battery voltage indicates that the power wire is in good condition.

NOTICE: The power wire supplies power to the entire fuse block.

4. Check the fuse (Ref Fig. 6).
   a. Place the red probe (+) to each wire terminal on the fuse block.
   b. A reading of battery voltage indicates that the fuse is in good condition.
   c. No reading indicates a faulty fuse. Replace the faulty fuse with a good fuse of the same amperage rating.

⚠ CAUTION ***The use of an incorrect fuse rating can damage the electrical components.***



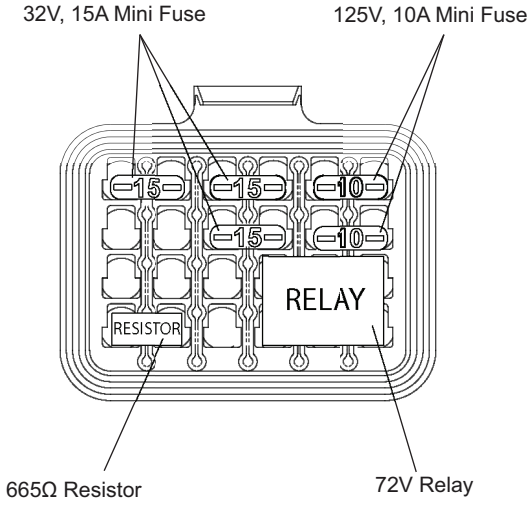


Fig. 6 Fuse Block

Accessory Wiring

After determining that there is power to the fuse panel, and the fuse is good, check the circuit using the procedures previously used to check the power supply (See Power Supply on page 77).

Use the wiring diagram to check for the correct wiring and wire routing (Ref Fig. 1). If there is power at the fuse end of the wire, there is power at the other end of the wire at the switch or electrical accessory, and there is continuity at the ground connection; then the circuit is complete. Electricity must flow from the fuse panel through the full length of the circuit to the ground connection. Correct any interruption of electricity flow, by repairing or replacing the wire or the switch or accessory.

Faulty Wire Replacement

Replace a faulty wire with one of the same gauge and color. Connect the new wire between the correct components, and secure it to the harness bundle with a wire tie. Cut the faulty wire back close to the harness and wrap the ends with vinyl electrical tape.

Tail Light and Bulb

Tool List	Qty.
Screwdriver, Phillips	1
Phillips Bit Socket	1
Torque Wrench, in. lbs.	1

1. Use an insulated wrench to disconnect the negative (-) battery terminal.
2. To replace the bulb only, remove the screws (3) securing the lens cap (10) (Ref Fig. 7).
3. To remove the entire taillight assembly, remove the screws (1) securing the assembly to the rear body.
4. Disconnect the push on connectors (2) from the main harness.

Assemble in the reverse order of removal. Tighten the screws to the torque listings below.

Item	Torque Specification
1	5 - 10 in. lbs. (.6 - 1.1 Nm)

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

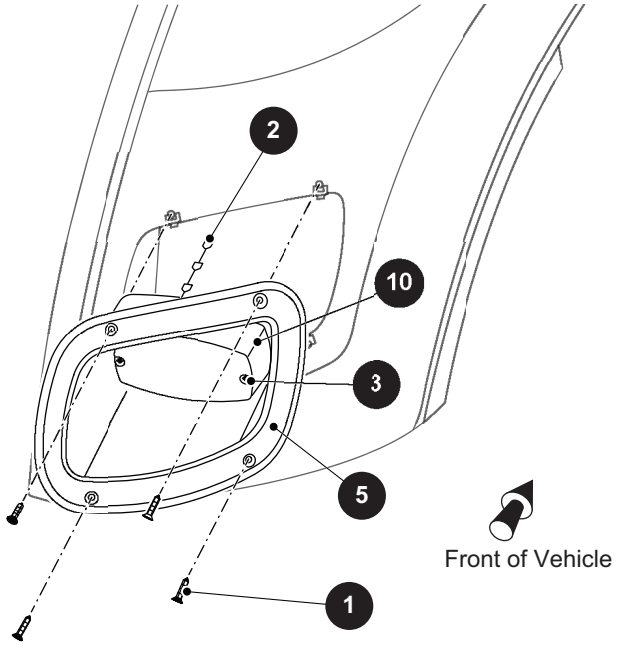


Fig. 7 Tail Light

Halogen Headlight Bulb

⚠ CAUTION ***Light components can get hot if they have been in operation. Allow the lights to cool before serving***

NOTICE: Do not touch a halogen bulb with bare fingers. Oil from skin leaves a residue that causes a hot spot and will diminish the life of the bulb.

1. Disconnect the main harness from the headlight bulb (Ref Fig. 8).
2. Rotate the bulb 1/4 turn to remove the headlight from the housing.
3. Insert and rotate the new bulb to lock it into place.
4. Reconnect the harness.

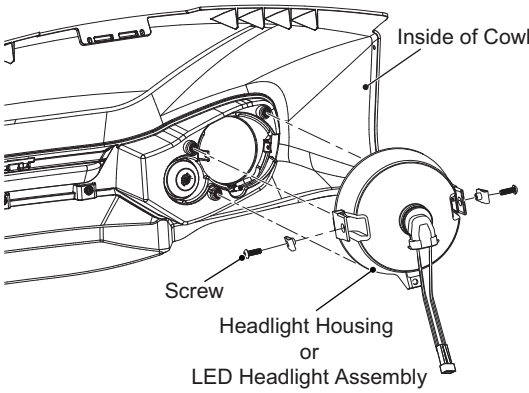


Fig. 8 Halogen Bulb

LED Bulb

If the vehicle is equipped with LED headlights. The headlight contains an LED light board rather than a light bulb. If the LEDs burn out, then the entire headlight assembly must be replaced.

Headlight Assembly

Tool List	Qty.
Socket, 10mm	1
Extension	1
Ratchet	1
Torque Wrench, in. lbs.	1

1. Use an insulated wrench to disconnect the negative (-) battery terminal.
2. Disconnect the electrical connection from the head light assembly to the main harness.
3. Remove the self threading nuts (4) securing the headlight assembly (15) to the cowl (Ref Fig. 9).

Assemble in the reverse order of removal. Tighten the self threading nuts to the torque values below,

Item	Torque Specification
4	18 - 30 in. lbs. (2 - 3.4 Nm)

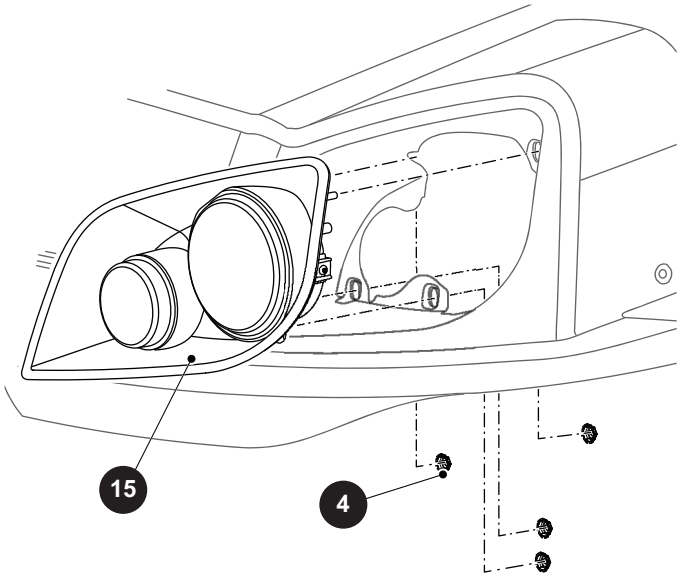


Fig. 9 Headlight Assembly

Controller Replacement

Tool List	Qty.
Socket, 7/16”	1
Socket, 10mm	1
Wrench, 7/16”	1
Wrench, 10mm	1
Ratchet	1
Torque Wrench, in. lbs.	1

⚠WARNING ***To prevent electrical shock, the negative (-) wire must be removed before discharging the controller. Use a large screwdriver to cause a short-circuit in the positive (+) and negative (-) terminals of the controller. Be sure to hold the screwdriver by the insulated handle.***

NOTICE: Record the location of the wiring on the controller before disconnecting it.

NOTICE: Always test the motors for a shorted condition before installing a new controller. An electrical motor short may be the cause of the controller failure and will damage the new controller (See AC Motor Bench Test on page 151).

1. Use an insulated wrench to disconnect the negative (-) battery terminal.
2. Disconnect the main harness from the controller (20) (Ref Fig. 10).
3. Remove the bolts (8) and lock washers (7) securing the wires from the battery and motor to the controller. Be sure to label the wires so they can be installed in the origin al location (Ref Fig. 11).
4. Remove the bolts (6) and lock nuts (9)securing the controller to the battery tray.

Assemble in the reverse order of removal using new lock nuts. Tighten the bolts (8) and lock nuts (9) to the torque values below.

Item	Torque Specification
8, 9	50 - 55 in. lbs. (5.6 - 6.2 Nm)

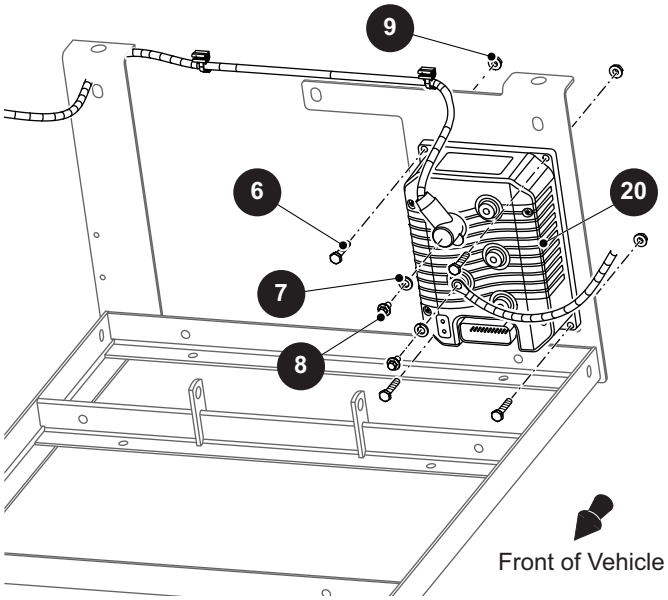


Fig. 10 Controller

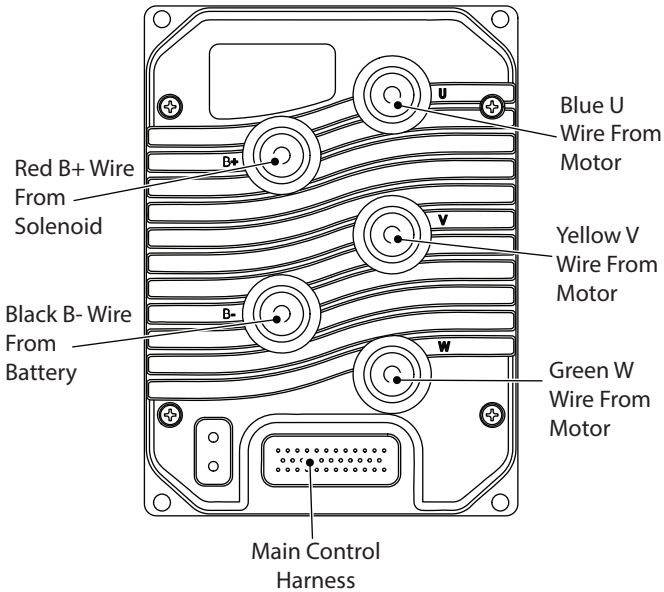


Fig. 11 Controller Wiring

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

Solenoid Replacement

Tool List	Qty.
Socket, 7/16”	1
Socket, 1/2”	1
Wrench, 7/16”	1
Wrench, 1/2”	1
Ratchet	1
Torque Wrench, in. lbs.	1

⚠WARNING ***To prevent electrical shock, the negative (-) wire must be removed before discharging the controller. Use a large screwdriver to cause a short-circuit in the positive (+) and negative (-) terminals of the controller. Be sure to hold the screwdriver by the insulated handle.***

NOTICE: Record the location of the wiring on the controller before disconnecting the wiring from the solenoid. Use an insulated wrench to remove the negative (-) wire from the battery.

1. Use an insulated wrench to disconnect the negative (-) battery terminal.
2. Remove the nuts (11) and lock washers (12) securing the wires to the solenoid (25) (Ref Fig. 12).
3. Remove the bolts (16), washers (14) and nuts (13) to remove the solenoid from the rear fender.

Assemble in the reverse order of removal using new lock nuts. Tighten the nuts to the torque values below.

Item	Torque Specification
11, 13	50 - 55 ft. lbs. (5.6 - 6.2 Nm)

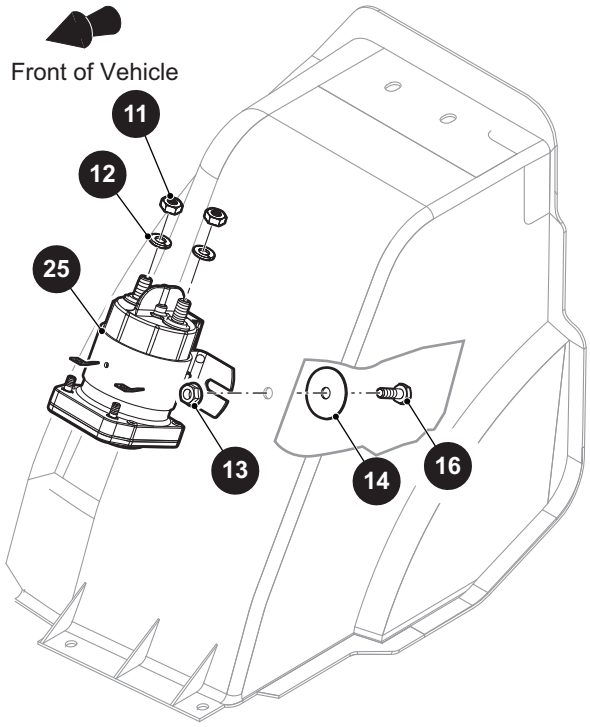


Fig. 12 Solenoid

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

DC to DC Converter

Tool List **Qty.**

Wrench, 7/16” 1
Socket, 7/16” 1
Ratchet 1

1. Disconnect the negative (-) battery cable using an insulated wrench.
2. Disconnect the electrical connectors (18) (Ref Fig. 13).
3. Remove the lock nuts (17) securing the DC to DC converter (30) to the fender.

Assemble in the reverse order of removal. Tighten the nuts to the torque values below

Item	Torque Specification
17	50 - 55 in. lbs. (5 - 6 Nm)

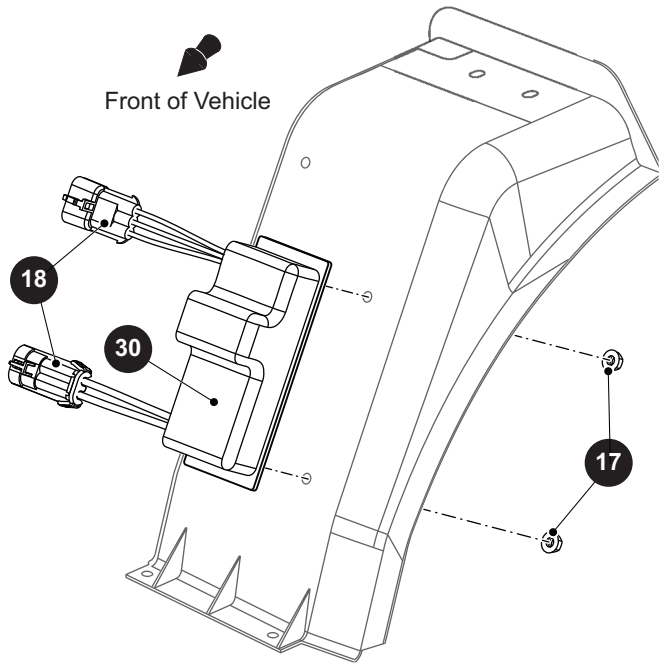


Fig. 13 DC to DC Converter

Reverse Buzzer

Tool List **Qty.**

Screwdriver, Phillips 1
Drill Bit 1
Drill 1
Rivet Gun 1

1. Disconnect the negative (-) battery cable using an insulated wrench.
2. Remove the control panel from the instrument panel (See Control Panel on page 21).
3. Disconnect the push on connections (19) (Ref Fig. 14).
4. Drill out the rivets (21) securing the reverse buzzer (35) to the instrument panel.

Assemble in the reverse order of removal using new rivets. Make sure that the black w/green wire connects to the negative (-) terminal of the buzzer and the gray wire connects to the positive (+) terminal.

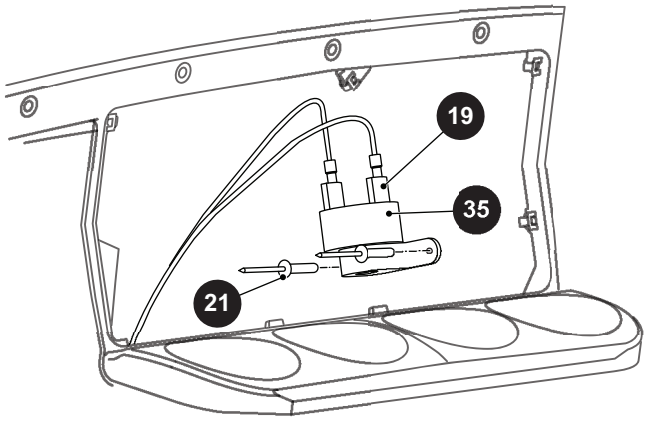


Fig. 14 Reverse Buzzer

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

Horn

Tool List

Wrench, 3/8” 1
Socket, 3/8” 1
Ratchet 1
Torque Wrench, ft. lbs. 1

NOTICE: The horn is mounted to the frame on the top side of the fascia.

1. Disconnect the negative (-) battery cable using am insulated wrench.
2. Remove the cowl (See Cowl on page 20).
3. Remove the push on electrical connectors from the horn (40) (Ref Fig. 15).
4. Remove the bolt (22) and washer (23) securing the horn (40) to the fascia (45) and frame.

Assemble in the reverse order of removal. Tighten the bolt (22) to the torque values below.

Item	Torque Specification
22	60 - 70 in. lbs. (7 -8 Nm)

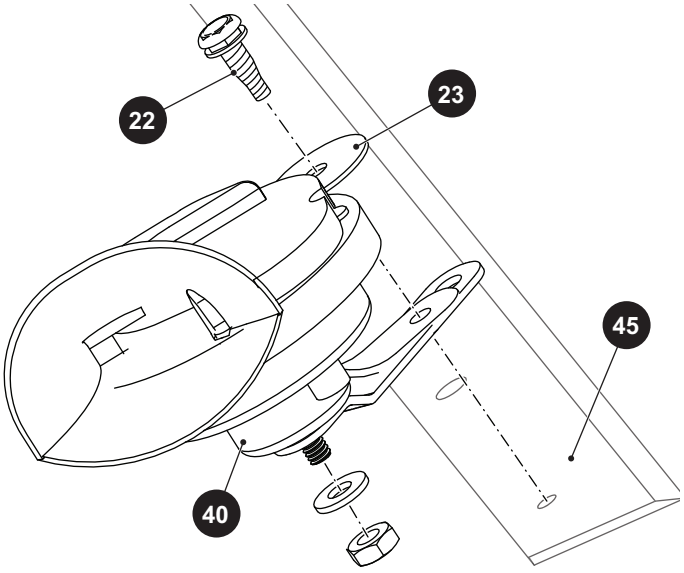


Fig. 15 Horn

FAULT TESTING

General

Knowledge of the use of wiring diagrams and a Digital Volt Ohm Meter (DVOM) is necessary to effectively determine a fault within the circuits that include the electrical accessories, lighting, and gauges.

The wiring diagram shows the path followed by a voltage or signal from its origination point to its destination. Each wire is indicated by color.

Knowledge of simple logic fault testing will reduce the number of steps required to isolate the problem.

Example 1: If the vehicle does not start and none of the lights operate or burn dimly, test the battery before trying to determine a fault within the lighting circuit.

Example 2: If a problem occurs in the lighting circuit that causes only one of the headlights to fail, it is not necessary to check the battery wiring or the fuse since voltage is present. Check the headlight that is not operating. If power is found at the connector and the ground wiring is satisfactory, the fault is 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 put the negatpive (-) probe on the negative battery terminal. Move the positive (+) probe to each wire terminal starting at the battery and moving out to the device that is not working. Check both sides of all switches and fuses.

When no battery voltage is found, the problem is 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 can 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 move toward the device that is not working with the positive (+) probe. When continuity is no longer indicated, a failed conductor or device is indicated.

Testing Battery Voltage

Determine the condition of the battery set before proceeding with any electrical testing.

An open voltage test is not helpful 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 the manufacturer’s instructions. If batteries are satisfactory, recharge the battery set.

With the adequacy of the batteries confirmed, use a DVOM connected directly to the battery terminal posts to determine the open voltage of the set.

In the following tests, this voltage level will be used as a reference.

Some voltage loss due to the resistance of the wires and connectors can be shown by readings that could be up to one volt less than battery reference voltage (BRV).

No reading indicates an “open” condition and the battery wires should be checked for a broken or disconnected wire or component.

Continuity Check

⚠WARNING ***To prevent a possible injury or death caused by a battery explosion, disconnect the electrical power. Use an insulated wrench to remove the negative (-) wire from the battery.***

Before removing the negative (-) wire at the battery, set the keyswitch to the OFF position, then remove the key from the switch. 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

Put one probe on one contact of the switch. Put the second probe on the second terminal of the switch (Ref Fig. 16).

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

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

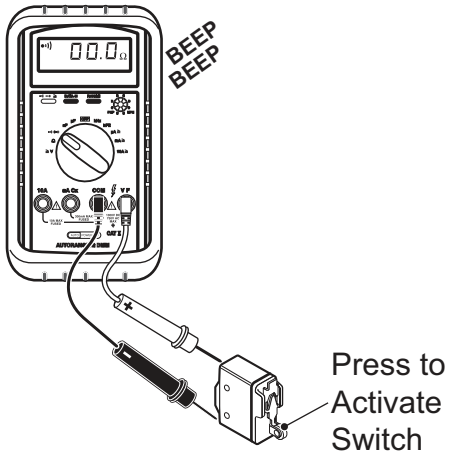


Fig. 16 Continuity Check of Switch

Testing A Solenoid for Continuity

Put one probe on one of the large terminals and the other probe on the second large terminal (Ref Fig. 17).

If the meter shows “0” or gives an audible indication, the solenoid terminals are “welded” closed and the solenoid must be replaced.

If the continuity test shows that contacts are not “welded” and the wiring to the solenoid coil is good, the coil has failed and the solenoid must be replaced.

