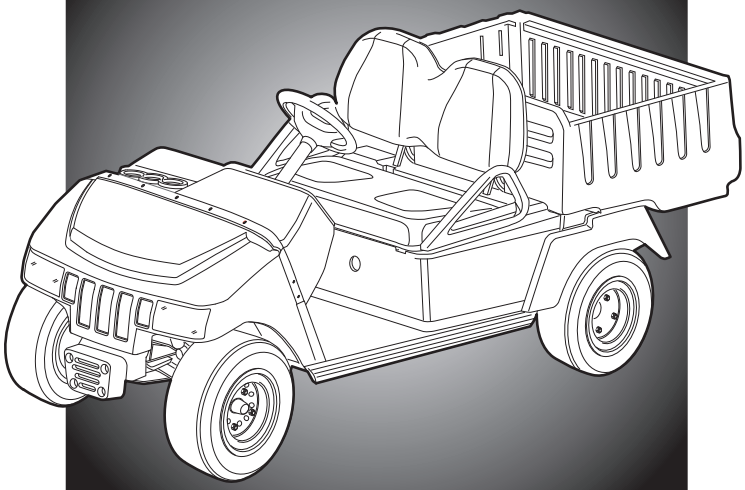
Club Car®

2005-2006 MAINTENANCE SERVICE MANUAL



XRT800 and XRT810 GASOLINE/ELECTRIC

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FOREWORD

Club Car vehicles are designed and built to provide the ultimate in performance efficiency; however, proper maintenance and repair are essential for achieving maximum service life and continued safe and reliable operation.

This manual provides detailed information for the maintenance and repair of the Club Car XRT 800 and XRT 810 series vehicles, and should be thoroughly reviewed prior to servicing the vehicle. The procedures provided must be properly implemented, and the DANGER, WARNING, and CAUTION statements must be heeded.

This manual was written for the trained technician who already possesses knowledge and skills in electrical and mechanical repair. *If the technician does not have such knowledge and skills, attempted service or repairs to the vehicle may render the vehicle unsafe.* For this reason, Club Car advises that all repairs and/or service be performed by an authorized Club Car distributor/dealer representative or by a Club Car factory-trained technician.

It is the policy of Club Car to assist its distributors and dealers in continually updating their service knowledge and facilities so they can provide prompt and efficient service for vehicle owners. Regional technical representatives, vehicle service seminars, periodic service bulletins, maintenance and service manuals, and other service publications also represent Club Car's continuing commitment to customer support.

This manual covers all aspects of typical vehicle service; however, unique situations sometimes occur when servicing a vehicle. If it appears that a service question is not answered in this manual, you may write to us at: Club Car, Inc., P.O. Box 204658; Augusta, GA 30917-4658 USA, Attention: Technical Services, or contact a Club Car Technical Service Representative at (706) 863-3000, ext. 3580.

This manual effective June 13, 2005.

⚠ WARNING

- **Read Section 1 – Safety before attempting any service on the vehicle.**
- **Before servicing vehicle, read complete section(s) and any referenced information that may be relevant to the service or repair to be performed.**

NOTE: *This manual represents the most current information at the time of publication. Club Car is continually working to further improve its vehicles and other products. These improvements may affect servicing procedures. Any modification and/or significant change in specifications or procedures will be forwarded to all Club Car dealers and will, when applicable, appear in future editions of this manual.*

Club Car reserves the right to change specifications and designs at any time without notice and without the obligation of making changes to units previously sold.

There are no warranties expressed or implied in this manual. See the limited warranty found in the vehicle Owner's Manual.

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SECTION 1 – SAFETY

To ensure the safety of those servicing these vehicles, and to protect the vehicles from possible damage resulting from improper service or maintenance, the procedures in this manual must be followed.

It is important to note that throughout this manual there are statements labeled DANGER, WARNING, or CAUTION. These special statements relate to specific safety issues, and must be read, understood, and heeded before proceeding with procedures. There are statements labeled NOTE, which provide other essential service or maintenance information.

⚠ DANGER

- **A DANGER indicates an immediate hazard that will result in severe personal injury or death.**

⚠ WARNING

- **A WARNING indicates an immediate hazard that could result in severe personal injury or death.**

⚠ CAUTION

- **A CAUTION with the safety alert symbol indicates a hazard or unsafe practice that could result in minor personal injury.**

CAUTION

- **A CAUTION without the safety alert symbol indicates a potentially hazardous situation that could result in property damage.**

GENERAL WARNING

The following safety statements must be heeded whenever the vehicle is being operated, repaired, or serviced. Service technicians should become familiar with these general safety statements. Also, other specific safety statements appear throughout this manual and on the vehicle.

⚠ DANGER

- **Battery – Explosive gases! Do not smoke. Keep sparks and flames away from the vehicle and service area. Ventilate when charging or operating vehicle in an enclosed area. Wear a full face shield and rubber gloves when working on or near batteries.**
- **Battery – Poison! Contains acid! Causes severe burns. Avoid contact with skin, eyes, or clothing. Antidotes:**
  - **External: Flush with water. Call a physician immediately.**
  - **Internal: Drink large quantities of milk or water. Follow with milk of magnesia or vegetable oil. Call a physician immediately.**
  - **Eyes: Flush with water for 15 minutes. Call a physician immediately.**
- **Gasoline – Flammable! Explosive! Do not smoke. Keep sparks and flames away from the vehicle and service area. Service only in a well-ventilated area.**
- **Do not operate gasoline vehicle in an enclosed area without proper ventilation. The engine produces carbon monoxide, which is an odorless, deadly poison.**

⚠ WARNING

- **Follow the procedures exactly as stated in this manual, and heed all DANGER, WARNING, and CAUTION statements in this manual as well as those on the vehicle.**
- **Only trained technicians should service or repair the vehicle. Anyone doing even simple repairs or service should have knowledge and experience in electrical and mechanical repair. The appropriate instructions must be used when performing maintenance, service, or accessory installation.**
- **Prior to servicing the vehicle or leaving the vehicle unattended, turn the key switch OFF, remove the key, and place the Forward/Reverse handle in the NEUTRAL position. Chock the wheels when servicing the vehicle.**

Gasoline vehicles only:

- **To avoid unintentionally starting the vehicle:**
  - **Disconnect battery cables, negative (–) cable first (Figure 1-1, Page 1-3).**
  - **Disconnect the spark plug wire from the spark plug.**
- **Frame ground – Do not allow tools or other metal objects to contact frame when disconnecting battery cables or other electrical wiring. Do not allow a positive wire to touch the vehicle frame, engine, or any other metal component.**

Electric vehicles only:

- **Place Tow/Run switch in the TOW position before disconnecting or connecting the batteries.**
- **To avoid unintentionally starting the vehicle, disconnect the batteries as shown (Figure 1-1, or 1-2 on page 1-3).**
- **After disconnecting the batteries, wait 90 seconds for the controller capacitors to discharge.**

All vehicles:

- **Wear safety glasses or approved eye protection when servicing the vehicle. Wear a full face shield and rubber gloves when working on or near batteries.**
- **Do not wear loose clothing or jewelry such as rings, watches, chains, etc., when servicing the vehicle.**
- **Moving parts! Do not attempt to service the vehicle while it is running.**
- **Hot! Do not attempt to service hot engine or exhaust system. Failure to heed this warning could result in severe burns.**
- **Use insulated tools when working near batteries or electrical connections. Use extreme caution to avoid shorting of components or wiring.**
- **Check the vehicle owner's manual for proper location of all vehicle safety and operation decals and make sure they are in place and are easy to read.**
- **Any modification or change to the vehicle that affects the stability or handling of the vehicle, or increases maximum vehicle speed beyond factory specifications, could result in severe personal injury or death.**
- **Lift only one end of the vehicle at a time. Use a suitable lifting device (chain hoist or hydraulic floor jack) with 1000 lb. (454 kg) minimum lifting capacity. Do not use lifting device to hold vehicle in raised position. Use approved jack stands of proper weight capacity to support the vehicle and chock the wheels that remain on the floor. When not performing a test or service procedure that requires movement of the wheels, lock the brakes.**

WARNING CONTINUED ON NEXT PAGE...

⚠ WARNING

- **If wires are removed or replaced, make sure wiring and wire harness are properly routed and secured. Failure to properly route and secure wiring could result in vehicle malfunction,**

property damage, personal injury, or death.

- **For vehicles with cargo beds, remove all cargo before raising the bed or servicing the vehicle. If the vehicle is equipped with a prop rod, ensure that it is securely engaged while bed is raised. Do not close bed until all persons are clear of cargo bed area. Keep hands clear of all crush areas. Do not drop cargo bed; lower gently and keep entire body clear. Failure to heed this warning could result in severe personal injury or death.**
- **Improper use of the vehicle or failure to properly maintain it could result in decreased vehicle performance, severe personal injury, or death.**
- **Do not leave children unattended on vehicle.**