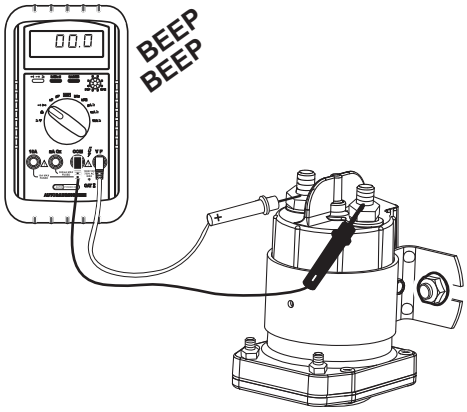


Fig. 17 Continuity Check of Solenoid

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

ACCESORIES

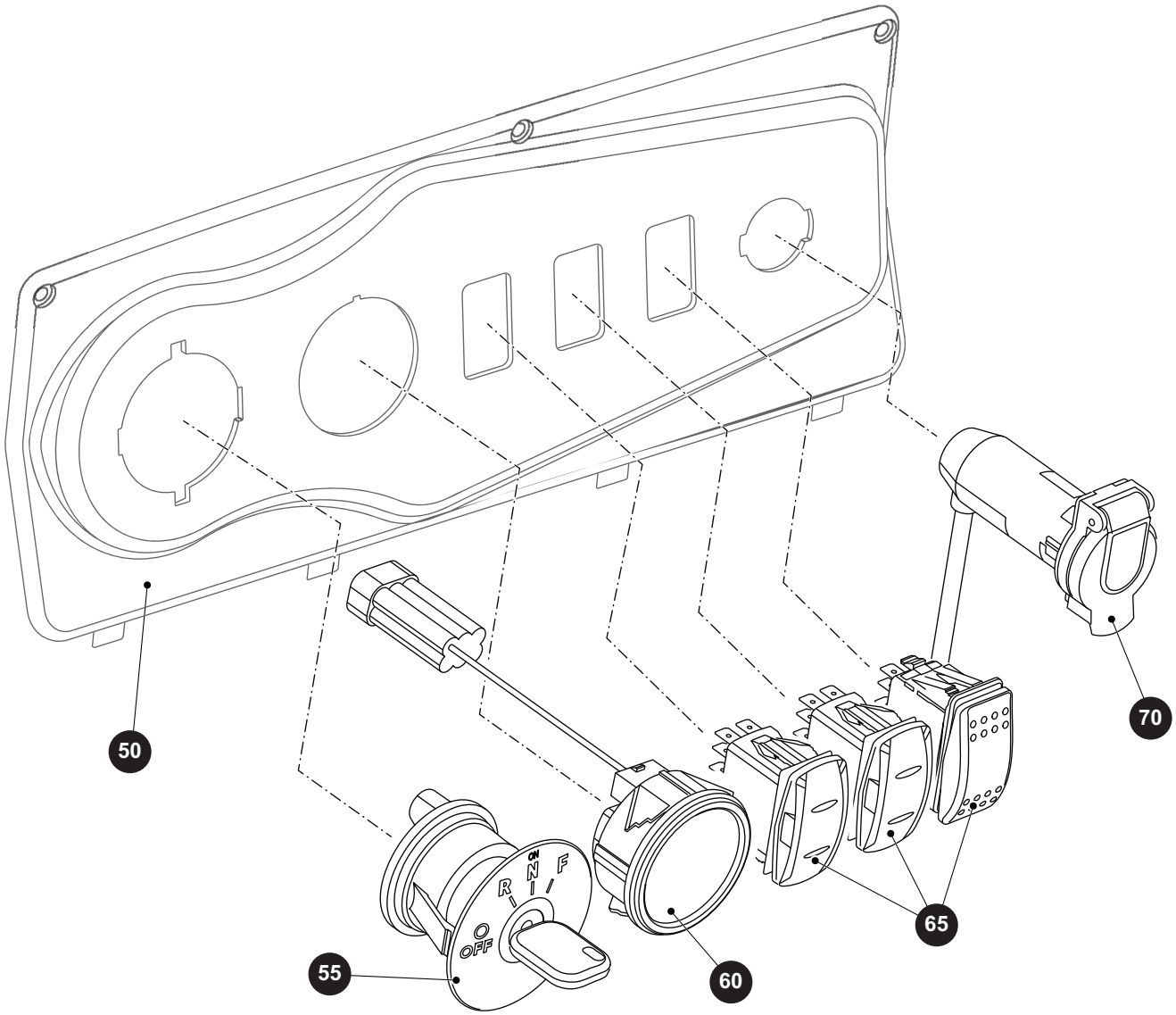


Fig. 18 Control Panel

Keyswitch

Tool List	Qty.
Screwdriver, Phillips	1
Pliers, Needle Nose	1

1. Set the keyswitch to the OFF position and remove the key.
2. Disconnect the negative (-) battery cable using an insulated wrench.
3. Remove the control panel (See Control Panel on page 21).
4. Disconnect the main wiring harness from the key switch.
5. Squeeze the tabs on the back side of the keyswitch (55) and push it through the front of the control panel (50) (Ref Fig. 18).

Assemble in the reverse order of removal. Confirm proper orientation using the alignment pegs.

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

Hour Meter

Tool List	Qty.
Screwdriver, Phillips	1
Pliers, Needle Nose	1

1. Disconnect the negative (-) battery cable using an insulated wrench.
2. Remove the control panel (See Control Panel on page 21).
3. Disconnect the main wiring harness from the hour meter.
4. Squeeze the tabs on the back of the hour meter (60) and push it through the front of the control panel (50) (Ref Fig. 18).

Assemble in the reverse order of removal. The hour meter will only go into the control panel in the correct orientation.

Rocker Switches

Tool List	Qty.
Screwdriver, Phillips	1
Pliers, Needle Nose	1

1. Disconnect the negative battery cable using an insulated wrench.
2. Remove the control panel (See Control Panel on page 21)
3. Disconnect the main wiring harness from the rocker switch.
4. Squeeze the tabs on the top and bottom of the backside of the rocker switch (65) and push it through the front of the gauge panel (50) (Ref Fig. 18).

Assemble in the reverse order of removal. Confirm proper orientation of the switch prior to seating it completely in the gauge panel.

USB Port

Tool List	Qty.
Screwdriver, Phillips	1
Pliers, Needle Nose	1

1. Disconnect the negative battery cable using an insulated wrench.
2. Remove the control panel (See Control Panel on page 21)
3. Disconnect the main wiring harness from the USB port.
4. Squeeze the tabs on the top and bottom of the backside of the USB port (70) and push it through the front of the gauge panel (50) (Ref Fig. 18).

Assemble in the reverse order of removal. Confirm proper orientation of the switch prior to seating it completely in the gauge panel.

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

Notes:

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

Notes:

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

MECHANICAL BRAKES

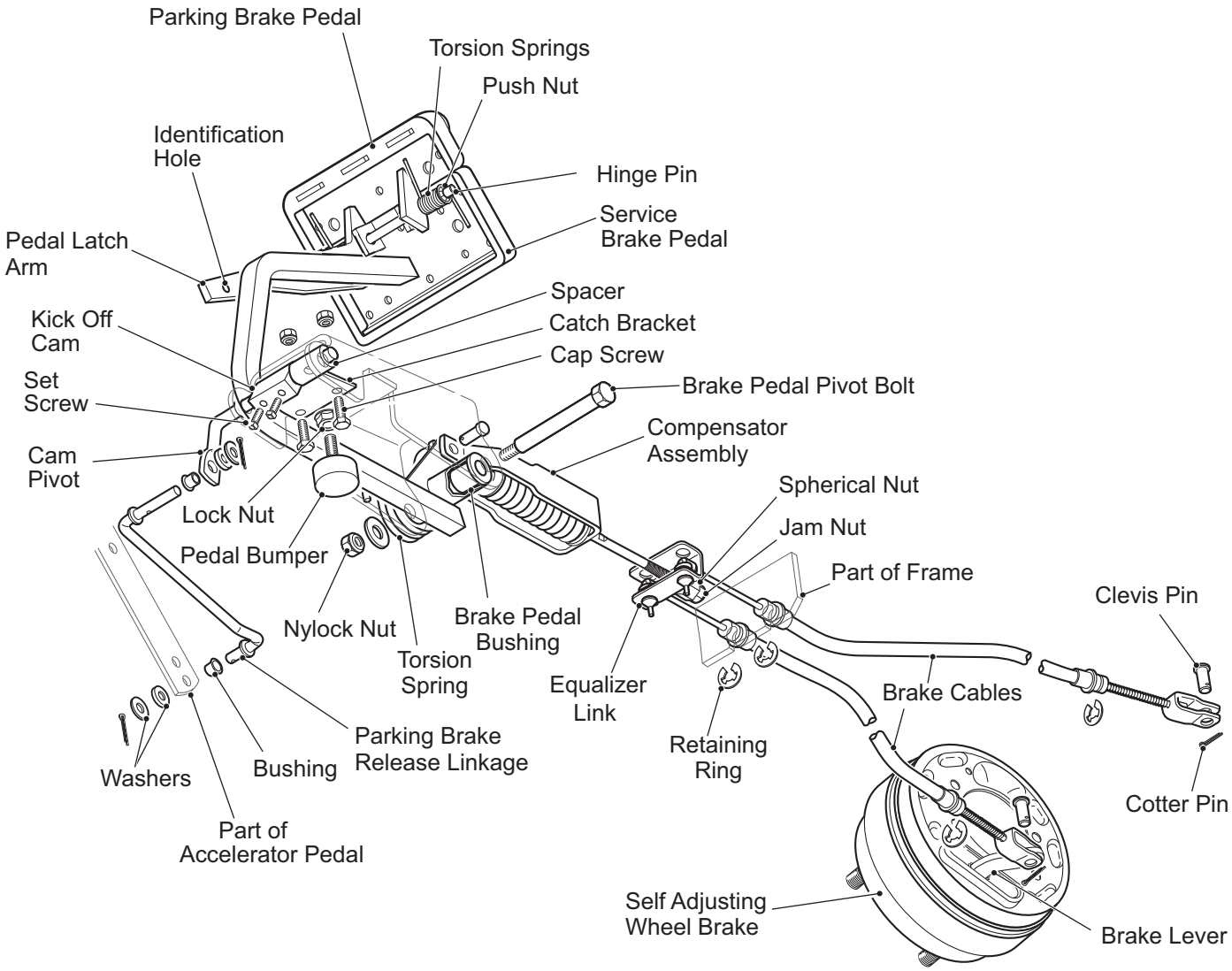


Fig. 1 Mechanical Brake System

MECHANICAL BRAKES

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

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, equalizer link, brake cables, and self adjusting wheel brake assemblies (Ref Fig. 1).

Although the brake system is similar to an automobile, it is **different in important ways**. The system operates in a very severe environment. Fertilizer, dust, grass clippings, tree roots, and other objects can cause corrosion and physical damage to the brake components. Unlike automotive hydraulic brakes, mechanical brakes depend on the travel of the brake cables to move the brake shoes against the brake drums. The travel of the brake cables is governed by the brake pedal. If the cables cannot travel far enough to absorb the slack (free travel) in the system and still apply the shoes to the drums, the braking effort at the wheel brake will not be adequate. The self adjusting mechanism in the wheel brakes requires enough cable travel at the wheel brake to work reliably. When the brake is released, there must be slack in the system so the brakes will release fully and the adjusters will function. Free pedal travel, pedal force, shoe to drum clearance, and braking capability are closely related. It is very important to maintain the proper relationships to assure braking performance and the best wheel brake adjustment.

How the Service Brake Works

Pressing the service brake pedal pulls the equalizer link, which is connected to the brake cables (Ref Fig. 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 mechanism and result in a gradual loss of brakes.***

The wheel brakes are equipped with an automatic adjuster mechanism that is designed to compensate for brake shoe wear and eliminate the need for manual brake shoe adjustment. Do not manually adjust the brakes by prying back the adjuster arm and turning the star wheel. Permanent damage to the adjuster will result.

Adjustment takes place only when the brake is fully applied and released **while the vehicle is moving**.

When the brake pedal is applied, the brake lever moves toward the front of the vehicle (A) (Ref Fig. 2).

The other end of the brake lever moves to the rear of the vehicle (B) where it contacts the brake adjuster arm, causing it to move.

The brake adjuster arm moves away from the star-wheel (C). The amount of adjuster travel is limited by the amount of brake shoe travel required to contact the brake drum. The amount of travel increases as the brake shoe lining wears.

When the brake pedal is released, the adjuster spring retracts the brake adjuster arm which contacts the star-wheel. Note that adjustment only takes place when the brake pedal is released while the vehicle is in motion.

If the shoes have worn far enough to permit the brake adjuster arm to contact the next tooth of the star-wheel, the star wheel will be advanced by the tension applied to the adjuster arm by the adjuster spring.

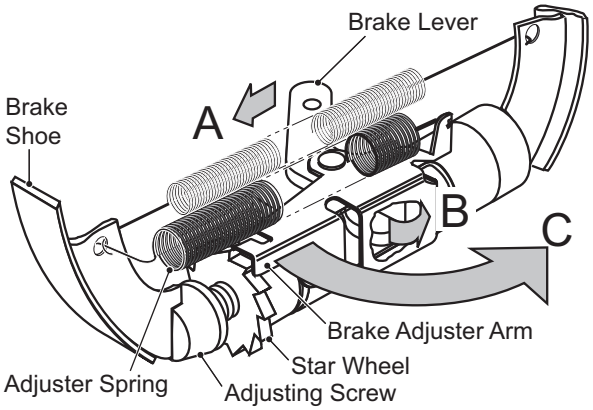


Fig. 2 Automatic Adjuster Mechanism

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

How the Parking Brake Works

The parking brake is operated by a smaller pedal which extends across the top of the service brake pedal. It is attached to the service brake pedal with a hinge pin and is spring loaded (Ref Fig. 3).

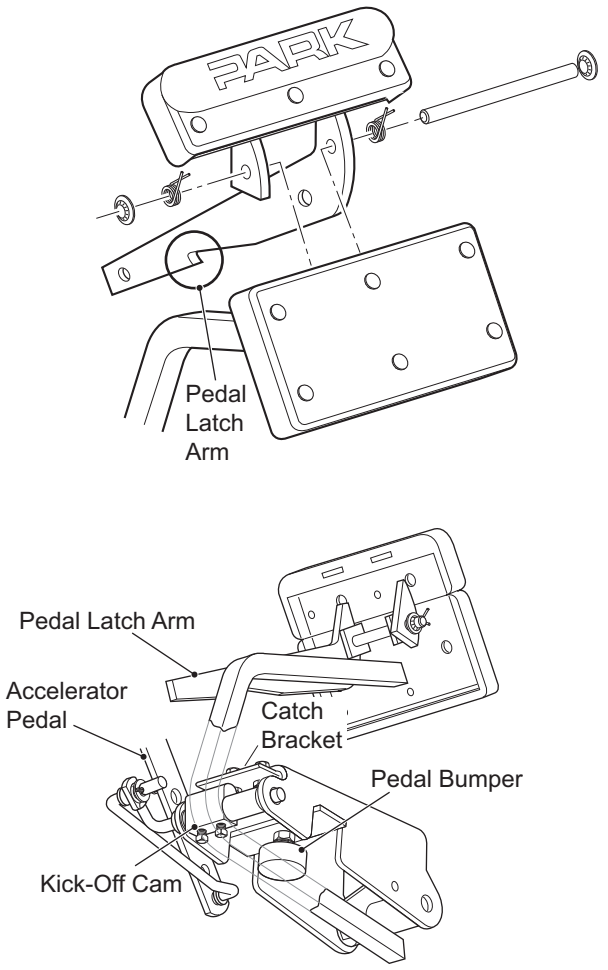


Fig. 3 Parking Brake and Kick-Off Mechanism

Pressing the parking brake pedal moves the latch arm against the catch bracket. As the parking brake is pressed, 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. The latch arm is held in position by the tension in the brake linkage. The Parking Brake can be released by two methods:

1. Pressing 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 method is preferred as it minimizes wear on components.
2. Pressing the accelerator pedal rotates the kick-off cam which forces the pedal latch arm to move away from the catch bracket. The spring loaded parking brake pedal returns to its original position, releasing the brake.

Compensator Assembly

The compensator assembly contains a spring, which is compressed until the stop tube within the spring is engaged and the linkage becomes solid (Ref Fig. 4). The brake compensator assembly applies a spring load to the parking brake system and ensures that the parking brake remains under tension whenever it is engaged

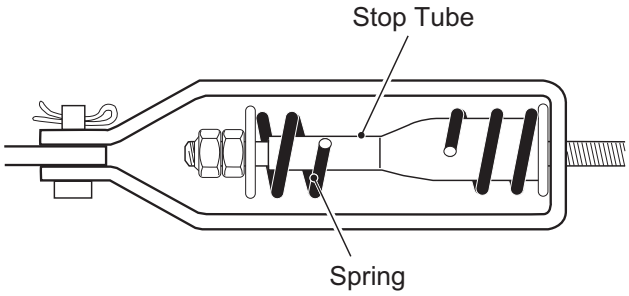


Fig. 4 Compensator Assembly

Kick-Off Actuating Linkage

The kick-off actuating linkage may require periodic adjustment to compensate for normal wear. Replacement of any linkage components will also require an adjustment (See Parking Brake Release Linkage and Kick-Off Cam Removal and Replacement on page 109).

MECHANICAL BRAKES

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

FAULT TESTING TABLE

Refer to the following fault testing table only after a thorough visual inspection, Periodic Brake Performance Test (PBPT), and Aggressive Stop Test is performed (Ref Fig. 5).

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.
In excess of 1 1/8" (2.9 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.
Less than 7/8" (2.2 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.
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.

Fig. 5 Fault Testing Table

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

Condition	Possible Cause	Correction
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. 5 Fault Testing Table

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

FAULT TESTING 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. When this occurs, the brake linkage should be adjusted (See Adjusting Brake Pedal Free Travel on page 101). After this initial period, no further adjustments should be required until routine maintenance is scheduled (See SERVICE SCHEDULE on page 4).

Fault Testing and Inspection Procedures

To fault test the mechanical brake system:

1. Inspect the brake pedal and linkage to find worn or damaged parts per the fault testing table (See FAULT TESTING TABLE on page 92).
2. Perform the Periodic Brake Performance Test to evaluate the system performance (See Periodic Brake Performance Test (PBPT) on page 97). Based on the results of the inspection and tests, refer to the fault testing table (Ref Fig. 5) to evaluate symptoms and repairs.
3. If required, disassemble the wheel brake to locate and correct internal faults (See Wheel Brake Service on page 103).

⚠ CAUTION ***Satisfactory brake performance does not eliminate the need for routine brake testing and inspection. Continued proper brake operation depends on periodic maintenance (See SERVICE SCHEDULE on page 4).***

Brake Pedal and Linkage Inspection

1. Inspect the 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. 6).
   - Replace or adjust the pedal bumper if required (See Pedal Bumper Adjustment on page 108).

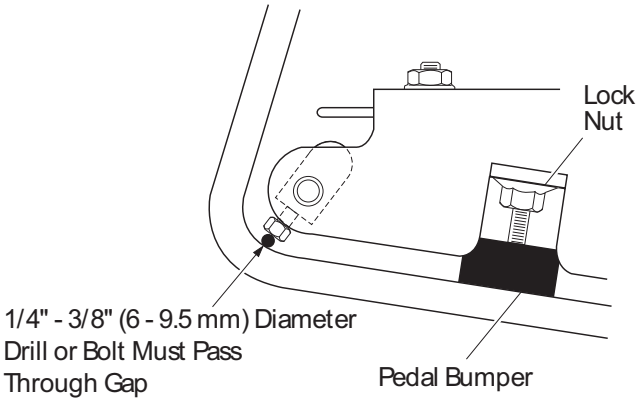


Fig. 6 Brake Pedal Bumper Inspection

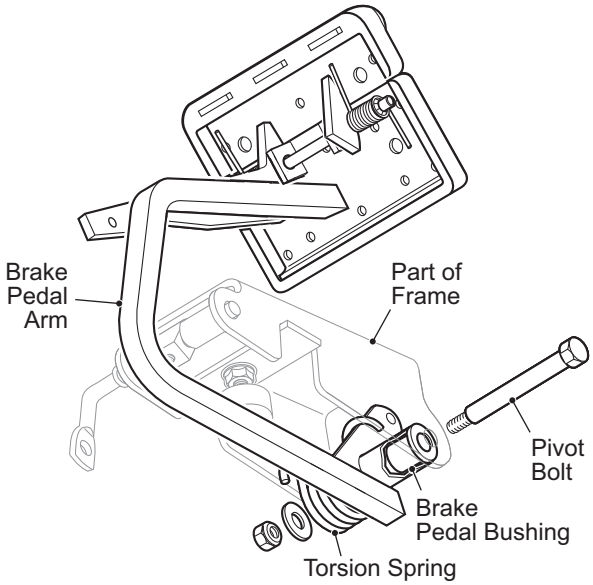


Fig. 7 Brake Pedal Inspection

2. Check the brake pedal return.
   - Apply the brake pedal and release.
   - Check that the brake pedal arm rests against the pedal bumper when released.

- If the pedal does not return fully or is sluggish, the brake pedal bushings and pivot bolt should be inspected (Ref Fig. 7).
- Replace the pedal, spring, bushings, and bolt as required (See Brake Pedal Removal and Installation on page 107).

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 pressed enough to remove slack from the compensator and cables.
   - Too much pedal free travel may indicate that the wheel brakes are not adjusting, wear in the cables and linkages, or initial break-in of components.
   - Not enough pedal free travel may indicate improper adjustment of the wheel brake or the brake linkage. Either condition can prevent the brakes from adjusting properly.

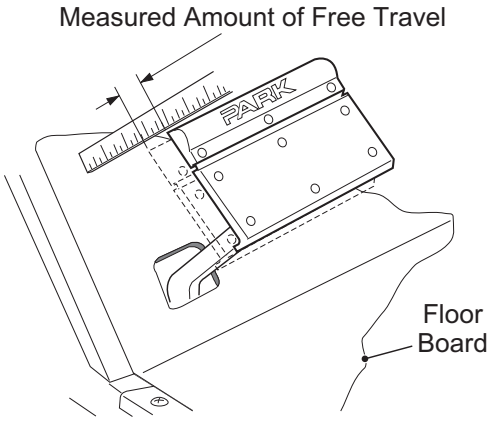


Fig. 8 Checking for Excessive Free Travel

   - Free travel should be set at 7/8” - 1 1/8” (2.2 - 2.9 cm) (Ref Fig. 8).
   - 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 (See Parking Brake Latching Force on page 102). Adjust the brake pedal free travel if required (See Adjusting Brake Pedal Free Travel on page 101).

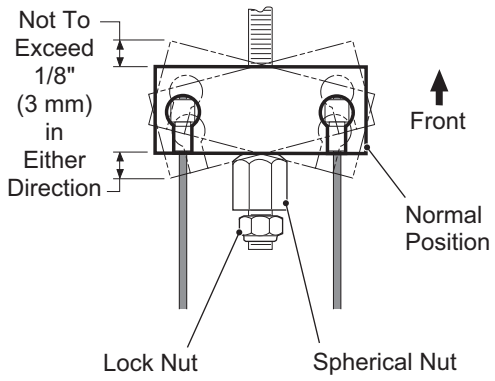
4. Inspect the brake cables.
   - Inspect for damage to the outer cable, fraying of the inner cable, or lack of free motion when the pedal is applied and released.
   - Inspect the brake cable support brackets to be sure the cables are properly secured.
   - If any of these conditions are found, replace all cables and the equalizer as a set (See Brake Cable and Equalizer Assembly Removal and Installation on page 105).

5. Check the clevis pins.
   - Check the clevis pins attaching the brake cables to the brake levers. They must be loose when the brake pedal has been released.
   - If the clevis pins are not loose, but the brake pedal free travel is correctly adjusted and the brake cables move freely, the problem is likely in the wheel brake (See Wheel Brake Inspection on page 98).

6. Inspect the brake cable equalizer linkage.
   - Inspect for signs of corrosion, damage, wear, or excessive misalignment.
   - 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. 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.

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



View From Below

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

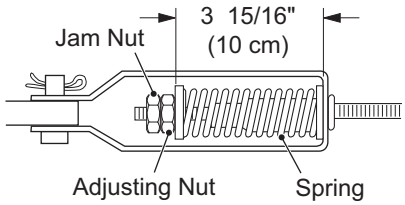


Fig. 9 Equalizer and Compensator

8. Inspect the 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. 10).
9. Check the condition and operation of the parking brake latching mechanism.
   - The parking brake should latch firmly and release as soon as the accelerator pedal is pressed.

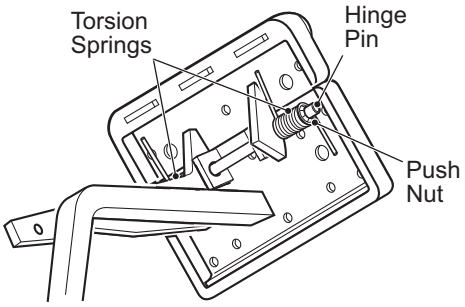


Fig. 10 Parking Brake Pedal Hinge Inspection

⚠WARNING ***To prevent a serious injury or death from the use of worn parking brake components, do not attempt to renew 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 the catch bracket and latch arm.
    - Replace if showing signs of wear or damage (Ref Fig. 11).
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 if required (See Kick Off Cam Adjustment on page 107).
    - 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 the 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 pressed.

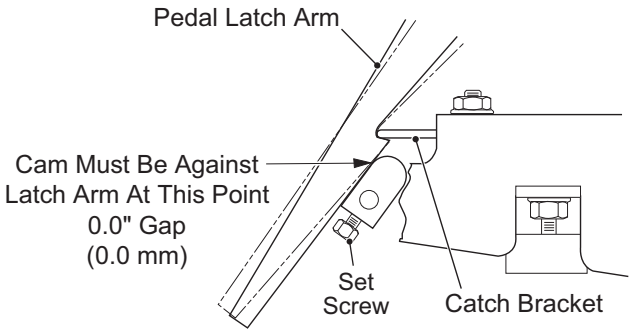


Fig. 11 Kick-off Cam Inspection

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

Periodic Brake Performance Test (PBPT)

⚠WARNING ***To prevent a severe injury or death resulting from operating a vehicle with an 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 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 fault testing 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 (See Brake Pedal and Linkage Inspection on page 94).

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 (Ref Fig. 12).

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 they are new and the range of stopping locations or distances recorded.