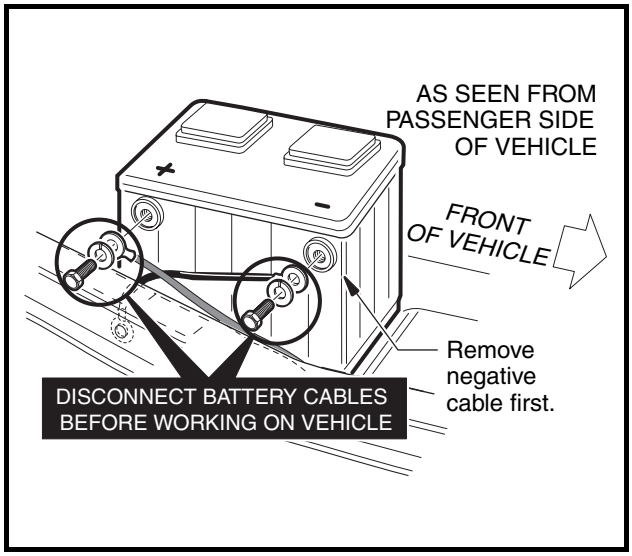


Figure 1-1 Gasoline Vehicle

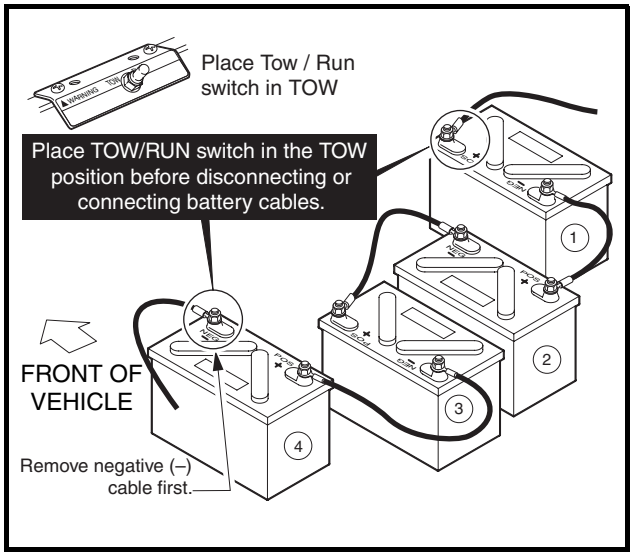


Figure 1-2 Electric Vehicle

SECTION 2 – VEHICLE SPECIFICATIONS

SPECIFICATIONS	Electric XRT 800-E	Electric XRT 810-E	Gasoline XRT 800	Gasoline XRT 810
POWER SOURCE				
Drive motor: Direct drive, 48 volts DC, shunt-wound, 3.2 hp	•			
Engine: 4-cycle OHV, 286 cc, 9.0 hp rated, single-cylinder, air-cooled, with pressure lubrication system			•	
Engine: 4-cycle OHV, 351cc, 11.0 hp rated, single-cylinder, air-cooled, with pressure lubrication system				•
Fuel system: Side-draft carburetor with float bowl, fixed jets, fuel filters, and impulse fuel pump			•	
Governor: Automatic ground-speed sensing, internally geared in unitized transaxle			•	
Ignition: Transistor electronic ignition with electronic RPM limiter			•	
Transaxle: Double reduction helical gear with 12.3:1 direct drive axle	•			
Unitized transaxle: Fully synchronized forward and reverse with neutral and reduced speed reverse (11.8:1 forward, 17.1:1 reverse)			•	
Torque converter: Automatic, variable-speed, dry type			•	
Electrical system: 48 volts DC, reduced speed reverse	•			
Electrical system: 12 volt, 500 cca at 0 °F (-17.8 °C), 650 at 32 °F (0 °C). 105-minute reserve capacity and 35-amp charging capacity			•	
Batteries: High capacity, deep cycle, Trojan PowerDrive 12-volt, 117 min. capacity	•			
Charger: Automatic, 48-volt; UL and CSA listed	•			
STEERING/SUSPENSION/BRAKES				
Steering: Self-adjusting rack and pinion	•			
Suspension: Front and rear tapered mono-leaf springs with dual hydraulic shocks	•			
Brakes: Dual rear wheel self-adjusting brakes with cast iron drums and single brake pedal with automatic-release park brake	•			
BODY/CHASSIS				
Frame/Chassis: Twin I-Beam welded aluminum	•			
Front body: ABS	•			
Rear body: TPO	•			
Tires: 20 x 10.0 – 8 tubeless, 4 ply rated	•			
DIMENSIONS/WEIGHT				
Overall length	100.2 inches (2545 mm)			
Overall width	45 inches (1143 mm)			
Overall height (at steering wheel)	46.9 inches (1191 mm)			
Wheelbase	66.5 inches (1689 mm)			
Ground clearance	5.5 inches (140 mm)			
Front wheel tread	34.5 in (88 cm)			
Rear wheel tread	38.5 in. (98 cm)			
Weight: (without batteries)	874 lb. (396 kg)	889 lb. (403 kg)		
Weight: (dry, without battery)			781 lb. (354 kg)	805 lb. (365 kg)

Vehicle Specifications continued on next page...

SPECIFICATIONS	Electric XRT 800-E	Electric XRT 810-E	Gasoline XRT 800	Gasoline XRT 810
Vehicle rated capacity: Level surface only	800 lb. (363 kg)			
Forward speed	17 mph (27 km)			
Standard seating capacity	2			
Liquid Capacities				
Transaxle	22 oz. (0.67 L)			
Engine crankcase (without filter)			32 oz. (0.95 L)	
Engine crankcase (with filter)			38 oz. (1.12 L)	
Unitized transaxle			27 oz. (0.8 L)	
Fuel tank			7 gallons (26.5 L)	
Tire Pressure				
Front and rear	18-20 psi (1.24-1.38 Bars)		18-20 psi (1.24-1.38 Bars)	

SECTION 3 – GENERAL INFORMATION

⚠ DANGER

- **See General Warning, Section 1, Page 1-1.**

⚠ WARNING

- **See General Warning, Section 1, Page 1-1.**

Important features unique to the different models covered in this manual are highlighted. It is recommended that the owner/operator read and understand this manual and pay special attention to features specific to their vehicle(s).

Refer to the owner's manual provided with the vehicle for information on the following topics:

- Controls and Indicators
- Pre-Operation and Daily Safety Checklist
- Driving Instructions
- Towing
- Transporting on a Trailer
- Subsequent Owner Registration
- Warranties

SERIAL NUMBER IDENTIFICATION

The serial number of the vehicle is printed on a bar code decal mounted on the frame directly above the accelerator pedal (Example: AQ0401-123456 for Electric or AG0401-123456 for Gasoline) **(Figure 3-1, Page 3-1)**. There is also a second serial number decal mounted on the front body frame behind the instrument panel. The instrument panel must be removed to view this decal.

NOTE: *Have the vehicle serial number available when ordering parts or making inquiries.*

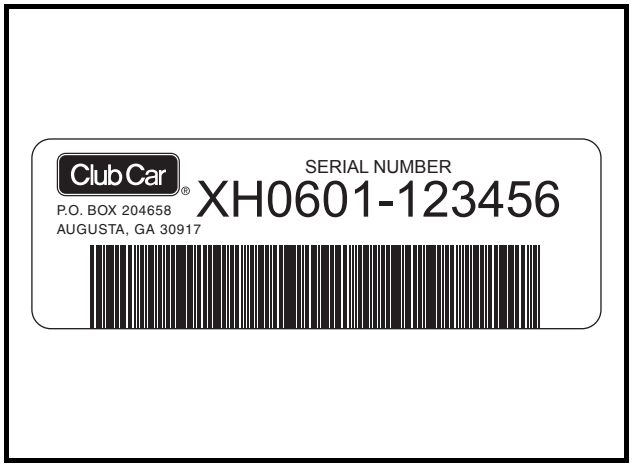


Figure 3-1 Serial Number Decal

STORAGE – GASOLINE VEHICLE

See General Warning, Section 1, Page 1-1.

⚠ DANGER

- **Do not drain gasoline when the engine is hot or while it is running.**
- **Be sure to clean up any spilled gasoline before operating the vehicle.**
- **Store gasoline in an approved gasoline container only. Store in a well-ventilated area away from sparks, open flames, heaters, or heat sources.**
- **Keep gasoline out of the reach of children.**
- **Do not siphon gasoline from the vehicle.**

⚠ WARNING

- **Turn the key switch OFF, remove the key, and leave the Forward/Reverse handle in the NEUTRAL position during storage. This is to prevent unintentionally starting the vehicle or a fire hazard.**
- **Turn fuel shut-off valve to closed (OFF) position (Figure 3-3, Page 3-3).**
- **Do not attempt to charge frozen batteries or batteries with bulged cases. Discard the battery. Frozen batteries can explode.**

⚠ CAUTION

- **Batteries in a low state of charge will freeze at low temperatures.**

PREPARING THE GASOLINE VEHICLE FOR EXTENDED OFF-SEASON STORAGE

1. Batteries should be clean and free of corrosion. Wash tops and terminals of batteries with a solution of baking soda and water (1 cup (237 mL) baking soda per 1 gallon (3.8 L) of water). Rinse solution off batteries. Do not allow this solution to enter the batteries. Be sure terminals are tight. Let the terminals dry and then coat them with Battery Terminal Protector Spray (CCI P/N 1014305).
2. Store vehicle in a cool, dry place. This will minimize battery self-discharge. If the battery appears to be weak, have it charged by a trained technician. Use an automotive-type 12-volt battery charger rated at 10 amps or less.
3. Drain carburetor and seal the fuel tank.
   - 3.1. Place the Forward/Reverse handle in the NEUTRAL position and the neutral lockout cam in the MAINTENANCE position. Turn the fuel shut-off valve to the closed (OFF) position **(Figure 3-3, Page 3-3)** and run the engine until fuel remaining in the carburetor and fuel lines is depleted and the engine stalls. Return the neutral lockout cam to the OPERATE position.
   - 3.2. Loosen, but do not remove, the carburetor drain screw and drain fuel remaining in bowl into a small container, then pour the fuel from the container into vehicle fuel tank. Tighten the carburetor drain screw.
   - 3.3. Disconnect fuel vent line from fuel tank vent nipple.
   - 3.4. Plug the fuel tank vent nipple so that it is air tight. We recommend using a slip-on vinyl cap.