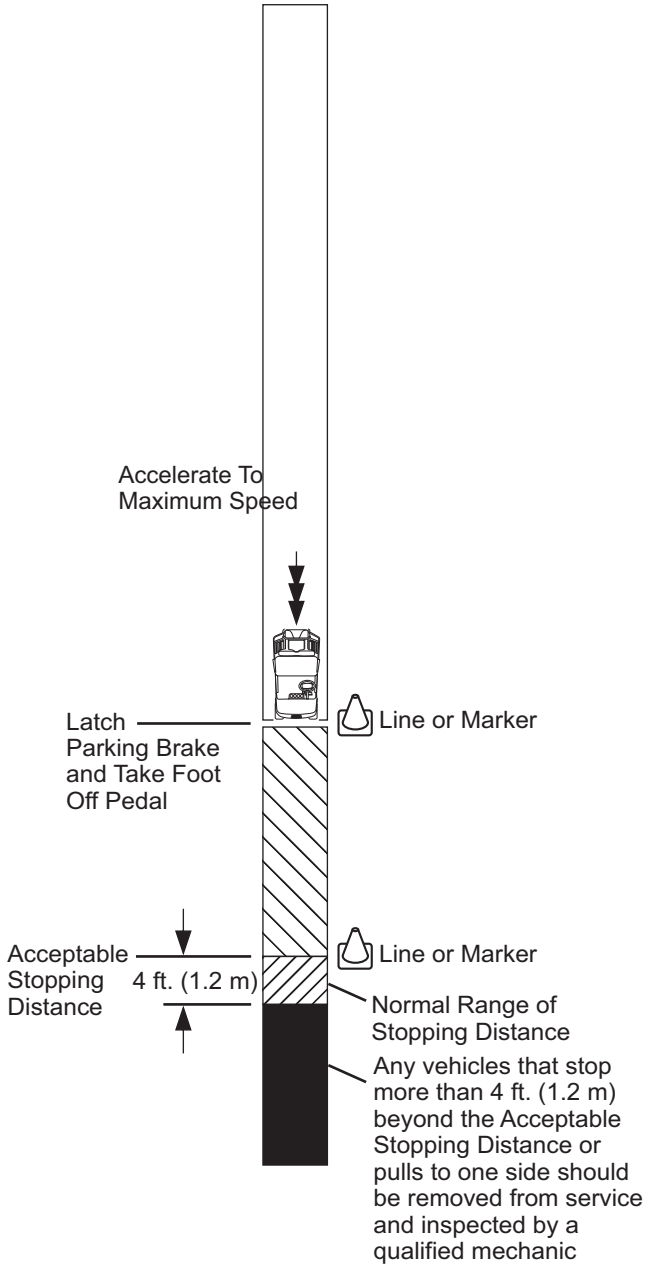


Fig. 12 Periodic Brake Performance Test

NOTICE: Over time, a subtle loss of performance may take place; therefore, it is important to establish the standard with a new vehicle.

1. Drive the vehicle at maximum speed on a flat, dry, clean, paved surface (Ref Fig. 12).
2. Quickly press the brake pedal to latch the parking brake at the line or marker in the test area and remove your foot from the pedal. The vehicle should stop aggressively. The wheel brakes may or may not lock.

3. 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.
4. 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.
5. Repeat the test two more times.
6. If the vehicle fails to pass two of three Periodic Brake Performance Tests, perform the Aggressive Stop Test 10 times, then repeat the Periodic Brake Performance Test three more times (second set of three).
7. 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 the vehicle to service. If they are tight, adjust the brake pedal free travel (See Adjusting Brake Pedal Free Travel on page 101).
8. Repeat the Periodic Brake Performance Tests.
9. If vehicle fails, remove it from service and inspect the wheel brake assembly to evaluate the reason for failure (See Wheel Brake Inspection on page 98).

Aggressive Stop Test

⚠ WARNING ***To prevent a 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.

1. Equally load both sides of the vehicle (Ref Fig. 13) and apply maximum force and travel to the service brake pedal while moving.
2. Do not latch the parking brake.
3. Do this a total of 10 times with the first few at slow speed.
4. If brake function is adequate or improves, increase speed for the remaining tests.
5. Before the end of the tests, both wheels should lock at approximately the same time and slide straight.

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.

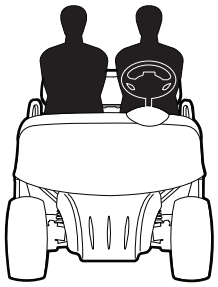


Fig. 13 Equally Load Vehicle

Wheel Brake Inspection

⚠ WARNING ***Wear a dust mask and eye protection whenever working the on wheel brakes. Do not use pressurized air to blow dust from the 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 the adjuster mechanisms (See Brake Drum Removal and Installation on page 102).
2. Remove any 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 and will cause drum failure and a loss of brakes which could cause severe injury or death.***

3. Inspect the brake drum.
   - Look for a blue coloration or blistered paint that would indicate that it has overheated.
   - Check for any evidence of scoring.
   - Check for any 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.
4. Remove any accumulated brake dust from the wheel brake assembly with a brush.
5. Visually inspect the axle seal for oil leakage and the condition of the thrust washer. If oil is present, a repair to the rear axle is necessary (See Axle Shaft, Bearing and Seal Removal on page 112).

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

6. Verify that the inner brake drum washer is present and check its condition. Replace it if it is damaged or missing.

⚠ WARNING ***If one wheel brake assembly requires replacement, the opposite 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.***

7. Visually check the condition and operation of the adjuster mechanism.
8. 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. 14)

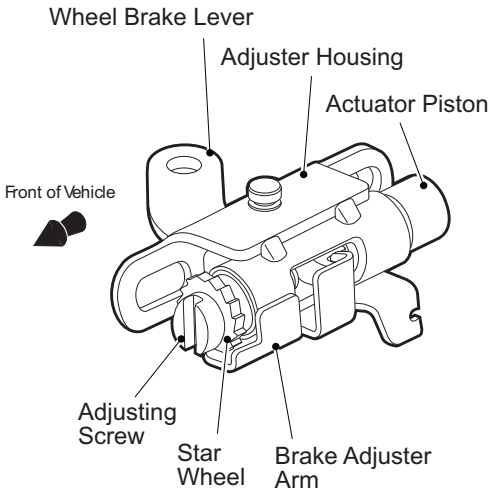


Fig. 14 .Adjuster Mechanism

   - If the adjuster arm **engages and turns** the star wheel, proceed to step 9. 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 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. 21).
9. Check the condition and operation of the moving anchor assembly.
   - 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.***

10. 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.
11. Measure the brake shoe thickness.
    - Measure at the most worn area. Brake shoe thickness must never be less than .060" (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. 15).
    - If the brake shoe thickness is approaching .060" (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.
12. Inspect the brake shoe springs.
    - Be sure that the springs are not broken or damaged and are correctly installed.
    - The hooked end of the adjuster spring is inserted through the front of the front shoe and the opposite end hooked to the adjuster with the hook end facing out.
    - The brake shoe springs must be installed with the light spring closest to the adjuster mechanism with the hook installed down through the rear brake shoe and up through the front brake shoe.
    - The heavy top spring is installed with both spring hooks installed down through the brake shoes (Ref Fig. 16).

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

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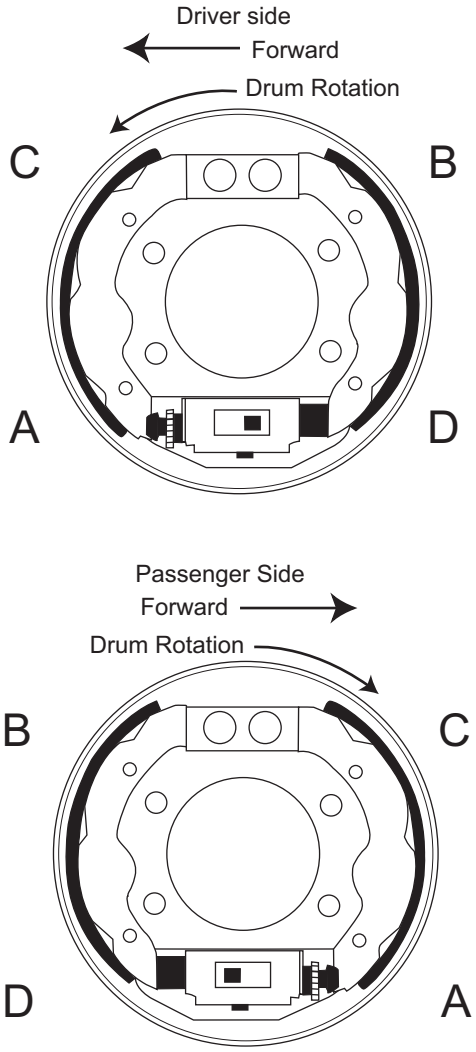


Fig. 15 Brake Shoe Wear

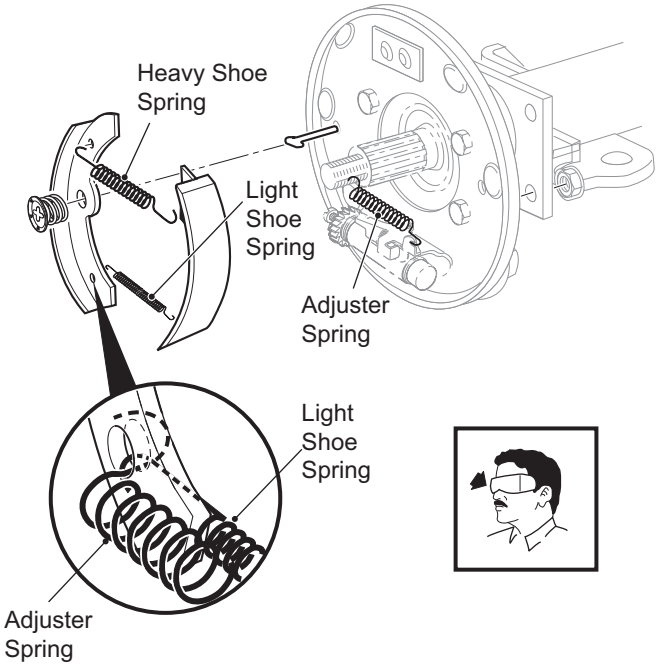


Fig. 16 Orientation of Brake Shoe Springs

13. Repeat the procedure at the opposite wheel brake.
14. Check/adjust the brake pedal free travel.
    - Whenever the brake system is serviced or requires a parts replacement, the brake pedal free travel must be checked and adjusted (See Adjusting Brake Pedal Free Travel on page 101).
    - This includes all linkage and wheel brake components.

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

MAINTENANCE AND REPAIRS

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

NOTICE: It is not necessary to lift the vehicle to access the compensator assembly.

Tool List	Qty.
Wrench, 1/2”	1
Wrench, 9/16”	1
Crow’s Foot Socket. 1/2”	1
Torque Wrench, ft. lbs.	1
Ruler	1

⚠ 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 pressed 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.

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

1. Pre-adjust the service brake pedal free travel to the correct setting by loosening the jam nut and adjusting the spherical nut (Ref Fig. 17).
2. Tighten the jam nut to the torque values below

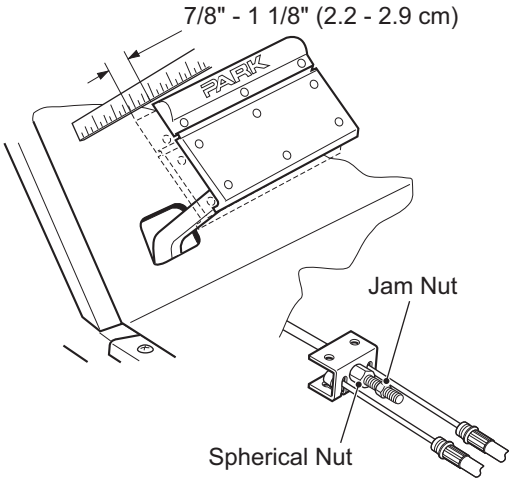


Fig. 17 Free Travel Adjustment

3. The correct brake pedal free travel should be set at 7/8” - 1 1/8” (2.2 - 2.9 cm).
4. 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.***

5. In a safe location free from people and vehicles, drive the vehicle at reduced speed and apply the brakes aggressively.
6. As the brakes adjust and stop the vehicle effectively, start driving at maximum speed and brake aggressively 10 times.
7. At the spherical nut, adjust the free travel as noted above.
8. Drive again and brake aggressively 10 times.
9. Repeat the previous steps until the pedal free travel does not change during the aggressive braking.
10. Check to see that the clevis pins attaching the brake cables to the brake levers are loose. If they are not loose, inspect the system again and correct as required (Ref Fig. 18).

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

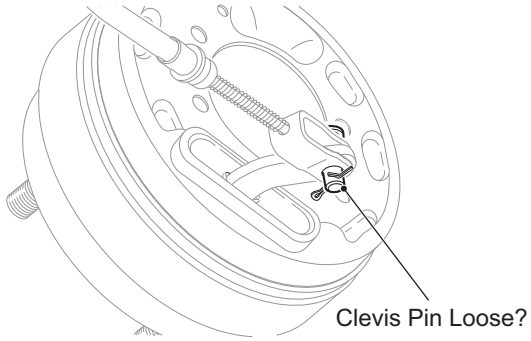


Fig. 18 Check Clevis Pins

11. Tighten the jam nut at the spherical nut to the torque values below.

Item	Torque Specification
Jam Nut	10 - 11 in. lbs. (14 - 15 Nm)

Parking Brake Latching Force

Tool List **Qty.**

Bathroom Scale 1

The parking brake latching force can be checked as verification after setting brake pedal free travel.

1. Place a 'bathroom' scale on the service and parking brake pedals.
2. Using both feet, press the scale down against the parking brake pedal until it latches.
3. The parking brake should latch between 60 and 70 lbs. (27 - 32 kg) indicated on the scale (Ref Fig. 19).

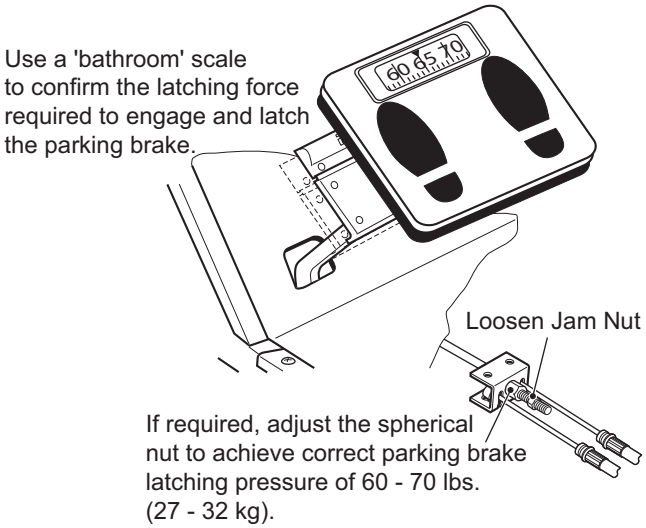


Fig. 19 Checking Parking Brake Latching Pressure

4. Perform the Periodic Brake Performance Test. Return the vehicle to service if the brake performance is satisfactory (See Periodic Brake Performance Test (PBPT) on page 97).

Brake Drum Removal and Installation

Tool List **Qty.**

Socket, 28 mm 1
Pliers, Needle Nose 1
Screwdriver, Straight Blade 1
Floor Jack 1
Jack Stands 2
Torque Wrench, ft. lbs. 1
Anti-Seize Compound ..... A/N

1. Raise and support the rear of the vehicle (See LIFTING THE VEHICLE on page 9).
2. Remove the cotter pin (2).
3. Remove the castellated nut (3) and washer (4).

NOTICE: Do not apply the brake when removing the nut. The shoes may not fully retract preventing removal of the brake drum.

4. Slide the brake drum (1) from the axle shaft (5). If required, tap the drum with a plastic faced hammer to loosen it from the axle shaft or use a drum puller (P/N 15947-G1) (Ref Fig. 20).

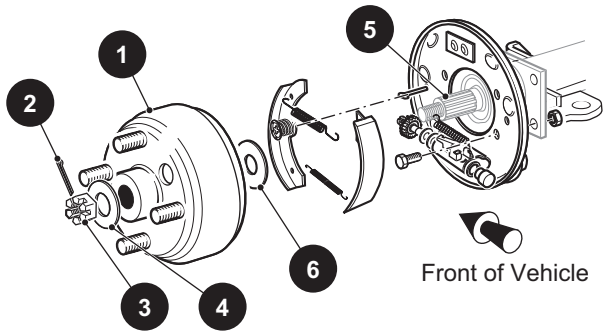


Fig. 20 Brake Assembly

⚠ CAUTION ***Use caution when raising the adjuster arm. Too much force will damage the adjuster and require that both wheel brake assemblies be replaced.***

5. If the drum does not slide from the brake assembly, the brake shoes must be retracted.
6. Rotate the hub so that the hole in the drum is in the six o'clock position which is directly over the brake mechanism.
7. Use a small straight blade screwdriver to raise the adjuster arm **just above** the star wheel.

8. 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:

1. Clean the axle shaft (5) and the splines on the brake drum (1) to remove dirt, grease and foreign matter.
2. Apply a small amount of anti-seize compound to the axle spline.
3. Install the inner brake drum washer (6) and slide the brake drum (5) into place (Ref Fig. 20).
4. Check to ensure the nose of drum hub is beyond the end of the axle splines. If not, remove the drum and install one additional inner brake drum washer (total of 2) to obtain the required spacing.

⚠ CAUTION ***Do not back off the castellated nut to install cotter pin.***

5. Install the remaining hardware and tighten the castellated nut (3) to the torque values below. Continue to tighten until a new cotter pin (2) can be installed through the castellated nut and the hole in the axle. Maximum torque is 140 ft. lbs. (190 Nm).

Item	Torque Specification
3	80 - 90 ft. lbs. (108 - 122 Nm)

Wheel Brake Service

Tool List **Qty.**

Socket, 24mm 1
Pliers, Needle Nose..... 1
Brush 1
Screwdriver, Straight Blade 1
Floor Jack..... 1
Jack Stands..... 2
Torque Wrench, ft. lbs. 1
Anti-Seize Compound ..... A/N
Brake Cleaner ..... A/N
Multi-Purpose Grease ..... A/N
Emery Cloth..... 1

Wheel brake service consists of removal, 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 SERVICE SCHEDULE on page 4). 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.

1. Remove the brake drum (See Brake Drum Removal and Installation on page 102).

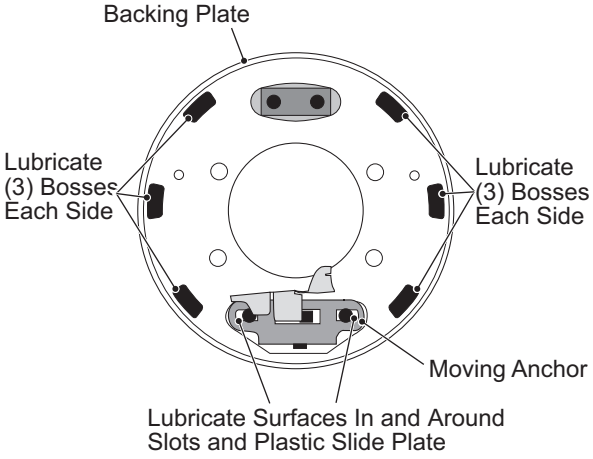
⚠ WARNING ***Wear eye protection and a dust mask when cleaning the brake components. Do not use compressed air to remove brake dust from the brake assembly.***

⚠ CAUTION ***Do NOT use a commercial brake cleaner unless the entire brake has been disassembled.***

2. Remove any accumulated brake dust with a brush.
3. Remove the brake shoes and adjuster mechanism (See Brake Shoe and Adjuster Replacement on page 104).
4. Clean the backing plate with a commercial brake cleaner and allow it to dry completely.

⚠ CAUTION ***It is important that the friction areas between the backing plate and the brake shoes are lubricated. Be careful not to allow the lubricant to contact the braking portion of the brake shoes or the friction surface of the brake drum. Use only recommended lubricants.***

5. Lubricate the backing plate friction points of the shoes and moving anchor with multi purpose grease (MPG) lubricant (Ref Fig. 21).



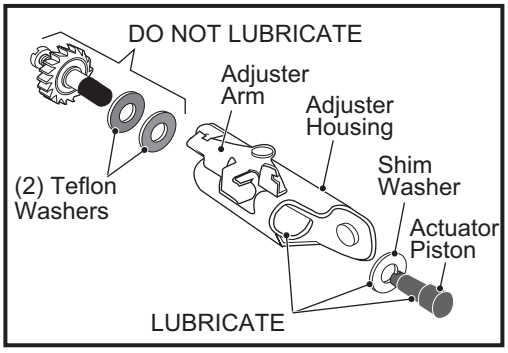


Fig. 21 Wheel Brake Lubrication Points

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

6. Install the actuator components, adjuster components and brake shoes (See Brake Shoe and Adjuster Replacement on page 104).
7. If the brake shoes and drum are not to be replaced, sand the friction surfaces lightly with an 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 (Ref Fig. 24). If the brake shoes are replaced, replace the three brake springs and the adjuster components.***

8. Replace the springs one side at a time, using the other side as a guide.
9. Install the brake drum (See Brake Drum Removal and Installation on page 102).
10. Repeat on the opposite side of vehicle.
11. Adjust the brake pedal free travel.

Backing Plate/Entire Wheel Brake Assembly Removal and Installation

Tool List	Qty.
Socket, 1/2”	1
Wrench, 1/2”	1
Floor Jack	1
Jack Stands,	2
Torque Wrench, ft. lbs.	1

1. Lift and support the rear of the vehicle (See LIFTING THE VEHICLE on page 9).
2. Remove the brake drum (See Brake Drum Removal and Installation on page 102).
3. Remove the clevis pin securing the brake cable to the brake lever.
4. Remove the bolts (7) and lock nuts (8) securing the wheel brake backing plate to the flange (10) on the axle tube (Ref Fig. 22).

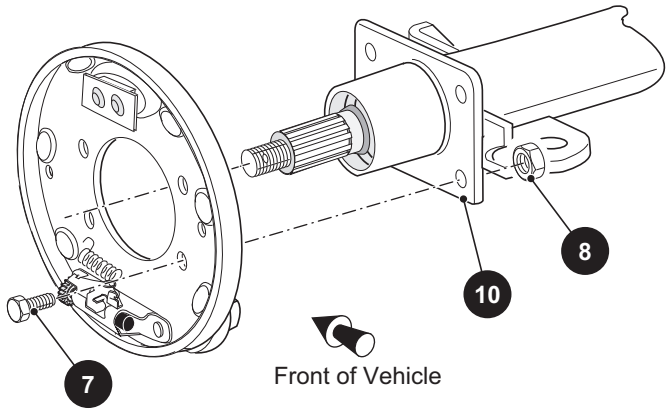


Fig. 22 Backing Plate Removal and Installation

Installation is the reverse of removal using new lock nuts. Tighten all hardware to the torque values below.

Item	Torque Specification
7	23 - 27 ft. lbs. (31 - 36.5 Nm)

Brake Shoe and Adjuster Replacement

Tool List	Qty.
Pliers, Needle Nose	1
Floor Jack	1
Jack Stands	2
Multi-Purpose Grease	A/N

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.

1. Lift and support the rear of the vehicle (See LIFTING THE VEHICLE on page 9).
2. Remove the brake drum (See Brake Drum Removal and Installation on page 102)
3. Remove the three brake shoe springs (11, 12, 13). Note the location of the heavy spring and the adjuster spring (Ref Fig. 23).
4. Hold the shoe clamp pin (14) and compress and rotate the shoe clamp (16) 90° to release it from the shoe clamp pin.
5. Remove the brake shoes (15), adjuster (20) and remaining components.
6. Clean the backing plate with a commercial brake cleaner and allow to dry completely.
7. Lubricate the friction points of the shoes and moving anchor with multi purpose grease (MPG) lubricant (Ref Fig. 21).

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

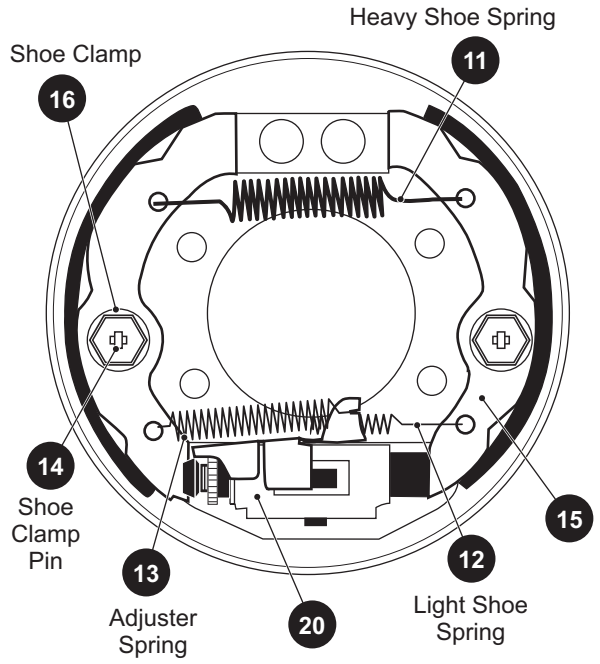


Fig. 23 Brake Shoes and Springs

⚠ CAUTION ***Be sure that the adjusting screw is screwed into the star wheel nut until only 1 - 2 threads are exposed.***

8. Install the adjuster mechanism (driver side silver, passenger side gold). Be sure that the two Teflon coated washers are installed as shown (Ref Fig. 21).
9. The adjusting screw must be screwed into the star wheel nut until only 1 - 2 threads are exposed (Ref Fig. 24).
10. Install the actuator piston. Be sure the hardened shim washer is installed as shown (Ref Fig. 21).

Always replace both brake shoes on both wheels as a set. Install the shoes as indicated and install the shoe clamp (5) over the shoe clamp pin (4) and rotate 90° to lock them in place (Ref Fig. 23).

New Brake Shoes
Screw Adjusting Screw In Until 1 - 2 Threads Are Exposed

Existing Brake Shoes
Adjust 'in' 10 - 15 'clicks'
(Minimum of 1 - 2 Threads Must Be Exposed)

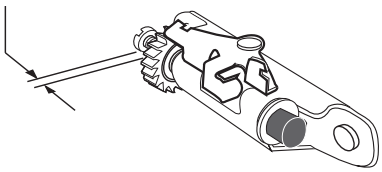


Fig. 24 Setting Adjuster Screw

11. Install new brake shoe (11, 12) and adjuster (13) springs. The hooked end of the adjuster spring is inserted through the front of the front shoe as shown(Ref Fig. 23).
12. The opposite end of the adjuster spring is hooked to the adjuster with the hook end facing out.
13. The brake shoe springs must be installed with the light spring closest to the adjuster mechanism with the hook installed down through the rear brake shoe and up through the front brake shoe.
14. The heavy top spring is installed with both spring hooks installed down through the brake shoes.
15. Check to see that the brake is functioning properly.
16. Install the brake drum (See Brake Drum Removal and Installation on page 102).
17. Repeat on the opposite side of vehicle.
18. Adjust the brake pedal free travel (See Adjusting Brake Pedal Free Travel on page 101).

Brake Cable and Equalizer Assembly Removal and Installation

Tool List	**Qty.**
Wrench, 1/2”	1
Wrench, 9/16”	1
Crow’s Foot Socket	1
Screwdriver, Straight Blade	1
Floor Jack	1
Jack Stands	4
Pliers, Needle Nose	1
Torque Wrench, ft. lbs.	1

NOTICE: The brake cables and equalizer are only serviceable as a complete assembly.

1. Remove the cotter pins and clevis pins connecting the brake cables to the brake levers.

2. Remove the retaining rings (18) connecting the brake cables to the brackets (19) at both ends of the cable (25) (Ref Fig. 25).

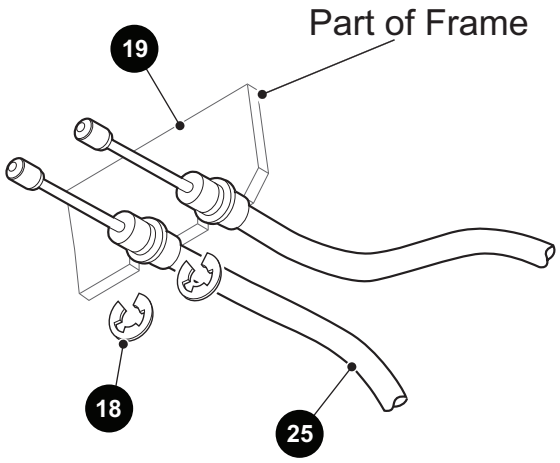


Fig. 25 Cable Connection (Pedal End)

3. Loosen and remove the jam nut (24) and the spherical nut (23) on the equalizer link (30).
4. Inspect the hardware and replace if needed.
5. Remove the brake cable (20) and equalizer assembly (30) (Ref Fig. 26).

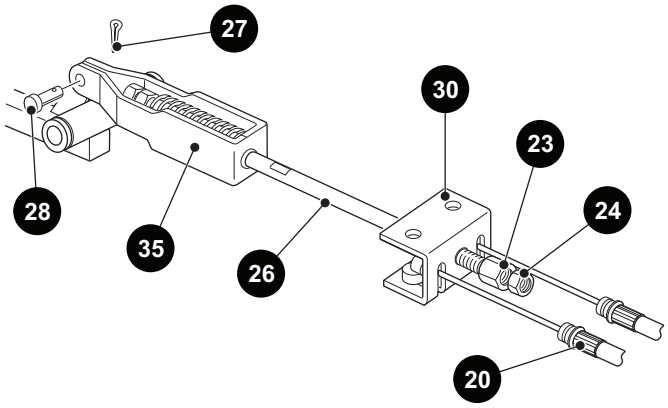


Fig. 26 Equalizer and Compensator

6. Slide the equalizer link (30) of the new assembly over the compensator rod (26).
7. Loosely install the spherical nut (23) and new locking jam nut (24).
8. Insert the cables (20) into the brackets (19).
9. Install new retaining rings (18) (Ref Fig. 25).
10. Connect the cables (20) to the brake levers using new clevis pins (22) and new cotter pins (21) (Ref Fig. 27).
11. Adjust the brake pedal free travel (See Adjusting Brake Pedal Free Travel on page 101).

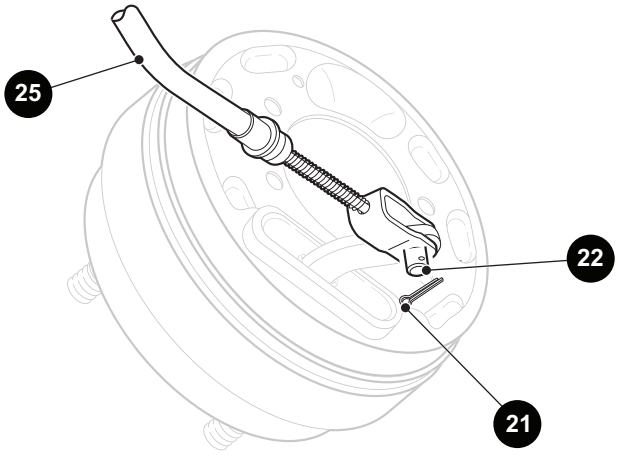


Fig. 27 Cable Connection (Drum End)

Compensator Assembly, Removal and Installation

Tool List **Qty.**

Wrench, 1/2” 1
Wrench, 9/16” 1
Pliers, Needle Nose 1

1. Disconnect the compensator assembly (35) from the brake pedal (40) by removing the cotter pin (27) and clevis pin (28) (Ref Fig. 26).
2. Loosen and remove the jam nut (24) and the spherical nut (23) connecting the compensator rod (26) to the equalizer link (30).
3. Remove the compensator assembly (35).
4. Assemble in the reverse order of removal using new cotter pins (11) in the clevis pin. If the clevis pins are worn, replace them as well.
5. Adjust the brake pedal free travel (See Adjusting Brake Pedal Free Travel on page 101).

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

Brake Pedal Removal and Installation

Tool List	Qty.
Wrench, 9/16”	1
Wrench, 3/4”	1
Socket, 9/16”	1
Socket, 3/4”	1
Screwdriver, Straight Blade	1
Pliers, Needle Nose	1
Torque Wrench, in. lbs.	1

1. Disconnect the compensator assembly (35) from the brake pedal (40) by removing the cotter pin (27) and the clevis pin (28) (Ref Fig. 28).
2. Unplug the wiring harness on models equipped with brake lights.
3. Unhook the torsion spring (36) 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.

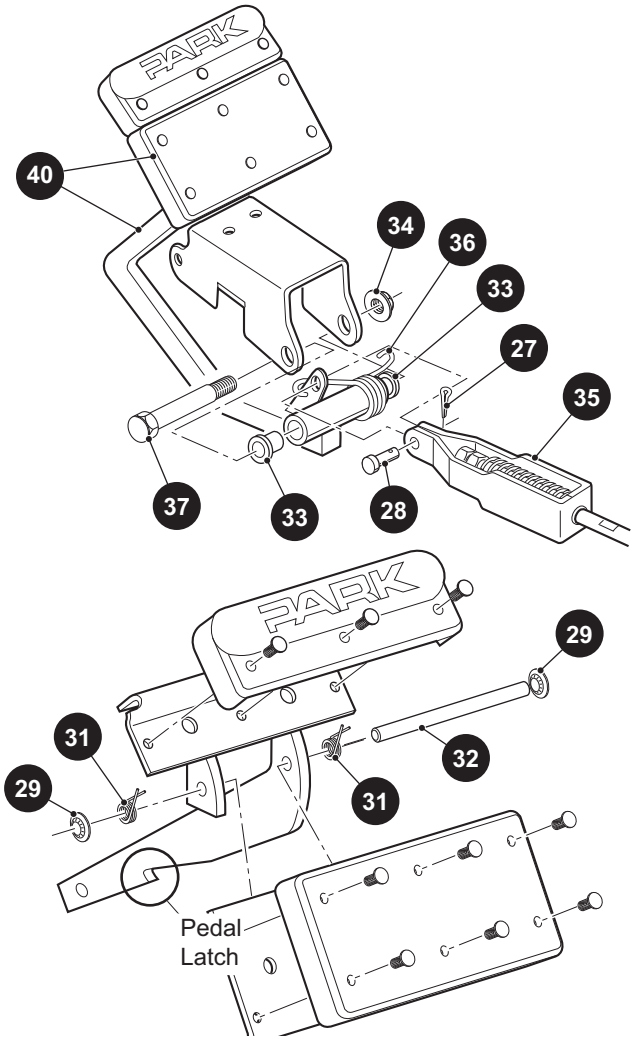


Fig. 28 Brake Pedal Removal and Installation.

4. Remove the lock nut (34) and bolt (37) and remove the brake pedal.
5. Inspect the bolt (37) for corrosion that could cause binding. The bolt and both bushings (33) must be replaced if corrosion or wear is found (Ref Fig. 28).
6. Assemble in the reverse order of removal using new cotter pins and lock nuts.
7. Tighten the nut (34) to the torque values below.
8. Connect the brake light wiring harness, if equipped.
9. Adjust the brake pedal free travel (See Adjusting Brake Pedal Free Travel on page 101).
10. Check for proper brake light operation if equipped.

Item	Torque Specification
34	8 - 11 in. lbs. (11 - 15 Nm)

Kick Off Cam Adjustment

Tool List	Qty.
Wrench. 1/4”	1
Crow’s Foot Socket, 1/4”	1
Torque Wrench, in. lbs.	1

With the parking brake engaged and fully latched, there should be no gap between the top of the cam and the latch arm (Ref Fig. 29).

1. Engage the parking brake and loosen the two cam setscrews (41).
2. Rotate the cam (42) until it is flush with (no gap) the latch arm.
3. Tighten the setscrews to the torque value below.

Item	Torque Specification
41	70 - 84 in. lbs. (8 - 9.5 Nm)

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

Parking Brake Catch Bracket Removal and Installation

Tool List **Qty.**

Wrench, 1/4” 1
Wrench, 7/16” 1
Socket, 7/16” 1
Ratchet 1

⚠ WARNING ***To prevent serious injury or death, do 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.***

1. Lift the front of the vehicle (See LIFTING THE VEHICLE on page 9).
2. Remove the front driver side wheel.
3. Remove the two bolts (38) and nuts (39) securing the catch bracket to the frame (Ref Fig. 29).
4. Assemble in the reverse order of removal using new lock nuts. Tighten the lock nuts to the torque values below.
5. If required, adjust the kick-off cam (35) (See Kick Off Cam Adjustment on page 107).
6. Install the wheel (See WHEEL AND TIRE SERVICE on page 13).

Item	Torque Specification
39	85 - 95 in. lbs. (9.5 - 10.5 Nm)

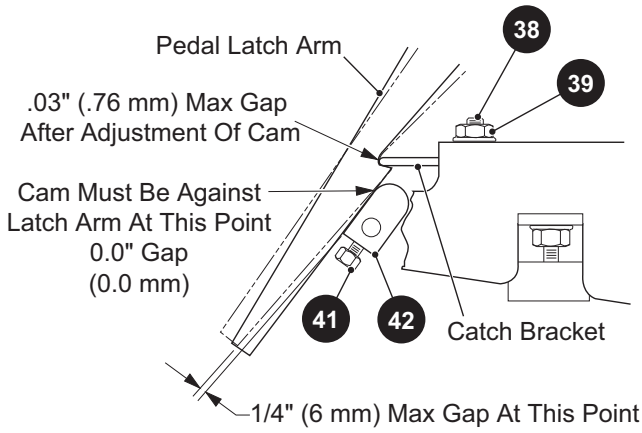


Fig. 29 Catch Bracket and Latch Arm

Parking Brake Pedal Removal and Installation

Tool List **Qty.**

Screwdriver, Straight Blade 1

1. Note the location and orientation of the two torsion springs (36).
2. Remove the push nuts (29) and pin (32) and remove the parking brake pedal (Ref Fig. 28).

⚠ WARNING ***To prevent serious injury or death, do 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.***

3. Assemble in the reverse order of removal using new push nuts (29) (Ref Fig. 28).
4. If required, adjust the kick-off cam (3) (See Kick Off Cam Adjustment on page 107).

Pedal Bumper Adjustment

Tool List **Qty.**

Wrench, 1/2” 1
Crow’s Foot Socket, 1/2”..... 1
Torque Wrench, in. lbs. 1

1. Loosen the bumper lock nut and adjust the bumper by rotating it (Ref Fig. 30).
2. The brake pedal must contact the pedal bumper when the pedal is released and the dimension from the top of the pedal arm to the setscrew heads in the kick-off cam should be approximately 1/4” - 3/8” (6 - 9.5 mm).
3. Tighten the lock nut to the torque values below.

Item	Torque Specification
Lock Nut	25 - 29 in. lbs. (3 - 3.3 Nm)

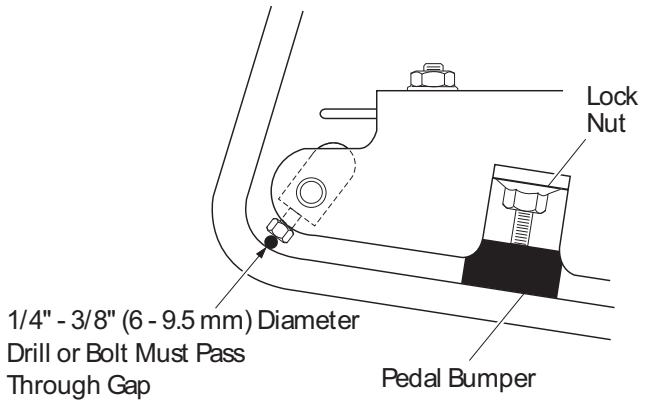


Fig. 30 Pedal Bumper Adjustment

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

Parking Brake Release Linkage and Kick-Off Cam Removal and Replacement

Tool List	Qty.
Wrench, 1/4”	1
Crow’s Foot Socket, 1/4”	1
Pliers, Needle Nose	1
Torque Wrench, in. lbs.	1

1. Remove the cotter pins (46), washers (47), and bushings (48) securing the linkage rod (45) to the accelerator pedal and the kickoff cam pivot (50). Remove the linkage rod (Ref Fig. 31).
2. Inspect the bushings (48) and replace them if they are worn.
3. Loosen the two setscrews (41) securing the cam (42) to the cam pivot (50).
4. Remove the cam (42), bushings (44), and spacer (43).
5. Inspect the bushings (44) and spacer (43) and replace them If they are worn.

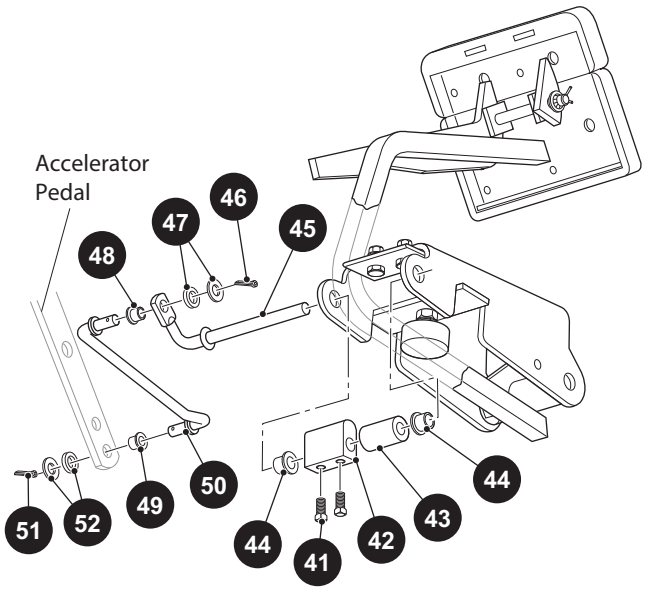


Fig. 31 Parking Brake Release Linkage and Kick-Off Cam Removal and Installation.

6. Assemble in the reverse order of removal using new epoxy patch setscrews (41).
7. Adjust the kickoff cam (42) (See Kick Off Cam Adjustment on page 107).
8. Tighten the setscrews (41) to the torque values than below.

Item	Torque Specification
41	70 - 84 in. lbs. (8 - 9.5 Nm)

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

Notes:

REAR AXLE

⚠ CAUTION ***The rear axle is a precession assembly and, therefore, must be repaired or replaced with extreme care in a very clean environment. Before attempting to repair the rear axle, be sure to read and fully understand all of the following content and illustrations and then begin to disassemble the axle manually.***

Use extra caution when handling splined shaft.

It is recommended that whenever you remove the bearing, sealing, or O-ring, no matter how many miles the vehicle has traveled, replace with new ones. Before installation, be sure to use a light oil to clean the sealing and O-ring.

⚠ WARNING ***In order to reduce the possibility of personal injury, it is necessary to follow the safety section of this manual for the lifting procedure. Place chocks both in front of and behind the front wheel and before starting the repairs. Be sure to check the stability of the vehicle on the jack stands. Do not work on any vehicle supported with only a jack.***

REAR AXLE MAINTENANCE

The only maintenance required for the first five years or 1000 hours of operation is the periodic inspection of the lubricant level. Unless leakage is evident, the lubricant only needs to be replaced every five years.

Replacing the Lubricant

Tool List	Qty.
Wrench, 1/2”	1
Socket, 1/2”	1
Ratchet	1
Ball Peen Hammer	1
Rigid Gasket Scraper or Putty Knife	1
Torque Wrench, ft. lbs.	1
Floor Jack	1
Jack Stands	4

If the lubricant is to be replaced, the vehicle must be raised and supported on a level plane (See LIFTING THE VEHICLE on page 9).

⚠ WARNING ***To decrease the risk of possible personal injury, follow the lifting procedure. Place wheel chocks in front of and behind the front wheels and check the stability of the vehicle on the jack stands before starting any repair procedure. Never work on any vehicle that is supported by a jack alone (See LIFTING THE VEHICLE on page 9).***

1. Remove the bolts (1) securing the oil pan (5) to the differential housing (10) (Ref Fig. 1).
2. Separate the oil pan (5) from the differential housing.
3. Remove all traces of the old gasket material from the both surfaces and from the bolt holes.
4. Clean the oil pan after emptying the old oil.

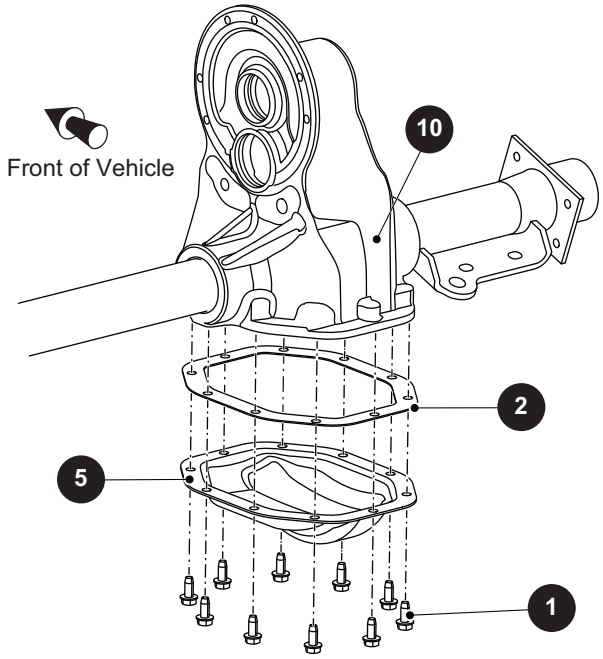


Fig. 1 Removal of Oil Pan

5. Apply Permatex RTV or equivalent to the gasket flange on the oil pan according to the product instructions.
6. Install the oil pan bolts (1) finger tight and then tighten to the torque values below in a cross bolt pattern.

Item	Torque Specification
1	16 - 24 ft. lbs. (22 - 33 Nm)

REAR AXLE

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

Fill Procedure

Tool List	Qty.
Fluid Pump	1
Flexible Tubing (to fit end of fluid pump)	3’ - 4’

Check the rear axle oil filler plug, and if the oil fill plug is equipped, operate according to the steps mentioned below:

1. Remove the fill plug.
2. Insert the flexible tubing into the opening where the fill plug was removed.
3. Connect the flexible tubing to the fluid pump.
4. Fill with 24 - 26 fl. oz. of MOBILFLUID 424.
5. Install the fill plug.

REAR AXLE REMOVAL

Please refer to the following section for axle removal (See REAR AXLE on page 117).

REAR AXLE DISASSEMBLY

Axle Shaft, Bearing and Seal Removal

Tool List	Quantity
Pliers, Needle Nose	1
Pliers, Internal Snap Ring	1
Arbor Press	1
Bearing Separator	1
Slide Hammer (P/N 18753G1)	1
Seal Puller	1
Seal Installer (P/N 18739G1)	1
Hammer, Ball Peen	1

1. Remove the outer snap ring (3) from the axle tube (Ref Fig. 2).

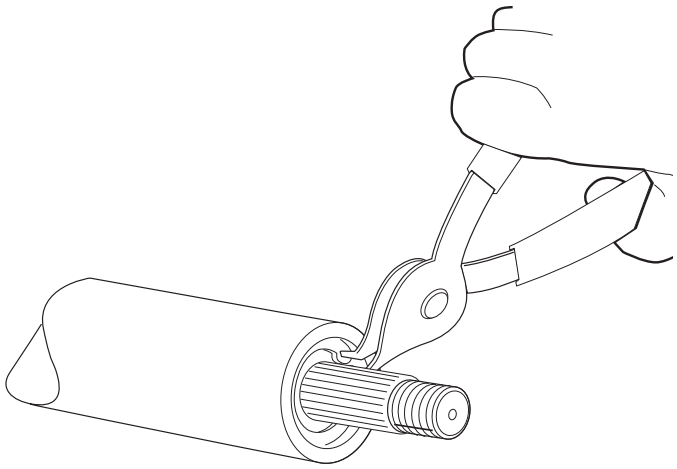


Fig. 2 Outer Snap Ring

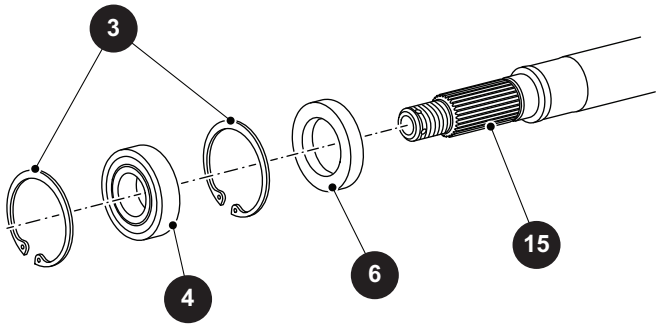


Fig. 3 Half Axle Parts

2. Attach a slide hammer to the axle shaft thread and remove the axle shaft (15), bearing (4) and retaining rings (3) from the axle tube as a complete assembly (Ref Fig. 3) (Ref Fig. 4).

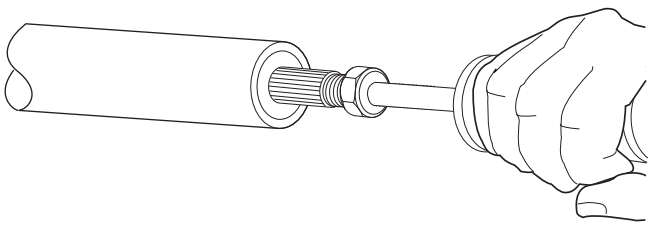


Fig. 4 Remove Axle Shaft

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

3. Remove the bearing by supporting the inner race of the bearing on an arbor press bed and applying pressure to the threaded end of the axle shaft (Ref Fig. 5).