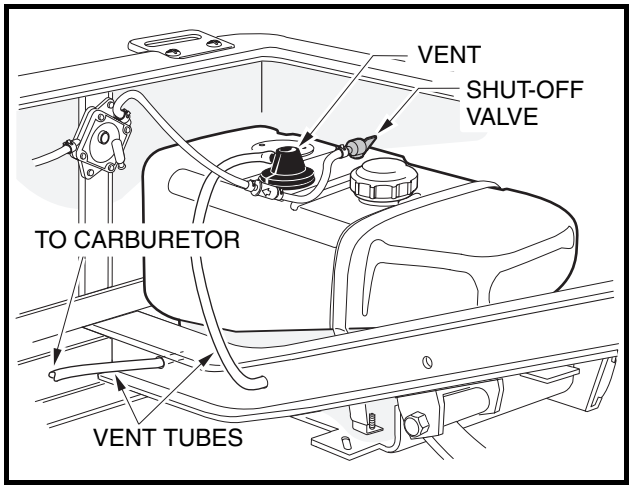


Figure 3-2 Fuel Tank, Vent, and Lines

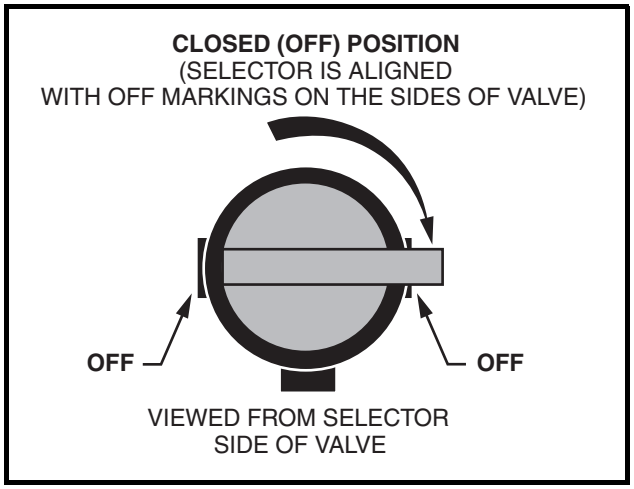


Figure 3-3 Fuel Shut-Off Valve – Closed Position

4. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-2.**
5. To protect the engine, remove the spark plug and pour 1/2 ounce (14.2 mL) of SAE 10 weight oil into the engine through the spark plug hole. Rotate the engine crankshaft by hand several times and then install the spark plug.
6. Adjust tires to recommended tire pressure. **See Section 2 – Vehicle Specifications.**
7. Perform semiannual periodic lubrication. **See Periodic Lubrication Schedules, Section 10, Page 10-4.**
8. Thoroughly clean front body, rear body, seats, engine compartment, and underside of vehicle.
9. Do not engage the park brake. Chock the wheels to prevent the vehicle from rolling.

RETURNING THE STORED GASOLINE VEHICLE TO SERVICE

1. Connect battery cables, positive (+) cable first.
2. Restore fuel system to operation.
   2.1. Remove plug from the fuel tank vent nipple and reconnect fuel vent line to nipple. Open the fuel shut-off valve **(Figure 3-4, Page 3-4)**. Make sure the valve is fully open. A partially closed fuel shut-off valve **(Figure 3-5, Page 3-4)** combined with the use of the choke, can result in a fouled spark plug and engine failure.
   2.2. Place the Forward/Reverse handle in the NEUTRAL position and the neutral lockout cam to the MAINTENANCE position. Crank the engine until fuel is pumped into the carburetor and fuel lines and the engine starts. Turn the engine off and return the neutral lockout cam to the OPERATE position. **See following NOTE.**

NOTE: *Due to the oil added to the engine in preparation for storage, the engine may smoke excessively for a short while when running it for the first time after storage.*

3. Adjust tires to recommended tire pressure. **See Section 2 – Vehicle Specifications.**
4. Perform the Pre-Operation and Daily Safety Checklist. **See the vehicle owner's manual.**

Returning the Stored Gasoline Vehicle to Service, Continued:

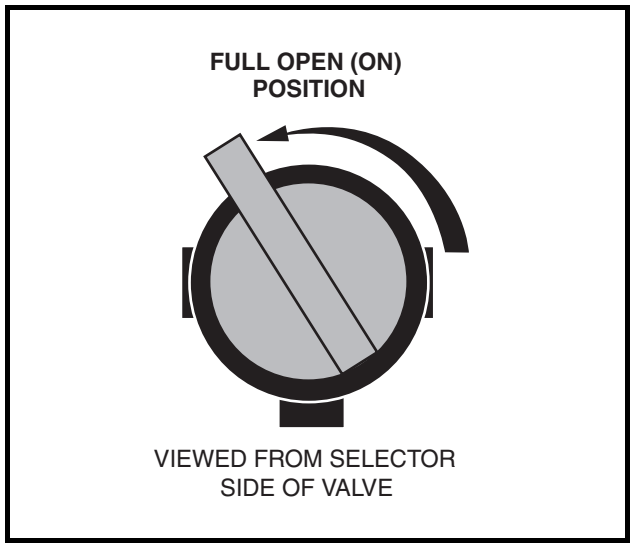


Figure 3-4 Fuel Shut-Off Valve – Open Position

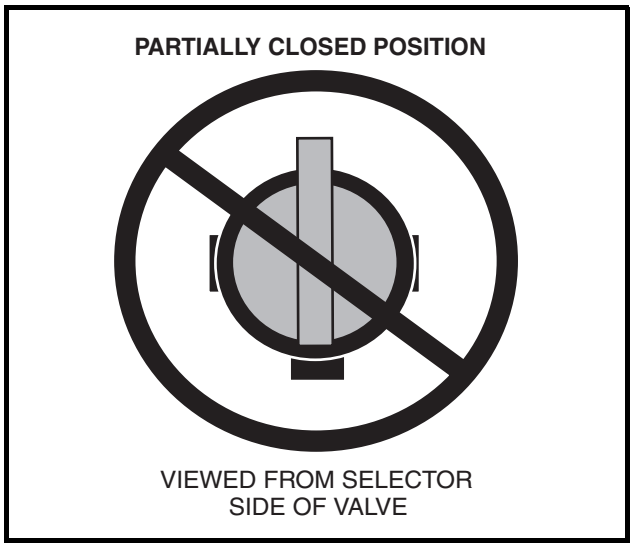


Figure 3-5 Incorrect Fuel Shut-off Valve Setting

STORAGE – ELECTRIC VEHICLE

See General Warning, Section 1, Page 1-1.

⚠ WARNING

- **Turn the key switch OFF, remove the key, and leave the Forward/Reverse handle in the NEUTRAL position during storage. This is to prevent unintentionally starting the vehicle or a fire hazard.**
- **Do not attempt to charge frozen batteries or batteries with bulged cases. Discard the battery. Frozen batteries can explode.**

⚠ CAUTION

- **Batteries in low state of charge will freeze at low temperatures.**
- **To avoid exposing electrical components to moisture and subsequent damage, do not use any type of pressure washing or steam cleaning equipment to wash the vehicle.**
- **Electric vehicles only: Place Tow/Run switch in the TOW position.**

PREPARING THE ELECTRIC VEHICLE FOR EXTENDED OFF-SEASON STORAGE

1. Fully charge batteries. **See Battery Charger, Section 20, Page 20-4.**
2. Batteries should be clean and free of corrosion. Wash tops and terminals of batteries with a solution of baking soda and water (1 cup (237 mL) baking soda per 1 gallon (3.8 L) of water). Rinse solution off batteries. Do not allow this solution to enter the batteries. Be sure terminals are tight. Let the terminals dry and then coat them with Battery Terminal Protector Spray (CCI P/N 1014305).
3. Store vehicle in a cool, dry place. This will minimize battery self-discharge.

4. Adjust tires to recommended tire pressure. **See Section 2 – Vehicle Specifications.**
5. Perform semiannual periodic lubrication. **See Periodic Lubrication Schedules, Section 10, Page 10-4.**
6. Thoroughly clean front body, rear body, seats, battery compartment, and underside of vehicle.
7. Do not engage the park brake. Chock the wheels to prevent the vehicle from rolling.
8. Keep batteries fully charged during storage.

NOTE: ***PowerDrive Battery Chargers:*** *Leave PowerDrive battery chargers plugged in during storage. The onboard computer will automatically activate the charger when necessary. If charger cannot remain plugged in, or AC power will not be available during extended storage, disconnect the batteries for storage.* ***See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-2.***

CAUTION

- **Check the vehicle monthly to ensure the charger is operating correctly during storage.**

RETURNING THE STORED ELECTRIC VEHICLE TO SERVICE

1. If necessary, connect batteries.
2. Fully charge batteries.
3. Adjust tire to recommended pressure. **See Section 2 – Vehicle Specifications.**
4. Perform the Pre-Operation and Daily Safety Checklist. **See the vehicle owner's manual.**

SECTION 4 – BODY AND TRIM

⚠ DANGER

- **See General Warning, Section 1, Page 1-1.**

⚠ WARNING

- **See General Warning, Section 1, Page 1-1.**

CLEANING THE VEHICLE

See General Warning, Section 1, Page 1-1.

CAUTION

- **Do not use detergents or cleaning solvents that contain ammonia, aromatic solvents, or alkali materials on body panels or seats.**
- **Do not allow battery acid to drip on body panels. Battery acid will cause permanent damage. Wash spilled battery acid from body panels immediately.**

These vehicles are equipped with ABS front body and TPO rear bodies. Use only commercially available automotive cleaners with a sponge or soft cloth for normal cleaning. A garden hose at normal residential water pressure is adequate.

We do not recommend any type of pressure washing or steam cleaning. Such a process (especially if the body has been removed) will expose electrical components to moisture. Moisture entering electrical components can result in water damage and subsequent component failure.

Use non-abrasive wax products. Battery acid, fertilizers, tars, asphalt, creosote, paint, or chewing gum should be removed immediately to prevent possible stains. **See following NOTE.**

NOTE: *Dispose of waste water properly.*

SEAT CLEANING

To preserve seat appearance, clean regularly with mild soap or detergent applied with a sponge or soft cloth. Use a soft bristle brush to clean areas that are especially soiled. Use the following guidelines:

Light Soiling: A solution of 10% liquid dish soap and warm water applied with a soft, damp cloth is recommended. A soft bristle brush may be used if necessary. Wipe off any residue with a water dampened cloth.

Difficult Stains: Dampen a soft, white cloth with a solution of 10% household bleach (sodium hypochlorite) and 90% water. Rub gently to remove stain, then rinse with a water dampened cloth to remove bleach concentration.

More Difficult Stains: Perform previous procedure using full-strength bleach, or allow bleach to puddle on affected area for approximately 30 minutes. Rinse with a water dampened cloth to remove any remaining bleach concentration. **See following CAUTION.**

CAUTION

- **To prevent damage to the vehicle when removing difficult stains or heavy soiling, remove the seat bottom from the vehicle first.**

FRONT AND REAR BODY REPAIR

See General Warning, Section 1, Page 1-1.

MINOR SCRATCHES AND SURFACE BLEMISHES

For minor scratches or blemishes in the body that do not penetrate the finish:

1. Thoroughly clean the affected area using a strong, non-abrasive detergent and hot water, then clean with Ultra-Kleen® Solvent Cleaner to remove any oil-based contaminants.
2. Lightly buff imperfection with a clean soft cloth or buff pad. Do not use any kind of rubbing (abrasive) compound on body assemblies.
3. Wax the entire body part to restore luster and weather protection.