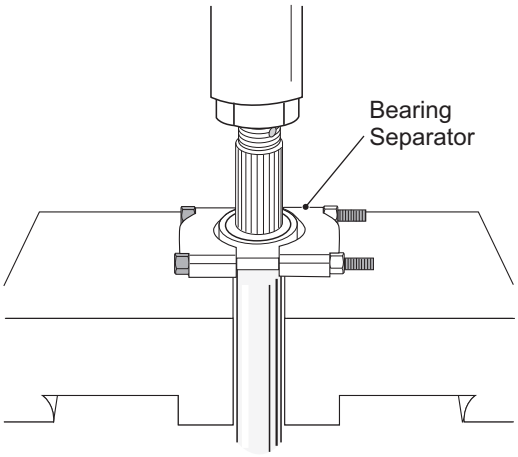


Fig. 5 Press Bearing from Shaft

4. Remove the inner snap ring (Ref Fig. 6).

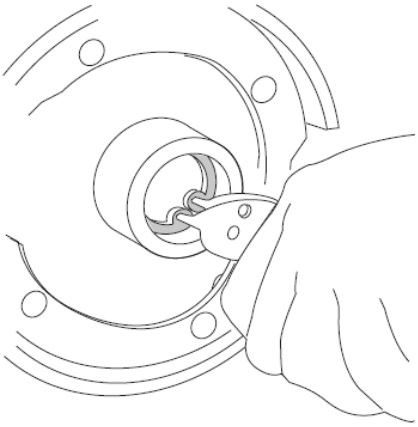


Fig. 6 Inner Snap Ring

⚠ CAUTION ***Use caution to prevent damage to the inner surface of the axle tube at the seal area.***

5. Remove the oil seal using a seal puller (Ref Fig. 7).

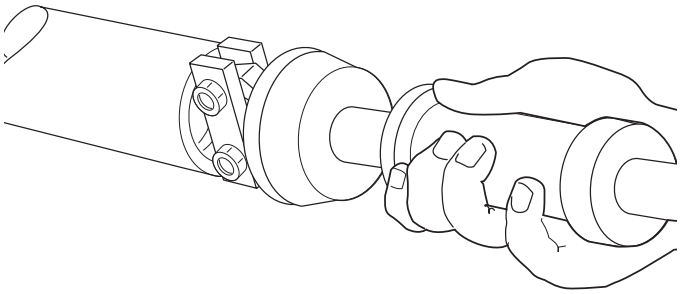


Fig. 7 Oil Seal Removal

6. Install the new oil seal using the seal installer (P/N 18739G1) to drive the seal into its correct position (Ref 7.).

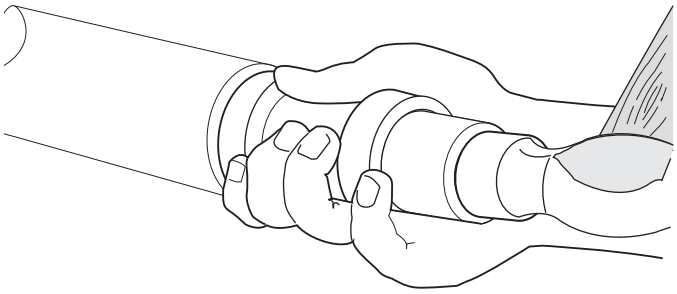


Fig. 8 Seal Installation

7. Install the inner snap ring.

⚠ CAUTION ***To prevent damage to the oil seal, lightly coat the axle shaft with bearing grease and support the shaft during installation.***

8. Carefully insert the axle shaft and bearing assembly through the oil seal. Rotate the shaft until the spline engages with the differential side gears.
9. Install the outer snap ring.
10. Install the rear hub.

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

Notes:

REAR SUSPENSION

GENERAL

⚠ WARNING ***To reduce the possibility of personal injury, follow the lifting procedure. Place wheel chocks in front of and behind the front wheels and check the stability of the vehicle on the jack stands before starting any repair procedure. Never work on any vehicle that is supported by a jack alone (See LIFTING THE VEHICLE on page 9).***

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 the original position unless otherwise stated. Non specified torques are shown in the torque table (See HARDWARE on page 5).

The rear suspension consists of the leaf springs, shocks, and the hardware that secures these items and mounts the leaf springs to the axle and to the vehicle frame. The removal of the rear axle is also covered in this section due to the nature of it being interrelated to the suspension components.

SHOCK ABSORBER

Removal

Tool List	Qty.
Wrench, 1/4”	1
Wrench, 9/16”	1
Deep Socket, 9/16”	1
Ratchet	1
Floor Jack	1
Jack Stands	2
Wheel Chocks	4

1. Lift and support the rear of the vehicle and remove the rear wheels (See LIFTING THE VEHICLE on page 9) (See WHEEL AND TIRE SERVICE on page 13).
2. Remove the vinyl cap (4), hex nut (3), washer (1), and rubber bushing (2) from the lower end of the shock absorber (5) (Ref Fig. 1).
3. Remove the vinyl cap, hex nut, washer, and rubber bushing from the upper end of the shock absorber
4. Compress the shock absorber and remove it from between the frame mounting bracket (15) and the lower mounting plate (10).

Installation

1. Install a washer (1) with the cupped surface facing upward and the rubber bushing (2) on the top stud of the shock absorber (5) (Ref Fig. 1).
2. Install a washer with the cupped surface facing downward and the rubber bushing on the bottom stud of the shock absorber.
3. Insert the top stud into the mounting hole on the frame bracket (15) and compress the shock absorber until the bottom stud can be installed into the lower mounting plate (10).
4. Install a rubber bushing and washer with the cupped surface facing down on the upper shock absorber stud.
5. Install the hex nut (3) and tighten it until the rubber bushing expands to the same diameter as the washer.
6. Install a rubber bushing and washer with the cupped surface facing up on the lower shock absorber stud.
7. Install the hex nut and tighten it until the rubber bushing expands to the same diameter as the washer.

Removal and installation of the shock absorber is the same for both sides of the vehicle.

⚠ CAUTION ***Replace any worn or damaged hardware with new parts.***

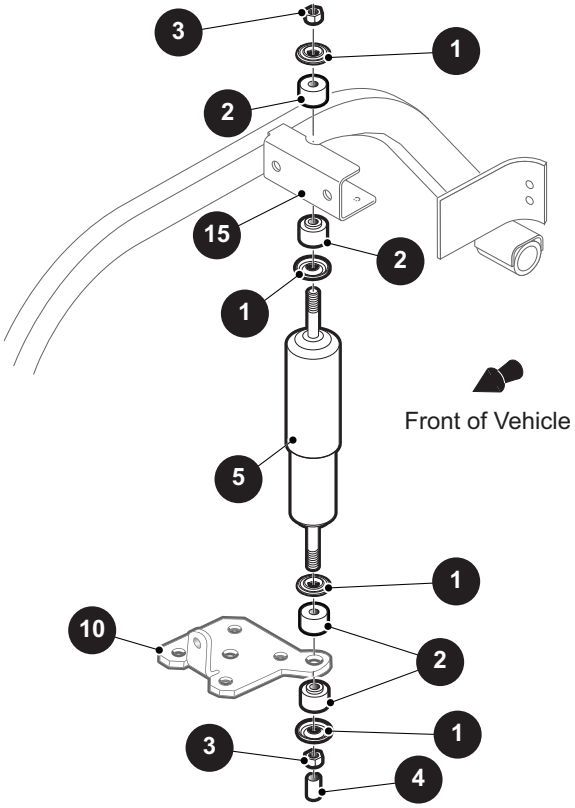


Fig. 1 Shock Absorber

REAR SUSPENSION

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

REAR LEAF SPRINGS

NOTICE: If the 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.

NOTICE: Be sure to note whether the springs are mounted on top or bottom of the axle.

Tool List	Qty.
Wrench, 9/16”	1
Wrench, 3/4”	1
Socket, 9/16”	1
Ratchet	1
Torque Wrench, ft. lbs.	1
Floor Jack	1
Jack Stands	4
Wheel Chocks	4

Removal

1. Lift and support the rear of the vehicle and remove the rear wheels (See LIFTING THE VEHICLE on page 9) (See WHEEL AND TIRE SERVICE on page 13).
2. Remove the shock absorbers (See SHOCK ABSORBER on page 115).
3. Remove the lock nuts (11) and washers (13) from the bolts (7) and remove the bolts from the lower leaf spring mounting brackets (25) (Ref Fig. 2).
4. Remove the upper leaf spring mounting bracket (21).
5. Place a floor jack under the rear frame and lift the vehicle enough to relieve pressure from the leaf springs on the lift bracket (19) and rear axle.
6. Remove the bolts (8) and lock nuts from the lower shackles (18) at the rear of the leaf spring.
7. Remove the bushings (14) and spacers (17).
8. Remove the lock nut (9), bolt (6), and bushings (16) from the forward leaf spring mounting bracket (15) on the frame.
9. The leaf spring (20) can now be removed from the vehicle.
10. Remove the lock nut (12), bolt (8), shackles (18), bushings (14), and spacer (17) from the rear mounting bracket on the frame.

Installation

1. Inspect all of the bushings and the hardware and replace any worn or damaged parts with new hardware.
2. Make sure that the lift bracket (19) is correctly positioned on top of the axle (Ref Fig. 2).
3. Install the large bushings (16) in the forward end of the leaf spring and place the leaf spring in the forward mounting bracket (15).
4. Install the bolt (6) and new lock nut (9) to secure the forward end of the leaf spring (20) in the bracket.
5. Install one pair of the smaller flanged bushings (14) and the spacer (17) in the rear frame mounting holes.
6. Position the shackles (18) over the bushings and install the bolt (8) and nut (12) in the upper bolt hole.
7. Install the remaining pair of smaller flanged bushings (14) and the spacer (17) in the rear of the leaf spring.
8. Position the leaf spring (20) into the shackles and install the bolt (8) and lock nut (12).
9. Align the pin on the leaf spring with the holes in the lift bracket (19) and upper leaf spring mounting plate (21).
10. Install the bolts (7) and washers (13) then secure in place with new lock nuts (11).
11. Torque all hardware to the torque values below making sure that the leaf spring pin remains aligned with the holes in the leaf spring mounting plate.

Removal and installation of the leaf spring is the same for both sides of the vehicle.

Item	Torque Specification
9	18 - 23 ft. lbs. (24.5 - 31 Nm)
11	16 - 20 ft. lbs. (21.5 - 27 Nm)
12	10 - 15 ft. lbs. (13.5 - 20 Nm)

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

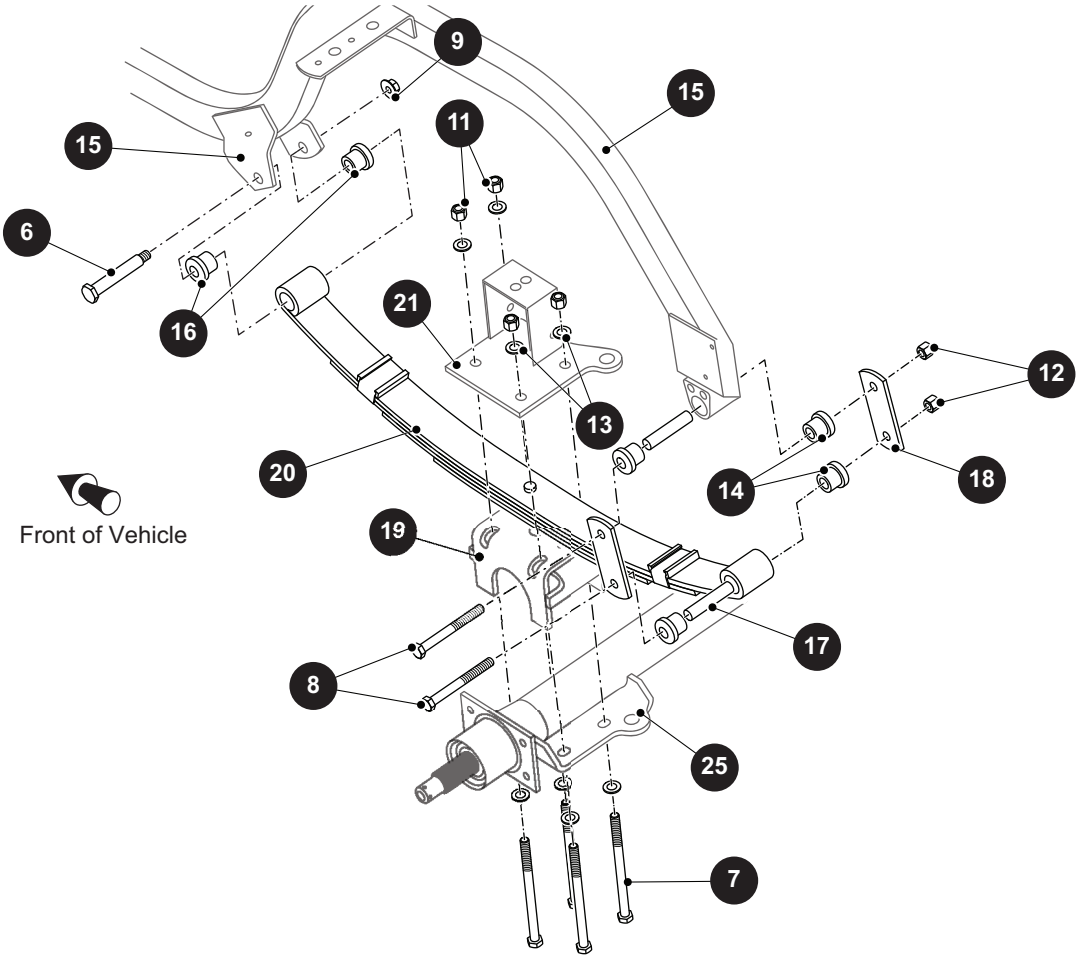


Fig. 2 Leaf Springs

REAR AXLE

Tool List	Qty
Wrench, 10mm	1
Wrench 1/4”	1
Wrench, 9/16”	1
Insulated Wrench, 9/16”	1
Wrench, 3/4”	1
Socket, 10mm	1
Socket, 9/16”	1
Deep Socket, 9/16”	1
Chalk or Paint Pen	1
Ratchet	1
Torque Wrench, ft. lbs.	1
Floor Jack	1
Jack Stands	4
Wheel Chocks	4

WARNING ***To reduce the possibility of personal injury, follow the lifting procedure of this manual (See LIFTING THE VEHICLE on page 9). 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 any vehicle that is supported by a jack alone.***

Removal

1. Lift and support the rear of the vehicle on the outer ends of the rear bumper (See LIFTING THE VEHICLE on page 9).
2. Remove the wheels (See WHEEL AND TIRE SERVICE on page 13).
3. Remove the motor (See Motor Removal on page 69).

4. Remove the shock absorbers (See SHOCK ABSORBER on page 115).
5. Remove the clevis pin from both brake cables where they attach to the wheel brake levers (See MECHANICAL BRAKES on page 89).
6. Remove the retaining rings at the axle end of the outer brake cable and move cables out of the way of the axle.
7. Place a floor jack under the center section of the rear axle and raise just enough to place a second set of jack stands under the axle tubes.
8. Remove the bolts (7) securing the axle to the leaf springs (20) (Ref Fig. 2).
9. Remove the jack stands from beneath the axle and lower the floor jack to remove the axle.

Installation

Assemble in the reverse order of removal.

Tighten all hardware to the torque values listed in the proper section (See SHOCK ABSORBER on page 115)(See REAR LEAF SPRINGS on page 116)(See Motor Installation on page 70).

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

Notes:

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

Notes:

WEATHER PROTECTION

GENERAL

⚠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 available from Service Parts.

Trailering

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

Secure the vehicle and contents.

Never ride on a vehicle being transported.

Always remove the windshield before trailering.

Maximum speed with the 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 the vehicle below highway speeds, check for tightness of hardware and cracks in the sun top at the mounting points. Always remove the 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 and load (see GENERAL SPECIFICATIONS for vehicle weight). Lock the park brake and secure the vehicle using ratchet tie downs.

SUN TOP

Tool List	Qty.
Plastic faced mallet	1
Wrench, 1/2"	1
Wrench, 9/16"	1
Socket, 1/2”	1
Socket, 9/16”	1
Ratchet	1
Screwdriver, Straight Blade	1
Torque Wrench, ft. lbs.	1

1. Remove the lock nuts (4), bolts (1), washers (2, 6), and spacers (3) securing the sun top (5) to the rear strut (10) (Ref Fig. 1).

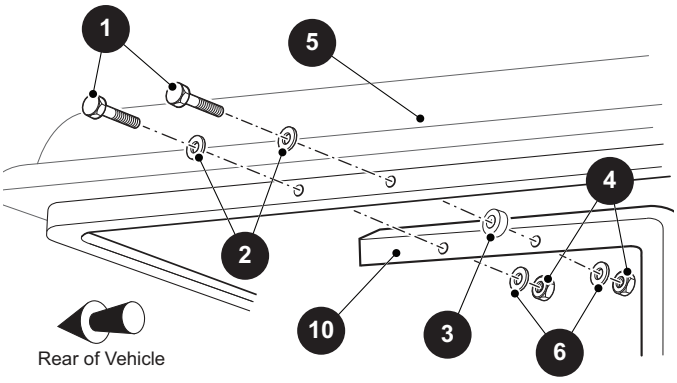


Fig. 1 Sun Top Rear

2. Remove the nuts (7), bolts (12), washers (8, 11), and spacers (9) securing the sun top (5) to the front strut (15) (Ref Fig. 2).

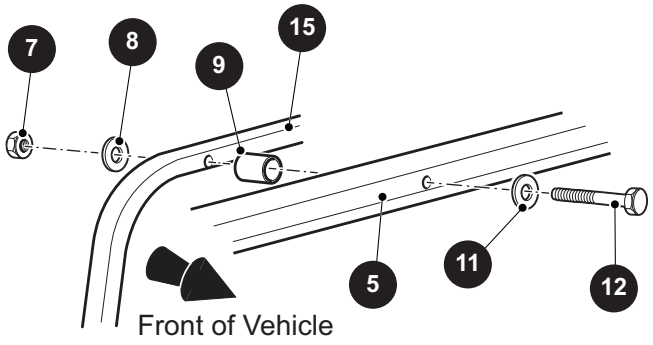


Fig. 2 Sun Top Front

3. Remove the sun top from the vehicle.

4. Remove the bolts (13), washers (16, 14, 17), and spacers (18) securing the front struts (15) to the cowl.

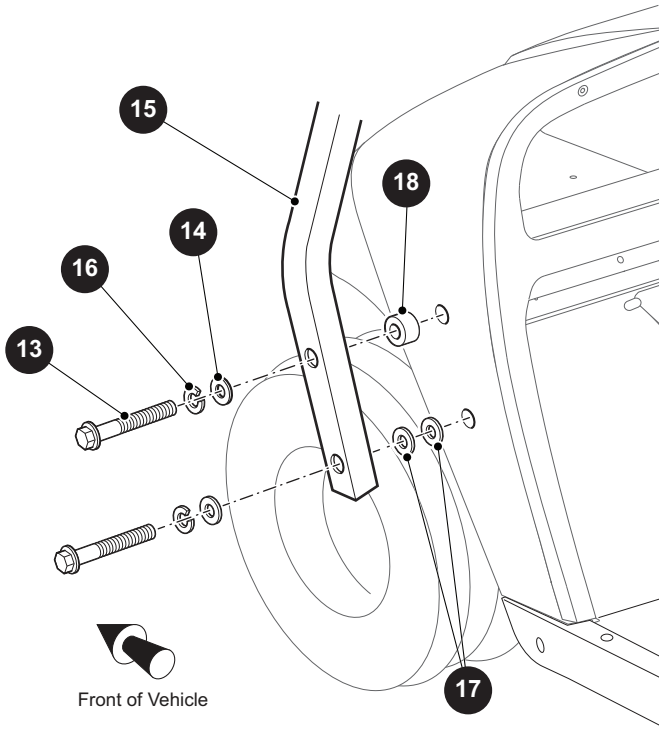


Fig. 3 Front Struts

5. Remove the lock nuts (19), bolts (23), and washers (21, 22) securing the rear strut (10) to the seat back support (20).

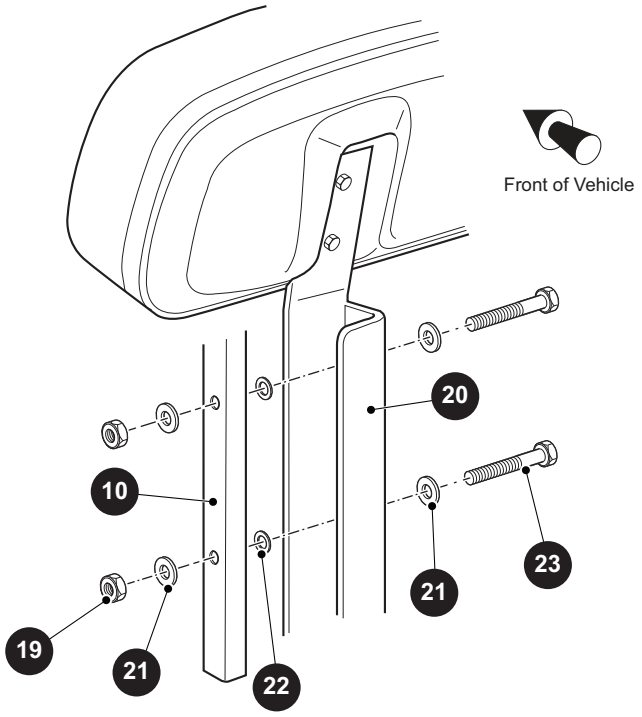


Fig. 4 Rear Struts

Assemble in the reverse order or removal. Tighten all hardware to the torque values below using new lock nuts.

Item	Torque Specification
4, 7, 13, 19	13 - 15 ft. lbs. (17.6 - 20.3 Nm)

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

SPILT WINDSHIELD

Tool List	Qty.
Wrench, 15 mm	1
Socket, 15 mm	1
Torx Plus Bit, 45 IP	1
Ratchet	1
Pry Bar	1
Torque Wrench. in. lbs.	1

⚠ CAUTION ***Use cation not to warp windshield when raising and lowering the top section of windshield.***

1. Remove the lock nuts (27) and bolts (24) securing the lower portion of the windshield (25) to the vehicle.
2. Fold down the upper portion of the windshield.
3. Pull the sashes (31) away from the front strut by pulling towards the front of the vehicle starting from the top and working down. It may be necessary to pry the sash away using a small pry bar.
4. Inspect the rubber grommets (26), lower seal (33), upper windshield latches (28), sashes (31) and windshield bumpers (32) for damage and replace if necessary.

Assemble in the reverse order of removal using new lock nuts. Tighten all hardware to the torque values below.

NOTICE: Do not over-tighten or squeeze the rubber grommets.