SMALL SCRATCHES THAT CANNOT BE BUFFED OUT

1. Thoroughly clean the affected area with alcohol and then dry thoroughly.
2. Using 240 grit or finer sandpaper, lightly sand the scratch to feather the edges. Finish sand the scratch with 320 grit or finer paper to remove gloss from the surface. Sand as little body surface as possible beyond the scratch. **See following CAUTION.**

CAUTION

- **Be careful not to sand completely through the finish to the body material.**

3. Using the brush provided with the touch-up paint apply paint to the scratch. Multiple layers of paint may be required to fill the scratch.
4. Allow paint to dry completely (approximately 10-20 minutes), then lightly buff the imperfection.
5. Wax the entire body part to restore luster and weather protection.

GOUGES, PUNCTURES, TEARS, LARGE SCRATCHES, AND ABRASIONS

Touch-up is not recommended. Replace the entire body part or have it repaired by a professional paint and body repair shop with experience repairing TPO bodies.

TOUCH-UP PAINT COLOR CHART

COLOR	CLUB CAR P/N
Club Car Red	CCI P/N 101997203
Club Car Dark Green	CCI P/N 101997209

FRONT BODY

See General Warning, Section 1, Page 1-1.

BUMPER REMOVAL

1. Remove bolts (3) and (5) and lock nuts (4) and pull bumper (1) from vehicle frame **(Figure 4-1, Page 4-3)**. **See following WARNING.**

⚠ WARNING

- **Have another person hold bumper firmly against the frame when removing the last bolt. The bumper weighs approximately 40 pounds. Hold the bumper securely during removal to avoid personal injury.**

BUMPER INSTALLATION

1. Position bumper against body and front frame and loosely install top bolts and lock nuts. **See following WARNING.**

⚠ WARNING

- **Have another person hold bumper firmly when installing first bolt. The bumper weighs approximately 40 pounds. Hold the bumper securely during installation to avoid personal injury.**

2. Install bottom bolts and lock nuts. Tighten hardware to 17.5 ft-lb (24 N·m).
3. Tighten top hardware to X17.5 ft-lb (24 N·m).

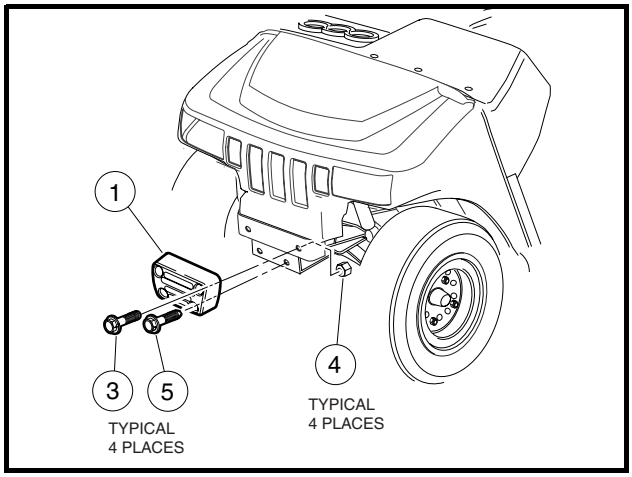


Figure 4-1 Front Bumper

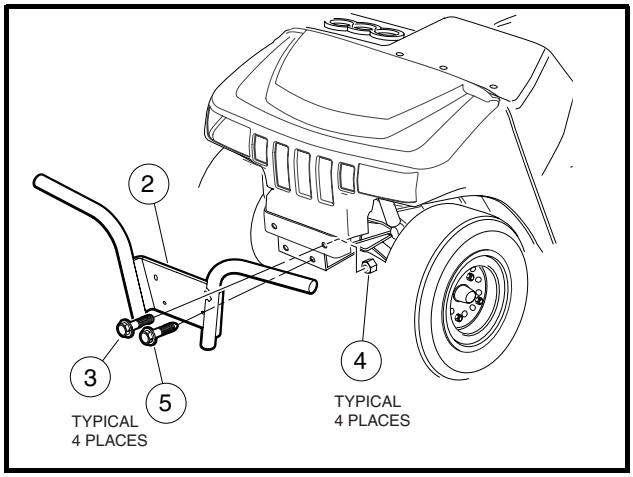


Figure 4-2 Front Brush Guard

BRUSH GUARD REMOVAL

1. Remove bolts (3) and (5) and lock nuts (4) and pull brush guard (2) from vehicle frame **(Figure 4-2, Page 4-3)**. **See following WARNING.**

⚠ WARNING

- **Have another person hold brush guard firmly against the frame when removing the last bolt. The brush guard weighs approximately 40 pounds. Hold the brush guard securely during removal to avoid personal injury.**

BRUSH GUARD INSTALLATION

1. Position brush guard against body and front frame and loosely install top bolts and lock nuts. **See following WARNING.**

⚠ WARNING

- **Have another person hold brush guard firmly when installing first bolt. The brush guard weighs approximately 40 pounds. Hold the brush guard securely during installation to avoid personal injury.**

2. Install bottom bolts and lock nuts. Tighten hardware to 17.5 ft-lb (24 N·m).
3. Tighten top hardware to 17.5 ft-lb (24 N·m).

FRONT BODY REMOVAL

1. Remove bumper or brush guard. **See Bumper Removal or Brush Guard Removal Page 4-4**.
2. Remove caps (5) from body and dash screws **(Figure 4-3, Page 4-5)**.
3. Remove screws (4) and plastic scalloped washers (6) from body and body support and slide body away from dash.
4. Remove plastic screws from sides of dash and body.
5. Pull front body (9) from body covers (12) and (13).

NOTE: *Body cover is not attached to the vehicle frame and may stay with the body when removed.*

6. Disconnect headlights from wire harness at spade connectors and remove from the vehicle.

DASH REMOVAL

1. Remove instrument panel:
   1.1. Remove the plastic panel screws from the instrument panel.
   1.2. Pull panel away from the dash to access electrical components.
   1.3. Disconnect the wires from the electrical components mounted on the instrument panel. Do not allow wires to touch.
   1.4. Slide instrument panel up and away from the steering column.
2. Slide the three dash clips along the bottom edge of the dash up and away from the frame and floor matt.
3. Raise dash up and pass steering wheel through instrument panel hole in dash and remove the dash from the vehicle.