Item	Torque Specification
27	70 - 97 in. lbs. (8 - 11 Nm)

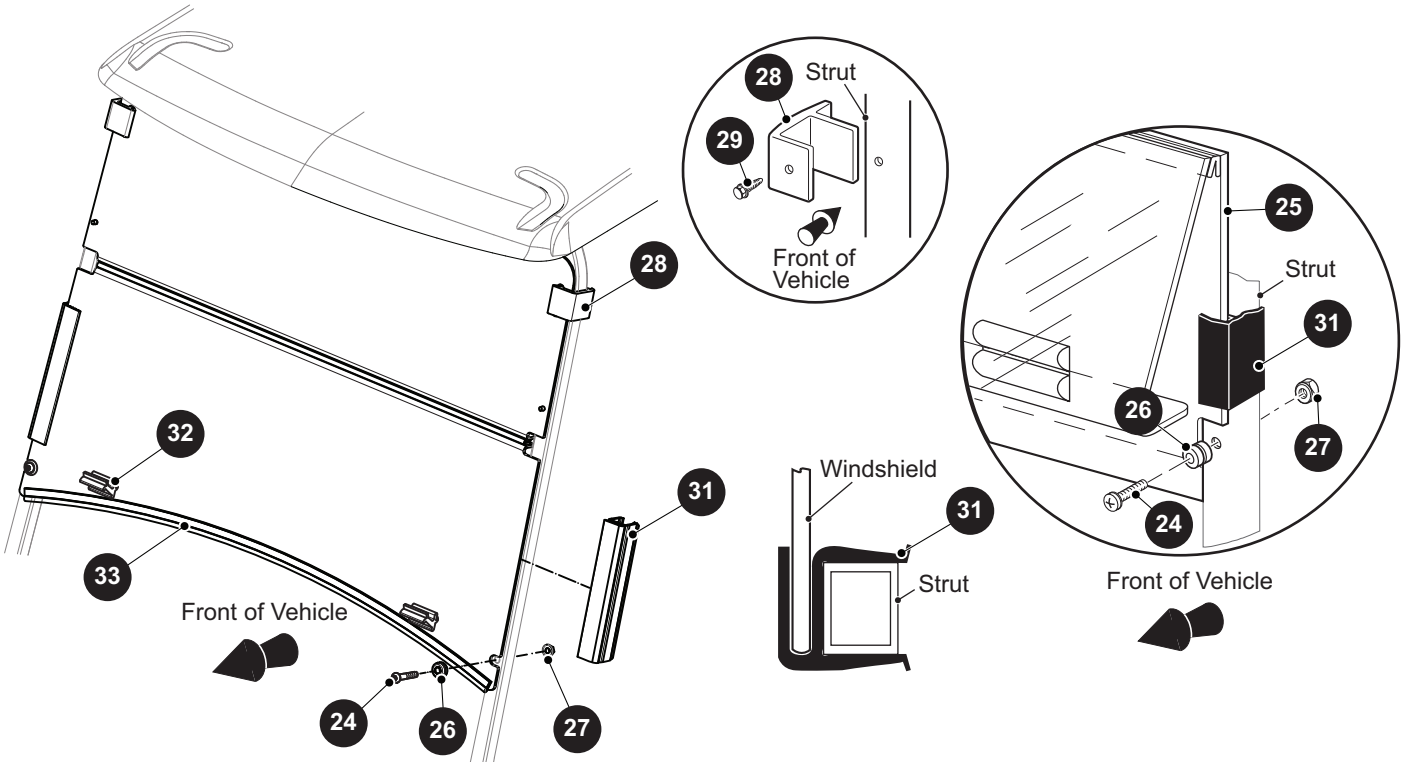


Fig. 5 Split Windshield

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

FULL WINDSHIELD

Tool List	Qty.
Wrench, 15 mm	1
Socket, 15 mm	1
Torx Plus Bit, 45 IP	1
Ratchet	1
Pry Bar	1
Torque Wrench, in. lbs.	1

1. Remove the lock nuts (27) and bolts (24) securing the lower portion of the windshield (25) to the vehicle.
2. Pull the sashes (31) away from the front strut by pulling towards the front of the vehicle starting from the top and working down. It may be necessary to pry the sash away using a small pry bar.
3. Inspect the rubber grommets (26), lower seal (33), and sashes (31) for damage and replace if necessary.
4. Assemble in the reverse order of removal using new lock nuts. Tighten all hardware to the torque values below.

NOTICE: Do not over-tighten or squeeze the rubber grommets.

Item	Torque Specification
27	70 - 97 in. lbs. (8 - 11 Nm)

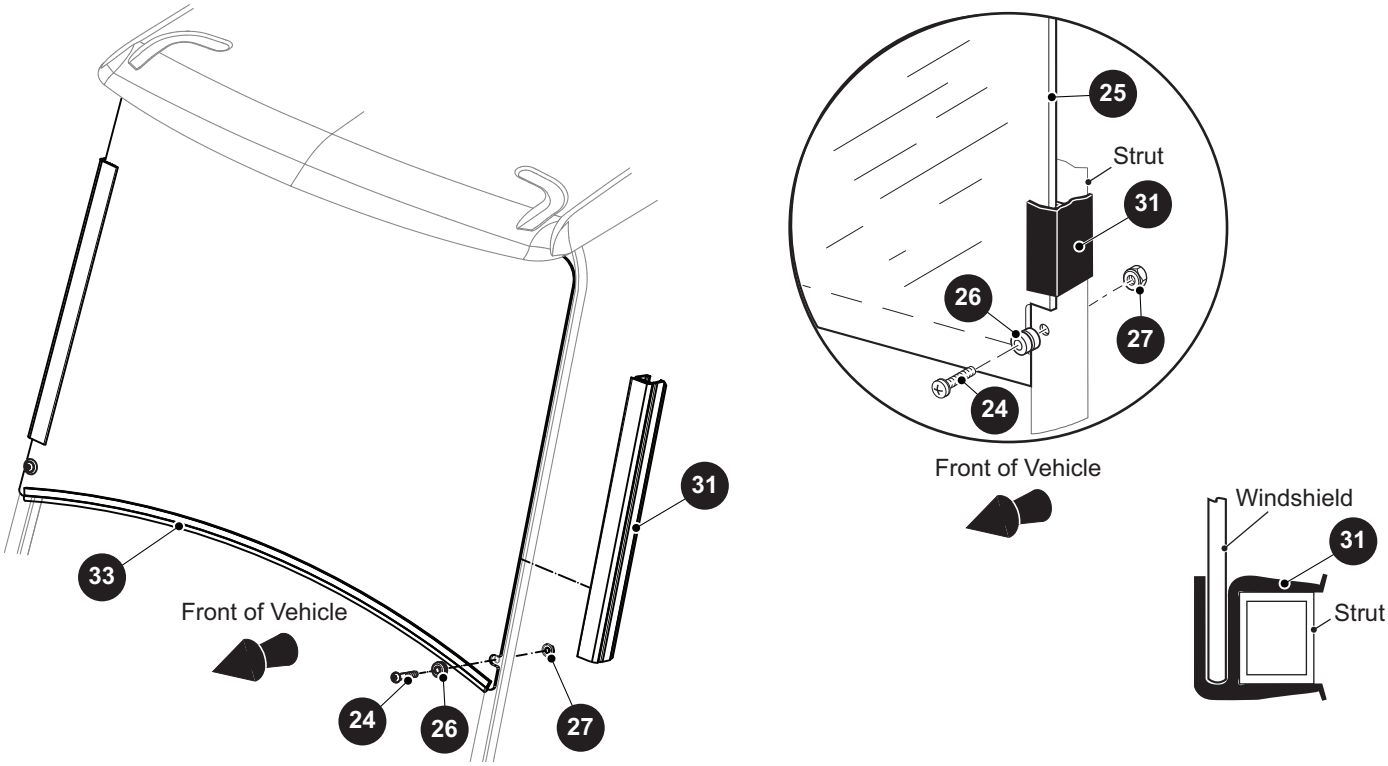


Fig. 6 Full Windshield

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

Notes:

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

Notes:

FAULT TESTING

SUSPENSION AND STEERING

Condition	Possible Cause	Correction
UNEVEN TIRE WEAR	Incorrect tire pressure	Inflate to recommended pressure
	Improper alignment (Incorrect toe in)	Align front tires
STIFF STEERING	Water has entered steering box and can freeze in cold conditions	Remove steering column, pinion and bearing and remove water before adding grease; Inspect gasket for good seal
	Excessive grease in steering box has moved into steering rack bellows	Raise the vehicle and observe the rack bellows while moving the steering from lock to lock Any distortion of the bellows can indicate an excess of grease has accumulated in the bellows Remove the bellows and remove excess grease
	Insufficient lubricant in king pins, tie rod ends, idler bushing, rack tensioner or steering box	Add one shot of lubricant to each grease fitting and operate steering from lock to lock. Do not over grease If steering does not return to acceptable condition, proceed to next step
	Bent rack	Remove rack and place on flat surface with rack teeth up; If a 0.015” (0.381 mm) feeler gauge will pass under the rack, the rack must be replaced
PLAY IN STEERING	Steering wheel loose	Inspect splines - replace steering wheel if required; Tighten steering wheel nut
	Steering components worn	Replace
	Loose wheel bearings	Adjust or replace
VIBRATION	Steering components worn	Replace
	Loose wheel bearings	Adjust or replace
	Out of round tires, wheels, or brake drums	Inspect and replace if out of round
STEERING PULLS TO ONE SIDE	Incorrect tire pressure	Inflate to recommended pressure
	Dragging wheel brakes	Service brake system
	Suspension component failure	Repair
	Alignment incorrect	Align

Fig. 1 Suspension and Steering Fault Diagnosis

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

CURTIS CONTROLLER

General

Use the Curtis handheld programmer for programming, fault testing, tuning, diagnosing and adjusting parameters for the speed controller and auxiliary devices (Ref Fig. 2).

Fig. 2 Curtis Handheld Programmer

WARNING ***Connect the Curtis handheld programmer power cord to the Curtis programmer port only. If connected to the wrong port, voltage from other interface circuits can permanently damage the programmer.***

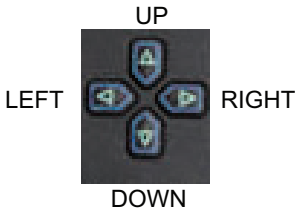
Fig. 3 Curtis Programmer Port

Fig. 4 Curtis Programmer Port Installation

Connect the Molex plug to the receptacle on the face of the controller.

Navigation

A blinking square on the left indicates the position of the cursor.



The blinking square moves vertically when the up or down arrow on the navigation key is pressed.

Press the right arrow on the navigation key to display a column of sub-menus. Press the right arrow a second time to display more than one level of sub-menus.

Changing Data Value

Press the up or down arrow on the data value key to change the value of the parameter.

Favorites

Press the favorites (star) key for four seconds (until the favorites set screen is displayed), to set a position in the menu.

Press the appropriate favorites key to move to a selected favorites position.

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

Main Menu Definitions

- PARAMETERS - Shows vehicle profile setting and adjustability.
- MONITOR - Shows vehicle real-time diagnostics.
- DIAGNOSTICS - Shows active and past faults.

NOTICE: The programmer does not request confirmation before deleting fault code history. Pressing "DELETE ALL" will permanently remove any historical codes.

- PROGRAMMING - Shows parameter setting uploads and downloads.
- SYSTEM INFO- Shows controller information.
- HHP SETTINGS- Shows handheld information and adjustment.

Menu	Submenu 1	Submenu 2	Submenu 3	Data Range	Default value
Parameters	Reset Controller			0 - 1	0
Monitor	Solenoid Coil			On - Off	On
	Rear Node Select			On - Off	On
	Solenoid PWM			0 - 100	0%
	Rear Controller	Run / Tow Switch		On - Off	
		Key Switch or Charger		On - Off	Off
		Economy Mode Switch		On - Off	Off
		Forward Switch		On - Off	Off
		Reverse Switch		On - Off	Off
		Throttles	Raw Primary Throttle	0.00 - 5.00	0.73V
			Mapped Primary Throttle	0 - 100	0.00%
			Raw Redundant Throttle	0.00 - 5.00	0.37V
			Mapped Redundant Throttle	0 - 100	0%
	Inputs	Throttle Command		0 - 100	0%
		Mapped Throttle		0 - 100	0%
		Throttle Pot		0.00 - 5.50	0.73V
		Pot2 Raw		0.00 - 5.50	0.37V
		Interlock		On - Off	Off
		Analog 2		0.00 - 10.00	1.24V
	Outputs	5 Volts		0.00 - 6.25	4.94V
		12 Volts		0.00 - 12.00	12.42V
		Ext Supply Current		0 - 200	63mA
		Pot Low		0.00 - 6.25	0.20V
	Battery	BDI		0 - 100	75%
		Capacitor Voltage		0.0 - 105.0	3.1V
		Key Switch Voltage		0.0 - 105.0	77.0V
	Motor	Motor RPM		-12000 - 12000	0 RPM
		Temperature		-100 - 300	29 °C
		Motor Speed A		-12000 - 12000	0 RPM
		Motor Speed B		-12000 - 12000	0 RPM

Fig. 5 CURTIS Handheld Controller Main/Sub-menus

Menu	Submenu 1	Submenu 2	Submenu 3	Data Range	Default value
Monitor (continued)	Controller	Current (RMS)		0.0 - 1000.0	≈1A
		Modulation Depth		0.0 - 100	0.00%
		Frequency		-300.0 - 300.0	0.0Hz
		Temperature		-100 - 300	25ºC
		Regen		On - Off	On
		Cutbacks	Motor Temp Cutback	0 - 100	100%
			Controller Temp Cutback	0 - 100	100%
			Under voltage Cutback	0 - 100	0%
			Over voltage Cutback	0 - 100	100%
	Vehicle	Vehicle Speed		-3276.8 - 3276.7	0
		Vehicle Odometer		0.0 - 10000000.0	Varies
		Braking Distance		0.0 - 1000000.0	0
		Distance Since Stop		0.0 - 1000000.0	
Diagnostics	Present Errors			Display active faults.	
	Fault History			Display non - active faults	
Functions	Settings	Get Settings From Controller		OK - Abort	
		Write Settings To Controller		OK - Abort	
		Reset All Settings		Yes - No	

Fig. 5 CURTIS Handheld Controller Main/Sub-menus (Continued)

Menu	Submenu 1	Submenu 2	Submenu 3	Data Range	Default value
Controller Information	Model Number			Display the controller model number	Display the controller model number
	Serial Number			Display the controller serial number	Display the controller serial number
	Hardware Version			Display the controller hardware version	Display the controller hardware version
	Protocol Version			Display the controller protocol version	Display the controller protocol version
	Parameter Block Version			Display controller PB version	Display controller PB version
	Model Number			Display the controller model number	Display the controller model number
	Mfg. Date Code			Display controller date of manufacture	Display controller date of manufacture
	OS Version			Display controller operating system	Display controller operating system
	Build Number			Display controller OS build number	Display controller OS build number
	SM Version			Display controller SM version	Display controller SM version
	VCL App Version			Display VCL App Version	Display VCL App Version

Fig. 5 CURTIS Handheld Controller Main/Sub-menus (Continued)

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

Menu	Submenu 1	Submenu 2	Submenu 3	Data Range	Default value
HHP Settings	Program	LCD Contract	-300		0
		Language		English	English
		Set Security Code		Set user lock code	
	Faults	Fault History		Display fault history of 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	
		Manufacturing Date		Display handheld manufacture date	
		Software Version		Display handheld software version	
		Hardware Version		Display handheld hardware version	
		MC-Protocol Version		Display MC-Protocol version	
		ES-Protocol Version		Display ES-Protocol version	
		S-Protocol Version		Display S-Protocol version	
		Device Type		Display device type	

Fig. 5 CURTIS Handheld Controller Main/Sub-menus (Continued)

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

LED Fault Code Chart

DIAGNOSTICS: Diagnostics information can be obtained by two methods:

- by reading the display on a 1313 programmer or
- by observing the fault codes issued by the Status LEDs on the top of the controller.

The 1313 programmer displays all faults that are currently set, as well as a history of the faults that have been set since the history log was last cleared. The 1313 displays the faults by name.

The pair of LEDs built into the controller (one red, one yellow) produce flash codes that display all the currently set faults in a repeating cycle. Each code has two digits. The red LED flashes once to indicate that the first digit of the code will follow, and the yellow LED then flashes the appropriate number of times for the first digit. The red LED flashes twice to indicate that the second digit of the code will follow, and the yellow LED flashes the appropriate number of times for the second digit.

Example: Battery Undervoltage (code 23).

In the Diagnostics menu of the 1313 programmer, the words “Undervoltage Cutback” will be displayed; the real-time battery voltage is displayed in the Monitor menu / Battery sub-menu: (”Keyswitch Voltage”).

The controller’s two LEDs will display this repeating pattern:

RED	YELLOW	RED	YELLOW
*	**	**	***
(first digit)	(2)	(second digit)	(3)

Fig. 6 Summary of LED Display Formats

The numerical codes used by the yellow LED are listed in the fault diagnosis chart, which also lists possible fault causes and describes the conditions that set and clear each fault.

The two LED’s have four different display modes that indicate the type of information they provide.

TYPES OF LED DISPLAY	
DISPLAY	STATUS
Neither LED illuminated	Controller is not powered on; or vehicle has dead battery; or severe damage.
Yellow LED flashing	Controller is operating normally.
Yellow and red LEDs both on solid	Controller is in Flash program mode.
Red LED on solid	Watchdog failure or no software loaded. Cycle KSI to restart, and if necessary load software.
Red LED and yellow LED flashing alternately	Controller has detected a fault. 2-digit code flashed by yellow LED identifies the specific fault; one or two flashes by red LED indicate whether first or second code digit will follow.

LED Code	1313 Display	Explanation	Controller Response	Recover When	Possible Cause
1-2	**Controller Over current**	Phase Current exceeded current limits	Vehicle Disabled	KSI Cycled	1.External short of phase U,V or W 2.Check wiring 3.Motor parameters are mis-tuned 4.Defective controller 5.Speed encoder noise problems
1-3	**Current Sensor Fault**	Controller current sensors have invalid offset reading	Vehicle Disabled	KSI Cycled	1.Short to car frame from phase U,V or W. 2.Controller defective
1-4	**Precharge Failed**	Capacitor bank failed to charge at KSI voltage	Vehicle Disabled	Cycle interlock	1.See handheld monitor menu - battery: capacitor voltage 2.External load on capacitor bank preventing capacitor charge 3.Check wiring 4.Check brake sensor if other faults are found
1-5	**Controller Sever Undertemp**	Heat sink temperature below -40ºC	Vehicle Disabled	Raise controller temp to above -40*C and cycle KSI or interlock	1.Controller is operating in an extreme environment 2.See monitor menu - controller: temperature
1-6	**Controller Sever Over temp**	Heat sink temperature above +95ºC	Vehicle Disabled	Reduce heat sink temperature below 95*C and cycle KSI or interlock	1.Controller is operating in an extreme environment 2.See monitor menu - controller: temperature 3.Excessive load on vehicle 4.Improper mounting of controller
1-7	**Severe Under voltage**	Capacitor voltage dropped below limit	Reduced Drive torque and speed	Condition clears	1.Battery menu parameters are mis adjusted 2.Non-controller system drain on batteries 3.Battery resistance too high 4.Battery disconnected while driving 5.See monitor menu - Battery: capacitor voltage 6.Blown B+ fuse or main contactor did not close

Fig. 7 Fault Code Chart

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

LED Code	1313 Display	Explanation	Controller Response	Recover When	Possible Cause
1-8	**Severe Overvoltage**	Capacitor bank voltage exceeded limit	Vehicle Disabled	Condition clears and KSI cycled	1.See monitor menu-Battery: capacitor voltage 2. Battery menu parameters are mis-adjusted 3. Battery resistance too high for given regen current 4. Battery disconnected while regen braking
2-2	**Controller Over temp Cutback**	Heat sink temp exceeded 85*C	Reduced drive and brake torque	Condition clears	1.See monitor menu-Controller: temperature 2.Controller is performance-limited at this temperature 3.Controller is operating in an extreme environment 4.Excessive load on vehicle
2-3	**Under voltage Cutback**	Capacitor bank voltage dropped below limit	Reduced Drive torque and speed	Condition clears	1.Normal operation. Fault shows that batteries need recharging 2.Battery parameters are mis-adjusted 3.Non-controller system drain 4.Battery resistance to high 5.Battery disconnected while driving 6.See Monitor menu-Battery: capacitor voltage 7.Blown B+ fuse or main contactor did not close
2-4	**Overvoltage Cutback**	Capacitor bank voltage exceeded Overvoltage limit	Reduced brake torque	Condition clears	1.Normal operation. Fault shows that the regen braking currents elevated the battery voltage during regen braking. Controller is performance limited at this voltage 2. Battery parameters are mis-adjusted 3. Battery resistance too high for given regen current 4.Battery disconnected while regen braking 5.See Monitor menu - Battery: ca (capacitor voltage)
2-5	**+5V supply Failure**	+ 5 V supply (pin 26) outside the +5V + or - 10% range	None: Check VCL	Condition clears	1.External load impedance on the + 5 V supply is too low 2.See Monitor menu-Outputs: 5 volts and ext supply current

Fig. 7 Fault Code Chart (Continued)

FAULT TESTING

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

LED Code	1313 Display	Explanation	Controller Response	Recover When	Possible Cause
2-6	**Digital Out Over current**	Digital output 6 (pin 19) current exceeded 15mA	None: Check VCL	Fix the over current cause and use the VCL function set dig out to turn driver on again	1.External load impedance on Digital Output 6 (pin 19) is too low
2-7	**Digital Out 7 Over current**	Digital output 7 (pin 20) current exceeded 15mA	None: Check VCL	Fix the over current cause and use the VCL function set dig Out() to turn driver on again	1.External load impedance on Digital Output 7 (pin 20) is too low
2-8	**Motor Temp Hot Cutback**	Motor temp is at or above Hot parameter setting	Reduced Drive torque and speed	Condition clears	1.Motor temperature is at or above the programmed temperature Hot stetting, and the requested current is being cut back 2.Motor temperature control menu parameters are mis-tuned 3.See Monitor menu-Motor: temperature and - Inputs: analog 2 4.Reduce load on motor
2-9	**Motor Temp Sensor Fault**	Motor thermistor input (pin8) is at voltage rail (0 or 10v)	Reduced speed, Motor temp cutback disabled	Condition clears	1.Motor thermistor is not connected 2.Check sensor
3-1	**Coil 1 Driver Open or Short - also can be Main Open or Short**	Driver 1 (pin6) is either open or shorted. This fault can only be set when main enable =off	Shutdown driver 1	Correct condition and cycle driver	1.Open or short on driver load 2.Dirty connector pins 3.Bad crimps or faulty wiring
3-2	**Coil 2 Driver Open or Short**	Driver 2 (pin5) is either open or shorted. This fault can only be set when main enable =off	Shutdown driver 2	Correct condition and cycle driver	1.Open or short on driver load 2.Dirty connector pins 3.Bad crimps or faulty wiring

Fig. 7 Fault Code Chart (Continued)

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

LED Code	1313 Display	Explanation	Controller Response	Recover When	Possible Cause
3-3	**Coil 3 Driver Open or Short**	Driver 3 (pin4) is either open or shorted. This fault can only be set when main enable =off	Shutdown driver 3	Correct condition and cycle driver	1.Open or short on driver load 2.Dirty connector pins 3.Bad crimps or faulty wiring
3-4	**Coil 4 Driver Open or Short**	Driver 4 (pin3) is either open or shorted. This fault can only be set when main enable =off	Shutdown driver 4	Correct condition and cycle driver	1.Open or short on driver load 2.Dirty connector pins 3.Bad crimps or faulty wiring
3-5	**PD Open or Short**	The Proportional driver (pin2) is either open or shorted. This fault can only be set when main enable =off	Shutdown PD driver	Correct condition and cycle driver	1.Open or short on driver load 2.Dirty connector pins 3.Bad crimps or faulty wiring
3-6	**Encoder Fault**	Motor encoder phase failure detected.	Throttle Shutdown	KSI cycled	1.Motor encoder failure 2.Bad crimp or faulty wiring 3.See Monitor menu - Motor: motor rpm
3-7	**Motor Open**	Motor Phase U,V or W detected open	Vehicle Disabled	KSI cycled	1.Motor phase is open 2.Bad crimps or faulty wiring
3-8	**Main Contactor Welded**	Prior to main contactor closing, capacitor bank voltage was loaded for a short time and did not discharge	Vehicle Disabled	KSI cycled	1.Main contactor tips are welded closed 2.Motor phase U or V is disconnected or open 3.An alternate voltage path is providing a current to the capacitor bank (B+ connection terminal)
3-9	**Main Contactor Did Not Close**	With the main contactor commanded closed, the bank voltage (B+ connection terminal) did not charge to B+	Vehicle Disabled	KSI cycled	1.Main contactor did not close 2.Main contactor tips are oxidized, burned, or not making a good contact 3.External load on capacitor bank (B+ connection terminal) that prevents capacitor bank from charging 4. Blown B+ fuse
4-1	**Throttle Wiper High**	Throttle pot wiper (pin16) voltage is higher than high fault setting	Shutdown throttle	Condition clears	1.See Monitor menu-Inputs: throttle pot 2.Throttle pot wiper voltage too high

Fig. 7 Fault Code Chart (Continued)