DASH INSTALLATION

1. Pass the steering wheel through the instrument panel hole in the dash.
2. Attach the dash clips along the bottom edge of the dash onto the frame above the floor matt.
3. Install the instrument panel:
   3.1. Attach electrical components to connections on the back of the instrument panel
   3.2. Position the instrument panel onto the dash and push plastic fasteners into place.
4. Install front body. **See Front Body Installation on page 4-5.**

FRONT BODY INSTALLATION

1. Position front body onto frame and attach head lights to wire harness at spade connectors.
2. Install body (9) under body covers (12) and (13), and align holes with dash and body support **(Figure 4-3, Page 4-5)**.
3. Install body and dash screws and scalloped washers on the top of the body. Tighten to 45 in-lb (5 N·m).
4. Attach plastic caps (5) onto dash screws.
5. Install plastic screws on the sides of the dash and body.
6. Install bumper or brush guard. **See Bumper Installation or Brush Guard Installation Page 4-4**.

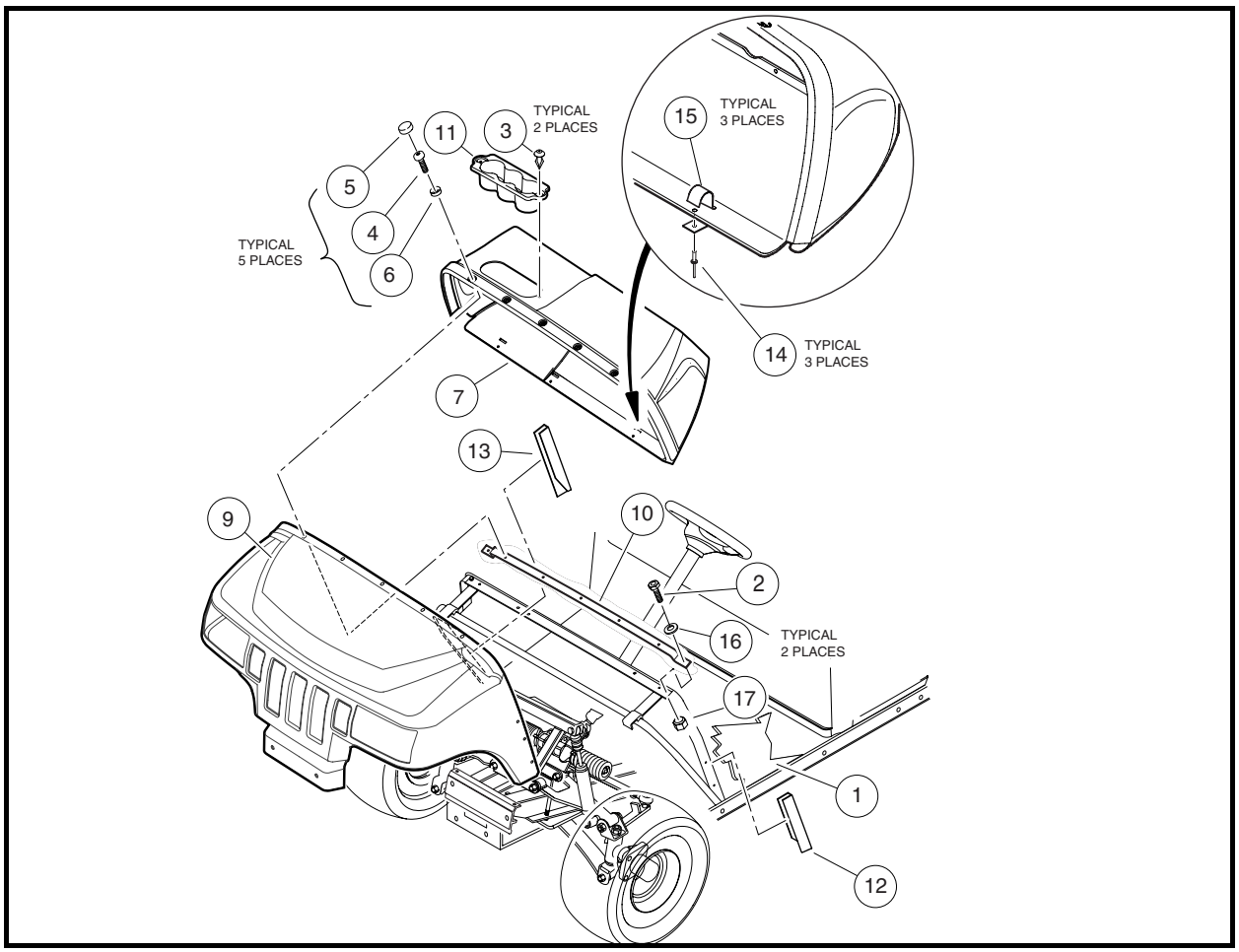


Figure 4-3 Front Body Assembly

CARGO BED

See General Warning, Section 1, Page 1-1.

CARGO BED REMOVAL

NOTE: *This procedure requires two people.*

1. Raise bed and remove the rue rings on the end of each clevis pin.
2. Remove hinge clevis pins and remove bed from vehicle. **See following CAUTION and WARNING.**

CAUTION

- **Support bed as pins are removed.**
- **Keep bed hinges as close to alignment as possible to avoid binding the pins during removal.**

⚠ WARNING

- **Keep hands and arms from between the bed and vehicle frame and do not allow the bed to drop.**

CARGO BED INSTALLATION

NOTE: *This procedure requires two people.*

Lubricate the hinge clevis pins with light motor oil prior to assembly.

1. Position the bed to align with the hinge locations.
2. Install hinge clevis pins and washers, with the head of the pin to the inside portion of the bed. **See following CAUTION and WARNING.**

CAUTION

- **Keep bed hinges as close to alignment as possible to avoid binding the pins during removal.**

⚠ WARNING

- **Keep hands and arms from between the bed and vehicle frame and do not allow the bed to drop.**

3. Install rue rings and washers on the end of the hinge clevis pins.
4. Lower the bed onto the bed latch plates. Adjust the latch plates if necessary.