FAULT TESTING

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

LED Code	1313 Display	Explanation	Controller Response	Recover When	Possible Cause
4-2	**Throttle Wiper Low**	Throttle pot wiper (pin16) voltage is lower than low fault setting	Shutdown throttle	Condition clears	1.See Monitor menu-Inputs: throttle pot 2.Throttle pot wiper voltage too low
4-3	**Pot 2 Wiper High**	Pot 2 wiper (pin17) voltage is higher than high fault setting	Full Brake	Condition clears	1.See Monitor menu-Inputs: pot2 raw 2.Pot2 wiper voltage too high
4-4	**Pot 2 Wiper Low**	Pot 2 wiper (pin17) voltage is lower than low fault setting	Full Throttle	Condition clears	1.See Monitor menu-Inputs: pot2 raw 2.Pot2 wiper voltage too low
4-5	**Pot Low Over current**	Pot low (pin 18) current exceeds 10mA	Shutdown Throttle and full Brake	Condition clears and KSI cycled	1.See Monitor menu-Outputs: pot low 2.Combined pot resistance connected to pot low is to low
4-6	**EEPROM Failure**	Controller operating system tried to write to EEPROM memory and failed	Vehicle Disabled	Download correct software (OS) and matching parameter default settings into the controller and c	1.Failure to write to EEPROM memory. This can be caused by EEPROM memory writes initiated by VCL, by the CAN bus, by adjusting parameters with the programmer, or by loading new software into controller
4-7	**HPD/ Sequencing Fault**	HPD sequencing fault caused incorrect sequence of KSI, interlock, direction and throttle input	Shutdown Throttle	Reapply inputs in correct sequence	1.KSI, interlock, direction and throttle inputs applied in incorrect sequence 2.Faulty wiring, crimps, or switches at KSI, interlock, direction, or throttle inputs. 3.See Monitor menu-Inputs
4-8	**Emer Rev HPD**	At the conclusion of Emergency Reverse, the fault was set because various inputs were not returned to neutral	Shutdown Throttle	If EMR_interlock=On, clear the interlock, throttle and direction inputs. If EMR_Interlock=Off, clear the throttle and direction inputs.	1.Emergency Reverse operation has concluded, but the throttle, forward and reverse inputs, and interlock have not been returned to neutral

Fig. 7 Fault Code Chart (Continued)

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

LED Code	1313 Display	Explanation	Controller Response	Recover When	Possible Cause
4-9	**Parameter Change Fault**	Adjustment of a parameter setting that requires cycling of KSI	Vehicle Disabled	KSI cycled	1.This is a safety fault caused by a change in certain parameter settings so that the vehicle will not operate until KSI id cycled
5-2	**Traction Throttle Mismatch**	Throttle input/output mismatched	Throttle Shutdown	Condition Clears	1.See Monitor menu-Inputs: Throttle 2.Check throttle return
5-3	**Throttle Input Out of Range**	Throttle input out of range	Throttle Shutdown	Condition Clears	1.See Monitor menu-Inputs: Throttle 2.Check throttle return 3.Check for water intrusion of throttle wiper
5-4	**Park Brake Set**	Park brake engaged when traction pedal was activated	Throttle Shutdown	Condition cleared	1.Park brake was engaged when throttle was activated 2.Release park brake and operate unit
5-5	**HPD/SRO Fault**	High pedal disable/ static return to off	Vehicle Disabled	Condition cleared. Correct start sequence applied	1.Verify correct start sequence. Unit must be in neutral prior to key on
5-6	**Solenoid Coil Open/Short**	Driver does not turn OFF	Vehicle Disabled	KSI cycled	1.Open or short on driver load 2.Dirty connector pins 3.Bad crimps or faulty wiring 4.When found in history, does not necessarily indicate a problem
6-8	**VCL Run Time Error**	Runtime VCL code error condition	Vehicle Disabled	KSI cycled or install new software to match parameters	1.VCL code encountered a runtime VCL error 2.See Monitor menu -Controller: VCL error module
6-9	**External Supply out of Range**	The external 5v and 12V supply is out of range.	None: Check VCL	External supply current within range	1.External load on the 5V and 12V supplies draws either too much or too little current 2.Fault checking menu parameters Ext supply max and Ext. supply min are mis tuned 3.See Monitor menu-Outputs: ext supply current
7-1	**OS General**	Internal controller fault detected	Vehicle Disabled	KSI Cycled	1.Internal controller fault detected 2.Cycle KSI

Fig. 7 Fault Code Chart (Continued)

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

LED Code	1313 Display	Explanation	Controller Response	Recover When	Possible Cause
7-2	**PDO Timeout**	Time between CAN PDO messages received exceeded the PDO timeout period	Shutdown Interlock. Set CAN NMT state to pre-operational	Cycle KSI or Cycle F&R	1.Time out period exceeded because of no inputs from throttle or controls 2.Cycle KSI and or F&R switch
7-3	**Stall Detected**	No Motor encoder movement detected	Vehicle Disabled	Cycle KSI	1.Stalled motor 2.Motor encoder failure 3.Bad crimps or faulty wiring 4.Problems with power supply for the motor encoder 5.See Monitor menu-Motor: motor rpm
7-4	**Fault on Other Traction Controller**	Fault found on slave controller	Depends on fault	KSI cycled	1.Check slave controller faults with handheld via direct connection to slave controller
7-5	**Dual Severe Fault**	Severe fault found on slave controller	Vehicle Disabled	KSI cycled	1.Check slave controller faults with handheld via direct connection to slave controller
8-7	**Motor Characterization Fault**	Motor Characterization failed during motor characterization process	Vehicle Disabled	KSI cycled or fault corrected	1.Motor characterization failed during MC process. See Monitor menu - Controller: motor characterization error for cause: 0=none 1=encoder signal seen, but step size not determined: set encoder step size manually 2=motortempsensorfault 3=motor temp hot cutback fault 4=controller over temp cutback fault 5=controller under temp cutback fault 6=under voltage cutback fault 7=severe over voltage fault 8=encoder signal not seen, or one or both channels missing 9=motor parameters out of characterization range
8-9	**Motor Type Fault**	Motor type parameter value is out of range	Vehicle Disabled	KSI cycled and or correct fault	1. Motor Type parameter value is out of range 2. Check controller command on hand held

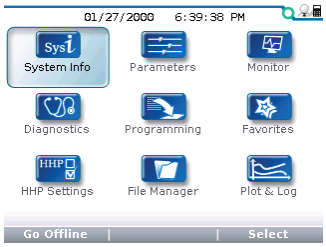
Fig. 7 Fault Code Chart (Continued)

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

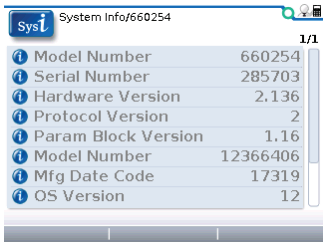
LED Code	1313 Display	Explanation	Controller Response	Recover When	Possible Cause
9-1	**VCL/OS Mismatch**	VCL and OS software do not match, when Ski is cycled a check is made to verify that they match and a fault is issued when they do not	Vehicle Disabled	Condition clears	1. The VCL software in the controller does not match the OS software in the controller- re-install software
9-3	**Encoder LOS (limited operating strategy)**	Encoder fault(code36) or stall detect fault (code73) was activated and brake or interlock has been applied to activate LOS control mode, allowing limited motor control	Vehicle Disabled	KSI Cycled or Fault cleared	1. Limited Operating Strategy control mode has been activated, as a result of either an encoder fault or stall detect fault 2. Motor encoder failure 3. Bad crimps or faulty wiring 4. Motor stalled
9-4	**EMER Rev Timeout**	Emergency reverse was activated and ran until the EMR timeout timer expired.	Throttle Shutdown	Condition clears	1. Emergency reverse was activated and concluded because of EMR timeout 2. The emergency reverse input is stuck on
9-8	**Illegal Model Number**	Model Number variable, cycles a check is made to confirm a legal model number is found, a fault is issued if not	Vehicle Disabled	Appropriate software downloaded	1. Model number variable is illegal for controller type 2. Software and hardware do not match 3. Defective controller

Fig. 7 Fault Code Chart (Continued)

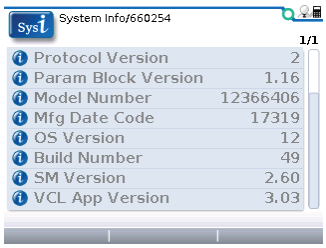
Curtis Handheld Diagnostic Tool Function

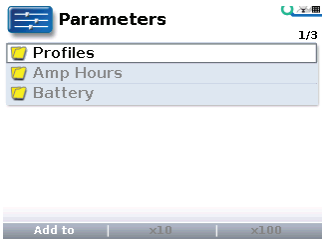


The first screen shown is the menu options list.

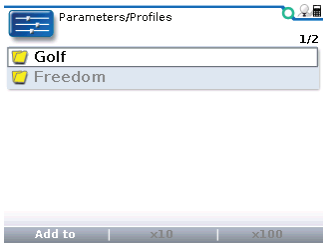


The “System Info” menu indicates detailed viewing of the controller information, such as model number, serial number, hardware version, protocol version, parameter block version, mfg date code, OS version, build number, SM version, and VCL application version.



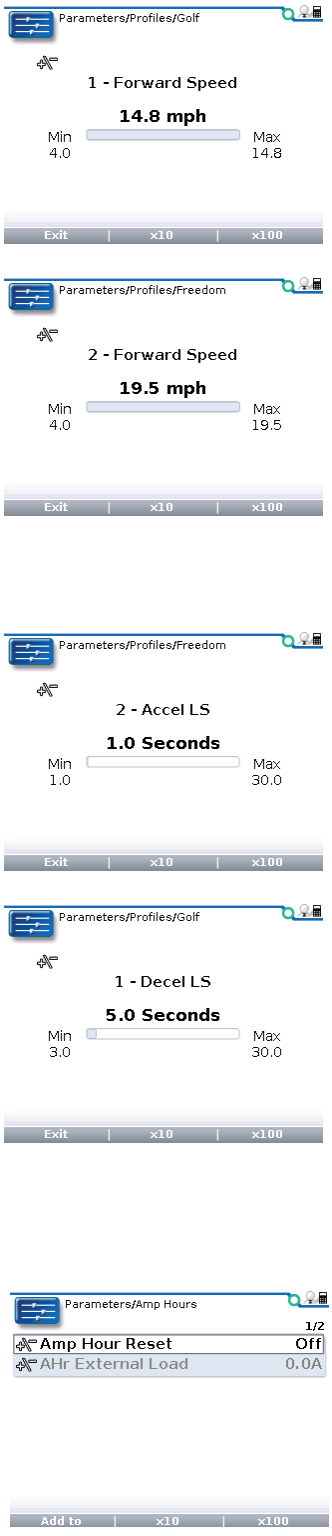


The “Parameters” menu includes the submenus for “Profiles,” “Amp Hours,” and “Battery.”



The “Profiles” submenu allows the user to access and adjust the parameters for speed and acceleration.

Fig. 8 Handheld Tool Function



The max speed can be adjusted under “Forward Speed” and “Reverse Speed.”

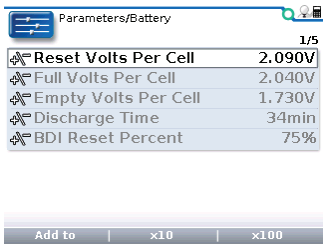
- Golf Vehicles
  - Forward
    - min value = 4.0 mph
    - max value = 14.8 mph
  - Reverse
    - min value = 3.0 mph
    - max value = 6.0 mph
- Freedom Vehicles
  - Forward
    - min value = 4.0 mph
    - max value = 19.5 mph
  - Reverse
    - min value = 3.0 mph
    - max value = 6.0 mph

Parameters for acceleration and deceleration rates can be adjusted. Settings are the same for both Golf and Freedom models.

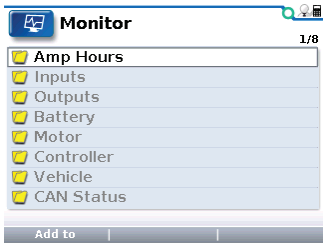
- Acceleration
  - HS
    - min value = 3.0 seconds
    - max value = 30.0 seconds
  - LS
    - min value = 1.0 second
    - max value = 30.0 seconds
- Deceleration
  - Both HS and LS
    - min value = 3.0 seconds
    - max value = 30.0 seconds
- Reverse Acceleration
  - Both HS and LS
    - min value = 7.0 seconds
    - max value = 30.0 seconds

The “Amp Hours” Submenu includes the parameters for “Amp Hour Reset” (normal values are ON and OFF) and “AHr External Load” (normal values are between 0.0 and 100.0).

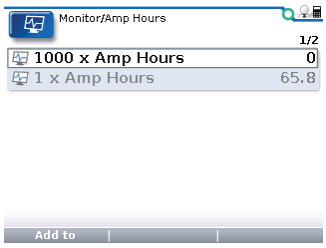
Fig. 8 Handheld Tool Function (Continued)



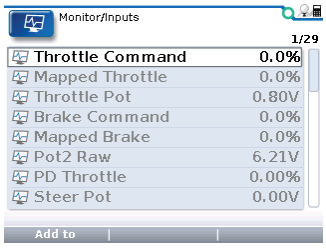
The “Battery” submenu includes the parameters for “Reset Volts per Cell,” “Full Volts per Cell,” “Empty Volts per Cell,” “Discharge Time,” and “BDI Reset Percent.”

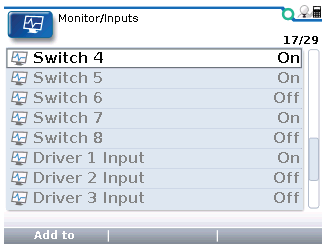


The “Monitor” menu allows the user to monitor numerous current conditions of the vehicle.

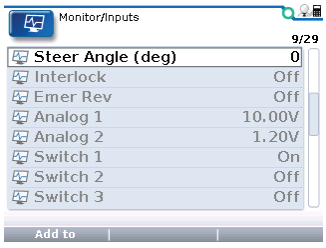


“Amp Hours Submenu”





“Inputs”



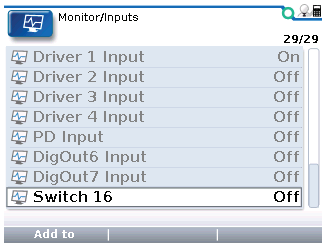
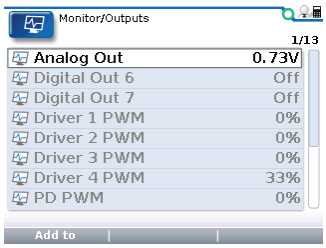
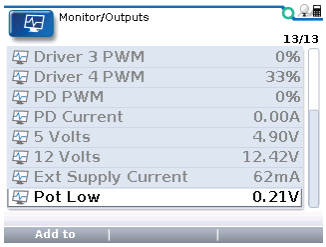


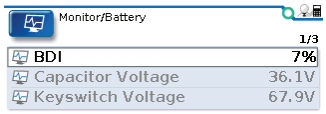
Fig. 8 Handheld Tool Function (Continued)

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

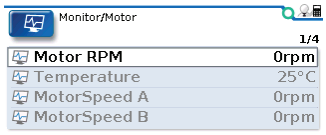




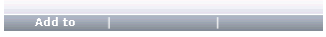
"Outputs"

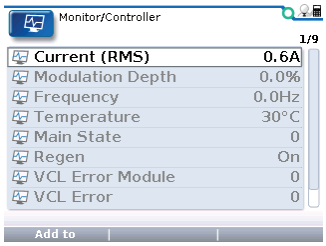


"Battery"

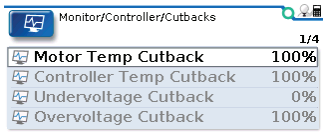


"Motor"



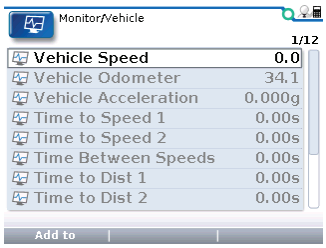


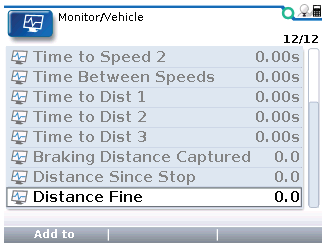
"Controller"



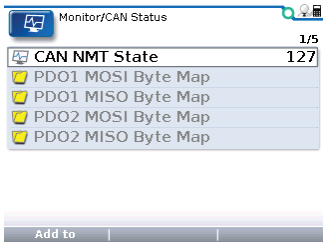
"Controller Cutbacks"

Fig. 8 Handheld Tool Function (Continued)

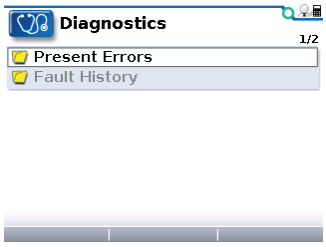




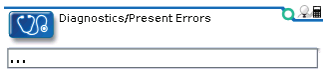
"Vehicle"



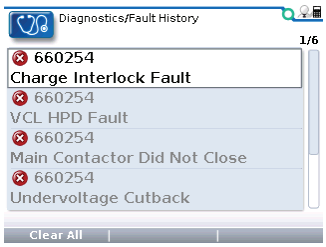
"CAN Status"



The "Diagnostics" menu can be used to diagnose present faults and view the fault history.



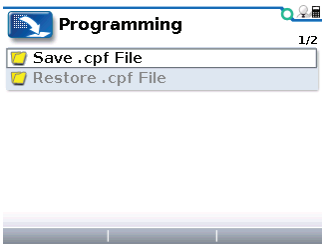
Any currently existing faults will appear under the "Present Errors" submenu.



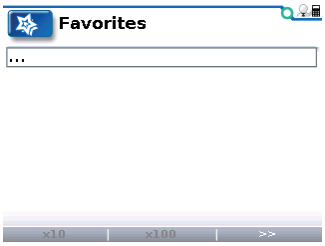
The "Fault History" submenu will show all past faults that have not been cleared.

Fig. 8 Handheld Tool Function (Continued)

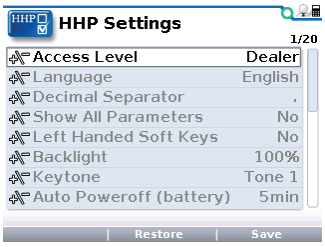
Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.

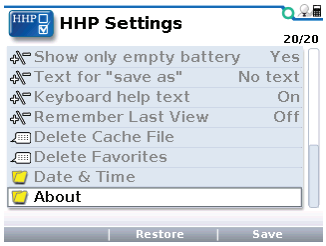


The “Programming” menu allows the user to both save current .cpf files and restore former .cpf files.

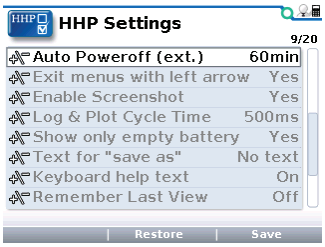


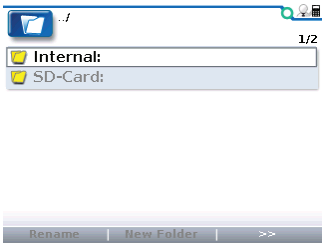
The user can bookmark frequently used functions in the “Favorites” menu.





.The “HHP Settings” shows the settings for the Curtis handheld tool.





The “File Management” menu is used to manage file on the internal memory of the tool and the SD card (if installed).

Fig. 8 Handheld Tool Function (Continued)

COMPONENT TESTING

Voltmeter

⚠WARNING ***Before performing any test of wiring components, disconnect the battery cables from the battery posts to prevent electrical shock or explosion.***

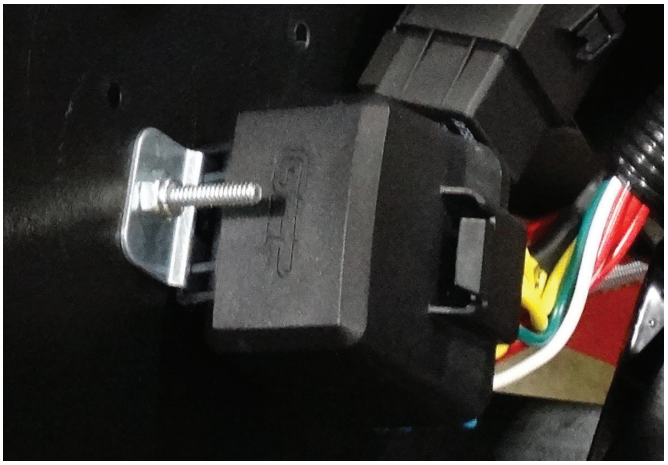
Electrical tests of the wiring for continuity can be done with a DVOM (Digital Volt Ohm Meter), available through the Service Parts Department (P/N 27481G01). The actual model can vary depending on availability. The DVOM (digital volt ohm meter) shown in Figure 10, is representative only. Any DVOM can be used, however the controls, displays and features can vary depending on the make and model. Always follow the meter manufacturer's recommendations and instructions for the use and care of the meter. For the purpose of this section, the red probe is represented as (+) and black probe as (-). Set the meter selector to the ohms scale, and check continuity between each circuit component as indicated.

Example: If a switch is open or if there is a break in the wiring, the meter will display a visual signal. If an analog meter is used, it will read infinity (∞).

Fig. 9 Digital Voltmeter

Fuses - Testing

Check all the fuses to make sure that components are properly powered (Ref Fig. 10). If the fuse is blown, replace the fuse.



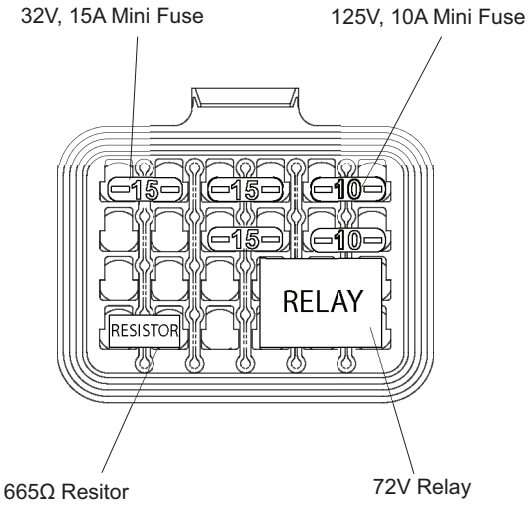


Fig. 10 Fuse Block

NOTICE: To test the components on the control panel, the control panel has to be removed to access the individual component circuit terminals (See Control Panel on page 21).

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

Key Switch - Testing

Use the handheld diagnostic tool to verify operation of the key switch. See the inputs on the monitor menu. Operate the switch to change its status. This will confirm a failed switch or a bad circuit.

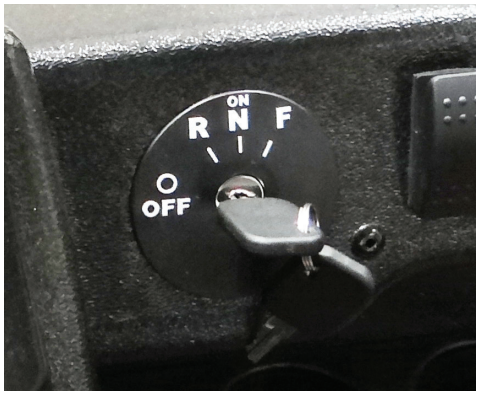


Fig. 11 Key Switch

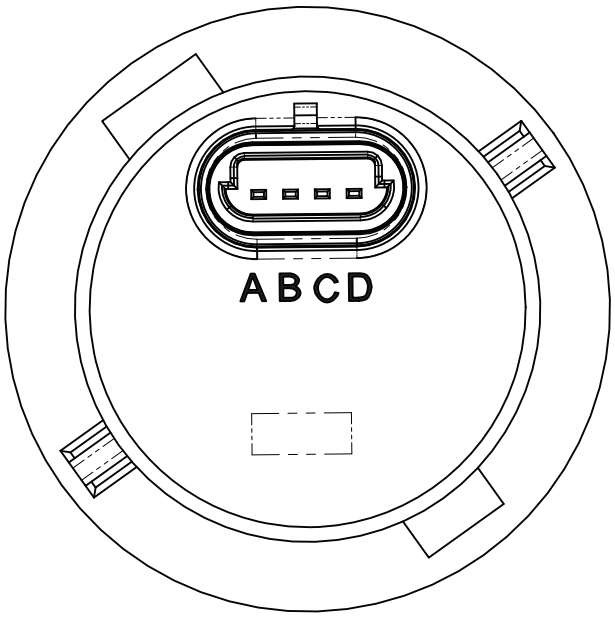


Fig. 12 Circuit Pins

NOTICE: This test can also be done with the hand-held tool. Scroll down to the direction functions in the Monitor Menu.

If a handheld programmer is not available, the key switch can be tested for continuity using a DVOM (See Electrical Schematic on page 74).

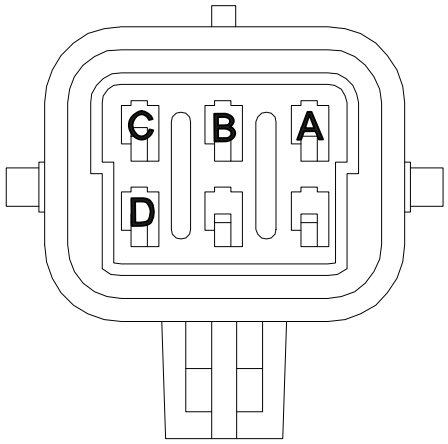
State of Charge (SOC) / Hour Meter - Testing

To test the SOC function of the meter, check for continuity between pin C and pin B (Ref Fig. 13).

To test the hour function of the meter, check for continuity between pin C and pin D.

If either function fails, the meter should be replaced.

If both functions pass and there is an issue with the meter, check the voltage at the harness with the key-switch in the ON position to determine the issue using the table below (Ref Fig. 13).



Pin A	Ground
Pin B	0-5V
Pin C	10-18V
Pin D	10-18V

Fig. 13 SOC / Hour Meter

Electronic Speed Controller Solenoid - Testing

To check the electronic speed controller solenoid for energy; follow the steps below:

1. Put the positive (+) meter probe on the white wire primary circuit terminal. Put the negative (-) meter probe on the black / orange primary circuit terminal. 72V should be indicated on the meter with the key on.
2. Put the negative meter probe on controller B or the negative 72V battery terminal. Put the positive probe on the secondary circuit battery side terminal. 72V should be indicated. If not, check the battery voltage and wiring.

NOTICE: The solenoid testing can also be done with the handheld tool. Scroll down to the Monitor Menu. Check the inputs and outputs for a change in status. Check for contactor related faults in the faults menu.

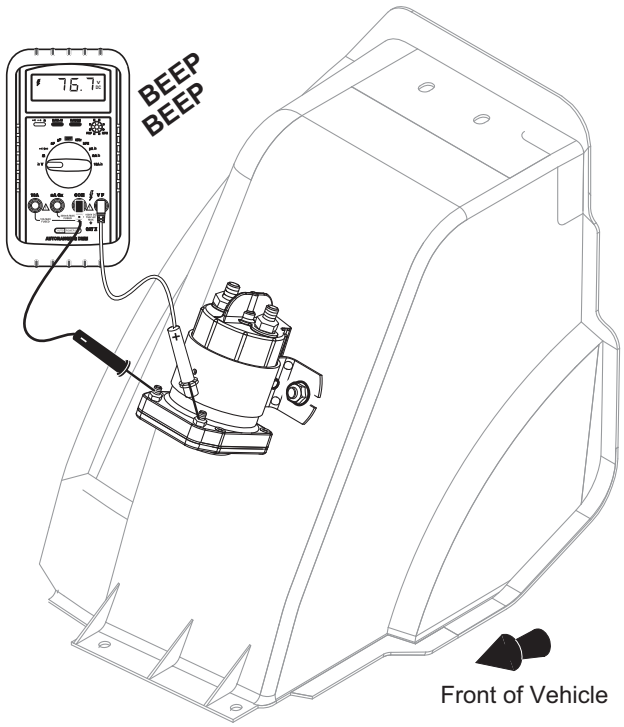


Fig. 14 Solenoid

Temperature Sensor - Testing

NOTICE: If the temperature sensor is faulty, the entire motor assembly must be replaced (See Front Motor Removal on page 66) (See Rear Motor Removal on page 68).

1. If possible, allow the vehicle to cool to room temperature.
2. Unplug the temperature sensor harness at the motor (Ref 2.)
3. Use the DVOM set on OHMS (**Ω**) and test the resistance between the two pins on the motor side.

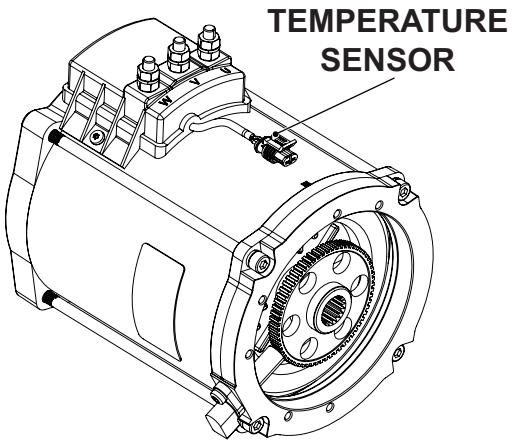


Fig. 15 Temperature Sensor

4. A reading showing at or below the minimum value indicates a bad sensor.
5. A reading showing at or above the thermal cutoff temperature indicates either a faulty sensor or a severely overheating motor (Ref Fig. 16) (Ref Fig. 17).

Minimum Value	≈359 Ω (-40° C)
Room Temperature	≈603 Ω (25° C)
Beginning of Thermal Cutback	≈1297 Ω (145° C)
Thermal Cutoff Temperature	≈1407 Ω (160° C)

Fig. 16 KTY Temperature Sensor (male pins on the connector)

Minimum Value	≈843 Ω (-40° C)
Room Temperature	≈962 Ω (25° C)
Beginning of Thermal Cutback	≈1555 Ω (145° C)
Thermal Cutoff Temperature	≈1610 Ω (160° C)

Fig. 17 PT1000 Temperature Sensor (female pins on the connector)

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

Electronic Speed Sensor - Testing

1. Use the DVOM probes to check the motor speed sensor while the connector is plugged in. With the key on and the direction selector in gear; put the positive meter probe in the red wire connection. Put the negative meter probe in the black wire connection. 5V should be indicated. If not, check the wiring and the signal from the controller. Replace the speed sensor if these are good.
2. Put the negative meter probe in the black wire connection. Put the positive meter probe in the green wire connection. A 0 – 5V flash signal should be indicated when the motor armature is rotated slowly. If not, check the sensor magnet in the motor, then replace the speed sensor.

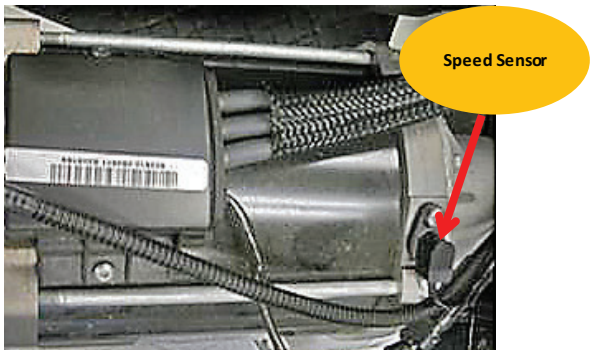


Fig. 18 Speed Sensor

Back probe pins are needed to perform electrical tests via wire harness connectors.

AC Motor Bench Test

Set a standard digital volt/ohm meter to the diode test position. Make sure the audible alarm can be heard.

1. Place one meter probe on the U-terminal and the other probe on the W-terminal. Full continuity should be observed (Ref Fig. 19).

Fig. 19 U and W terminal

2. Now place one meter probe on the V-terminal and the other probe on the W-terminal. Full continuity should be observed (Ref Fig. 20).

Fig. 20 V and W terminal

3. Then place one meter probe on the U-terminal and the other probe on the V-terminal. Full continuity should be observed (Ref Fig. 21).

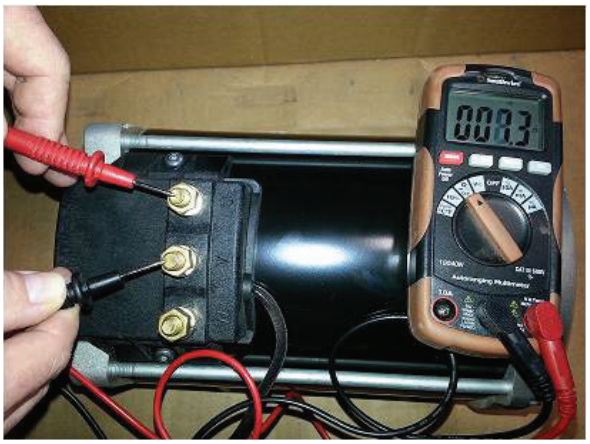


Fig. 21 U and V terminal

NOTICE: If continuity is not observed between terminals; an open motor field condition may exist. Disassemble the motor to visually confirm.

4. Place one meter probe on any of the three motor terminals. The other meter probe should be placed on the motor case. No continuity should be observed (Ref Fig. 22).

NOTICE: If continuity is observed between the case and terminals; a field to motor case short exists.

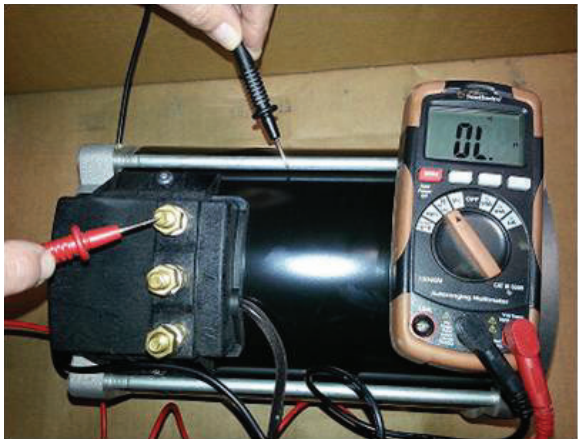


Fig. 22 Terminal and Motor case

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

Notes:

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

Notes:

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

GENERAL SPECIFICATIONS

VEHICLE SPECIFICATIONS

• Solid State continuously variable separately excited speed controller	• Full torque, reduced speed reverse
• Dash mounted key switch/direction selector (Forward-Neutral-Reverse)	• Inductive throttle sensor
• Anti-roll back, walkway braking and alarm	• Diagnostic indicator
• Anti-stall motor protection	• Factory programmable to application
• Regenerative 'Pedal Down' and/or 'Pedal Up' braking	
Battery Charger: 72 VDC Delta Q, 120/230 VAC 50/60 Hz. Underwriters Laboratories (U.L.) Listed, (C.S.A. Certified)	
Motor: 72 Volt AC Induction, solid copper windings. Non vented 22.4 hp (16.7 kW) Continuous.	
Drive Train: Direct motor shaft connected to transaxle pinion shaft	
Electrical System: 72 Volt DC, six, 12V deep cycle storage batteries	
Transaxle: Differential with helical gears	
Brakes: Dual rear wheel mechanical self-adjusting drum brakes. Automatic single point park brake release with self-compensating system. Regenerative 'pedal down' and/or 'pedal up' braking	

Item	Specification
Seating Capacity	6(4 with stake side option) Person
Overall Length	144 in. (364 cm)
Overall Width	49 in. (125 cm)
Overall Height (No Canopy)	52.5 in. (134 cm) (Top of steering wheel)
Overall Height (With Canopy)	78 in. (197 cm)
Wheel Base	97 in. (245 cm)
Front Wheel Track	38.5 in. (98 cm)
Rear Wheel Track	38.5 in. (98 cm)
Ground Clearance (at Differential)	7 in. (18 cm)
Power Source	72 Volts DC
Motor Type	AC Induction
Horsepower (kW)	22.4 hp (16.7 kW) Peak
Electrical System	72 Volt
Batteries (Qty, Type)	Six, 12V Deep Cycle
Key or Pedal Start	Pedal Start
Battery Charger	72 VDC Delta Q, 120/230 VAC, UL & CSA
Speed Controller	350 Amp AC
Drive Train	Motor Shaft Direct Drive
Transaxle	Differential with helical gears
Gear Selection	Dash mounted, key switch with Forward-Neutral-Reverse
Rear Axle Ratio	17:1
Dry Weight (Without Batteries)	1068 lb. (485 kg)
Curb Weight	1560 lb. (708 kg)
Bed Load Capacity Stake Side Bed Load Capacity Truck Bed	400 lb. (181 kg) 325 lbs. (147 kg)
Flip Seat Load Deck Capacity	250 lbs. (115 kg)
Vehicle Load Capacity	1200 lb. (544 kg)
Cargo Box Width (Inside)	42.5 in. (108 cm)
Cargo Box Depth (Inside)	11.5 in. (29 cm)
Cargo Box Capacity	9 cu. ft. (.25 m3)

GENERAL SPECIFICATIONS

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

Cargo Box Material	Wood stake sides
Outside Clearance Circle	25.5 ft. (7.8 m)
Speed (Level Ground)	16.5 mph ± 0.5 mph (26.4 kph ± 0.8 kph)
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, regenerative 'pedal down' and/or 'pedal up' braking
Parking Brake	Self-compensating, single point engagement
Front and Rear Tires	Terra Trac 23 x 10.5 - 12, Alloy Wheel
Frame	Welded steel, DuraShield™ powder coat
Body and Finish	Injection Molded TPO
Seat Pod	Thermoform ABS
Standard Color	Champagne
Headlights	Halogen standard
Some items shown may be optional equipment	
Vibration, WBV	Total value of vibration is 2.12 m/s^2. Uncertainty of measurement K is 0.42.
Vibration, HAV	Highest RMS value of total value is less than 2.5 m/s^2.*
Some listed items may be optional equipment.	

APPENDIX A

BATTERY CHARGER USER'S GUIDE

APPENDIX A

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

QuiQ™ 1500 Industrial Battery Charger Product Manual

This manual contains important safety and operating instructions for Delta-Q QuiQ 1500 chargers. Please read this information in its entirety before using your QuiQ Charger. For technical support, please visit delta-q.com/support or contact the manufacturer of your vehicle or machine, as their versions of this charger may require special instructions.

Warning

Use charger only with an algorithm selected that is appropriate to the specific battery type. 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 (e.g. maximum charge rates and if cell caps should be removed 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 portions of output connector or uninsulated battery terminals. Disconnect the AC supply before making or breaking the connections to the battery. Do not open or disassemble charger. Do not operate this charger if the AC supply cord is damaged or if the charger has received a sharp blow, been dropped, or is damaged in any way – refer all repair work to the manufacturer, or qualified personnel. This charger is not intended for use by persons (including children) with reduced physical, sensory or mental capabilities, or lack of experience and knowledge on electrical systems and battery charging, unless they have been given supervision or instruction concerning use of the charger by a person responsible for their safety. Children should be supervised to ensure that they do not play with the charger.

Attention

Utiliser le chargeur seulement avec un algorithme approprié au type spécifique de batterie. D´autres types de batteries pourraient éclater et causer des blessures ou dommages. Les batteries peuvent produire des gaz explosifs en service normal. Ne jamais fumer près de la batterie et éviter toute étincelle ou flamme nue à proximité des batteries. Fournissez une ventilation adéquate du chargement. Ne jamais charger une batterie gelée. Prendre connaissance des mesures de précaution spécifiées par le fabricant de la batterie, p. ex., vérifier s´il faut enlever les bouchons des cellules lors du chargement, et les taux de chargement.

Danger

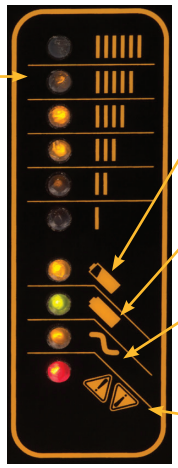
Risque de décharge électrique. Ne pas toucher les parties non isolées du connecteur de sortie ou les bornes non isolées de la batterie. Toujours connecter le chargeur à une prise de courant mise à la terre. Déconnectez la source AC avant de faire ou défaire les connections à la batterie en chargement. Ne pas utiliser le chargeur si le cordon d'alimentation AC est endommagé ou si le chargeur est abîmé suite à une chute ou autre indicent. Ne pas ouvrir ni désassembler le chargeur – référer toute réparation aux personnes qualifiées. Cet appareil n'est pas destiné à un usage par des personnes (dont les enfants) avec des facultés motrices, sensorielles ou mentales réduites, ou ayant une expérience et des connaissances insuffisantes, à moins qu'elles sont sous la supervision ou reçoivent les instructions sur l'utilisation de l'appareil d'un répondant garant de leur sécurité. Les enfants devraient être surveillés afin qu'il ne jouent en aucun temps avec l'appareil.

Operating Instructions

- The charger may become hot during charging. Use hand protection to safely handle the charger during charging.
- Extension cords must be 3-wire cord no longer than 30m (100') at 10 AWG or 7.5m (25') at 16 AWG per UL guidelines.
- Only connect one QuiQ Charger to a single 120VAC 15A circuit, or the circuit may become overloaded.
- The charger will conduct a self-test after being powered on, visible by flashing all of its LEDs in sequence.

Charger 10-LED Display

Ammeter
- If solid: Displays scale of output during bulk phase.
- If flashing: Output has been reduced due to high internal charger temperature. Displays charge profiles 1-6 for 11 seconds if no battery is connected.



Bulk Charge Indicator
- If solid: Bulk charge phase complete (80% charged); in absorption phase.
- If flashing: Displays charge profile number if no battery is connected.

Charge Completion Indicator (Green Light)
- If solid: Charging complete and maintenance mode is active.
- If flashing: Absorption phase complete, in finishing phase.

AC Indicator
- If solid: AC voltage is above 185 volts.
- If flashing: AC voltage is between 105 volts and 185 volts.
- If off: AC voltage is below 105 volts.

Fault Indicator (Red Light)
- Charger error. Refer to troubleshooting information below.

(DOCUMENT 710-0188 Rev 1 Date: 31/05/2015)

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

LED Color	Indication
Green	✚ If solid: Charging complete and maintenance mode is active. ✚ If flashing: Short: <80% Charge. Long: >80% Charge. When battery is not connected: Charge Profile (Algorithm Number) is displayed when first connected to AC, then will show "Battery low voltage" error
Amber	✚ If flashing: Reduced power mode due to high internal charger temperature.
Red	✚ If flashing: Charging error. Reset charger power and refer to Troubleshooting Instructions below.

Maintenance Instructions

1. Do not expose charger to high pressure water spray when cleaning vehicle.
2. The enclosure of the charger meets IP66, making it dust-tight and protected against powerful water jets. The AC connection is rated to IP20, which is not protected against water. Protect the AC connection if used in wet or dusty environments.
3. If the detachable input power supply cord set is damaged, replace with a cord that is appropriate for your region:
   - ✚ This charger is provided with a cord set for connection to outlets operating at nominal 120 Volts (or 240 Volts as appropriate). If the input plug does not fit the power outlet, contact Delta-Q Technologies for the proper cord set terminating in an attachment plug of the proper configuration for the power outlet.
   - ✚ 'North America: UL or CSA listed / approved detachable cord, 3 conductor, 16AWG minimum and rated SJT; terminated in a grounding type IEC 60320 C14 plug rated 250V, 13A minimum
   - ✚ For all other regions: Safety approved detachable cord, 3 conductor, 1.5mm^2 minimum, rated appropriately for industrial use. The cord set must be terminated on one end with a grounding type input connector appropriate for use in the country of destination and, on the other end, an output grounding type IEC 60320 C14 plug.

Troubleshooting Instructions

If a fault occurs, count the number of red flashes between pauses and refer to the table below.

Flashes	Cause	Solution
⏸ ✸ ⏸	Battery high voltage	Check battery size and condition. This fault will clear automatically once the condition has been corrected.
⏸ ✸ ✸ ⏸	Battery low voltage	Check battery size and condition. This fault will clear automatically once the condition has been corrected.
⏸ ✸ ✸ ✸ ⏸	Charge timeout caused by battery pack not reaching required voltage; or charger output reduced due to high temperatures.	Check connections, that battery type matches selected charge profile and operate the charger at a lower ambient temperature. Reset the charger by interrupting AC power for 15+ seconds.
⏸ ✸ ✸ ✸ ✸ ⏸	Battery could not be trickle charged up to minimum voltage.	Check for shorted or damaged cells. Reset the charger by interrupting AC power for 15+ seconds.
⏸ ✸ ✸ ✸ ✸ ✸ ⏸	Charger shutdown due to high internal temperature.	Ensure sufficient cooling airflow. Reset the charger by interrupting AC power for 15+ seconds.
⏸ ✸ ✸ ✸ ✸ ✸ ✸ ⏸	Internal charger fault	Reset the charger by interrupting AC power for 15+ seconds. Return to service depot if fault persists.

Note: This is a Class A product complying with United States Federal Communications Commission, Code of Federal Regulations; 47CFR part 15. In a domestic environment this product may cause radio interference, in which case the user may be required to take adequate measures.

WARNING: Charger connectors must be mated to connectors from the same manufacturer. Failure to do so may void warranty and cause a hazardous condition or equipment damage.

delta-q TECHNOLOGIES

www.delta-q.com

Selecting A Charge Profile

Delta-Q's QuiQ 1500 Charger can store up to 10 charging profiles, also called charge algorithms. This section shows how to identify the default profile and select a new profile using the "tap method."

QuiQ chargers are reprogrammable using the QuiQ Programmer supplied by Delta-Q to its OEM partners. Pre-2006 QuiQ chargers with serial number prefix DQCP allow pre-loaded profiles to be selected, but cannot be reprogrammed with new profiles.

Identify the default profile

1. Required supplies include an insulated wrench, eye protection and gloves.

2. Disconnect the AC power source from the charger, either from the wall outlet, or from the IEC320 connector on the charger.

Figure 1: Disconnect AC power.

3. Use your insulated wrench to remove the positive lead from the positive terminal on the battery pack.

Figure 2: Remove positive lead from positive terminal on the battery pack.

4. Reconnect AC power.

Figure 3: Reconnect AC power to the charger.

5. Charger will conduct a self-test of its LED indicators.

Figure 4: Charger LED indicator self-test.

6a. For 11 seconds after the self-test, the charger will display its default charge profile. Profiles #1-6 will display on the ammeter, as well as on the bulk charge indicator.

Figure 5: Charge profile #1 on the ammeter.

6b. Charge profiles #7 and above will display on the bulk charge indicator. If the charge profile number has two digits, it will be displayed by one or more flashes, a pause, then one or more flashes (e.g. #13 = ☀ ◘ ☀ ☀ ☀)

Figure 6: Bulk charge indicator displays charge profiles 7 and above.

Select a new profile

7. Disconnect AC power (see Figure 1).

8. Reconnect AC power (see Figure 3).

9. Touch the positive lead to the positive terminal for three seconds (+/- 0.5 seconds), then remove the lead. You will see the next profile displayed on the charger's display. Repeat this step until you reach the desired charge profile.

Figure 7: Touch the positive lead to the positive battery terminal for 3 seconds.

10. When the charger displays the desired charge profile, apply the positive lead to the positive battery terminal for 10 seconds. When the charge profile is locked, you will hear a click from the charger. See Figure 7 for how to apply the positive lead to the positive terminal.

11. Disconnect AC power, wait for the LED indicator display to turn off, then reconnect AC power. (See Figure 3)

12. Check the LED display to ensure that the desired charge profile is selected.

13. Disconnect the charger from AC power and wait for the LED indicator display to turn off. (See Figure 1)

14. Reconnect the positive lead to the positive battery terminal.

Figure 8: Reattach the positive lead to the positive terminal after disconnecting AC power.

YouTube Visit www.youtube.com/deltaqtechnologies for instructional videos.

NOTICE: Read the following warnings before operating the vehicle:

⚠WARNING ***When leaving the vehicle, turn the keyswitch to the OFF position and remove the key from the vehicle.***

Drive the vehicle only as fast as the terrain and conditions allow. Consider the environmental conditions that change the terrain and your ability to control the vehicle.

Do not drive fast downhill. Sudden stops or changes of direction can cause a loss of control. Use the service brake to control the speed of the vehicle when driving down a slope.

When possible, stay in approved areas and do not drive on steep slopes.

Always keep feet, legs, hands and arms inside the vehicle.

Do not drive the vehicle on rough terrain.

Before driving in reverse, make sure the area behind the vehicle is clear.

Make sure the direction selector is in the correct position before pressing the accelerator pedal.

Decrease speed before and during turns.

Make sure to completely stop the vehicle before moving the direction selector.

Do not load the vehicle beyond the capacities (See GENERAL SPECIFICATIONS on page 155).

NOTICE: Read the following information and warnings before operating vehicle:

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

Normal use, age, wear or abuse can cause some components on the vehicle to fail. The manufacturer can not know all possible component failures or the methods that failures can occur.

A vehicle in need of repair does not operate correctly can be dangerous.

Be careful when servicing the vehicle. Be aware of your safety and the safety of any bystanders.

Some components are heavy, spring loaded, corrosive, explosive, can cause high amperage, or get hot. Battery acid and hydrogen gas can cause injury. Do not put hands, face, feet or body in a location that can expose them to injury if an unexpected situation occurs.

Always use the correct tools shown in the tool list and wear recommended safety equipment.

⚠WARNING ***Remove all jewelry before servicing the vehicle.***

Do not allow loose clothing or hair to contact any moving parts.

Do not touch hot objects.

The drive wheels must be lifted and supported on jack stands before performing any service to the powertrain when the motor is in operation.

Always wear eye protection when servicing the vehicle. Be careful when working around batteries or working with solvents or compressed air.

Use wrenches with insulation to decrease the risk of a short-circuit if a wrench falls across the battery terminals. A battery short-circuit can cause an explosion.

To prevent the risk of battery explosion, keep all flammable materials, open flames or sparks away from the batteries.

Hydrogen gas is produced as a byproducts of battery charging. Do not charge the batteries without proper ventilation.

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