BED LATCH ASSEMBLY

1. Remove the two latch link support bolts and remove latch rod and catch plate assembly from bed **(Figure 4-4, Page 4-7)**.
2. Remove and replace any damaged or broken latch springs.

Figure 4-4 Bed Latch Link Bolt

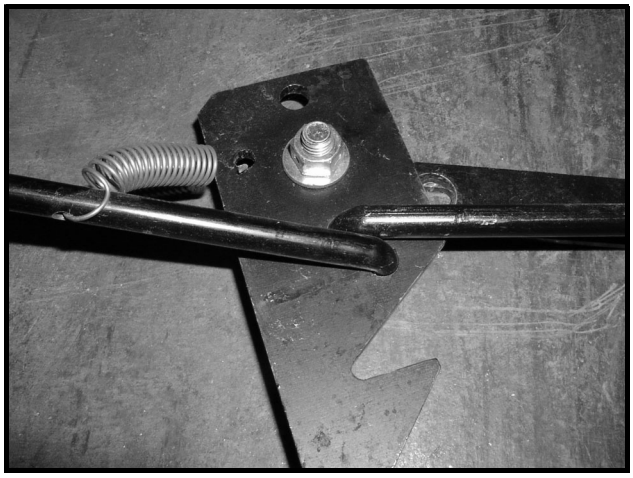


Figure 4-5 Passenger Side Catch Rods and Catch Plate

Catch Rod and Catch Plate Removal

1. Remove latch springs.
2. Remove bolts and mechanical lock nuts from latch link and catch plates **(Figure 4-5, Page 4-7)**.
3. Remove bronze bearings from catch plates.
4. Pry off push nuts from catch rod ends **(Figure 4-7, Page 4-7)**. **See following NOTE.**

NOTE: *Push nuts cannot be reused. Replace with either new push nuts or use cotter pins and washers.*

Catch Rod and Catch Plate Installation

1. Install new bronze bearings into the catch plates.
2. Install the bolts and use new mechanical lock nuts to assemble the catch plates and latch link. Tighten hardware to 75 in-lb (8.4 N·m), then back-off 1/2 turn so that latch operates freely.
3. Install bed catch rods. Use new push nuts or use a flat washer and cotter pin to secure the ends of the rods **(Figure 4-7, Page 4-7)**.
4. Install new springs from the catch plates to the catch rods **(Figure 4-6, Page 4-7)**.

Figure 4-6 Latch Spring

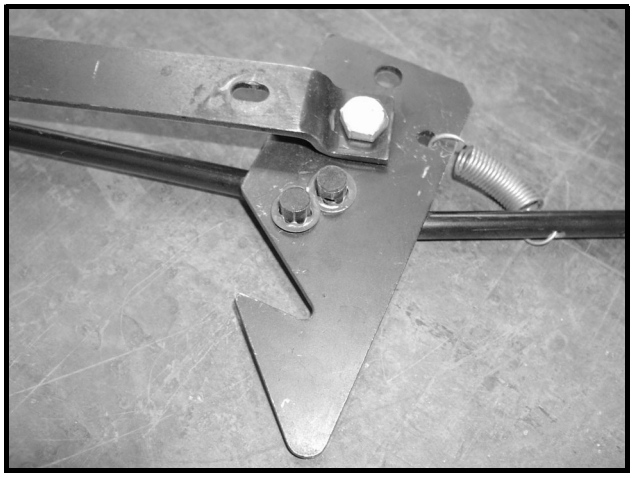


Figure 4-7 Push Nuts

Bed Hinge and Support Bracket Removal

1. Remove steel bushings and urethane bushings from hinge brackets **(Figure 4-8, Page 4-8)**.
2. Remove bolts from hinges and remove hinges from supports.
3. Remove support channel bolts and bushings form hinge support channel **(Figure 4-9, Page 4-8)**.
4. Remove hinge support bolts and supports **(Figure 4-9, Page 4-8)**. **See following NOTE.**

NOTE: *Note the location of the two different size bolts.*

It may be necessary to deflect the rear fender slightly to remove support bolts.

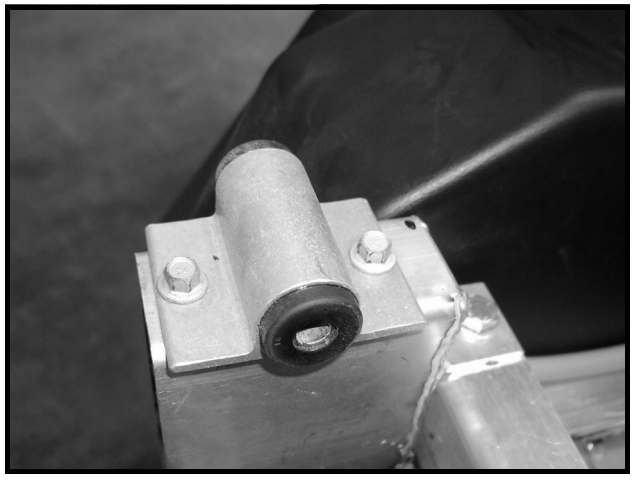


Figure 4-8 Bed Hinge

Figure 4-9 Hinge Support

BED LATCH ASSEMBLY INSTALLATION

1. Position latch link and catch plate assembly onto bed with support located at bolt holes and catch rods positioned into bed slots.
2. Attach latch link with screws. Tighten hardware to 7 ft-lb (9.5 N·m) **(Figure 4-4, Page 4-7)**.

SEAT BACK SUPPORT BRACKETS

See General Warning, Section 1, Page 1-1.

NOTE: *The bed latch plates are a part of each of the seat back support bracket. Removing latch plates will require adjustment for bed catch plates **(Figure 4-10, Page 4-9)**.*

Figure 4-10 Bed Latch Plates

SEAT BACK SUPPORT BRACKET REMOVAL

1. Remove bolts from seat back and support brackets and remove seat back.
2. Remove seat back support bolts and bed support weldment with bed bumpers from seat back supports **(Figure 4-11, Page 4-9)**.
3. Remove seat back support bolts from body and remove from vehicle **(Figure 4-12, Page 4-9)**.

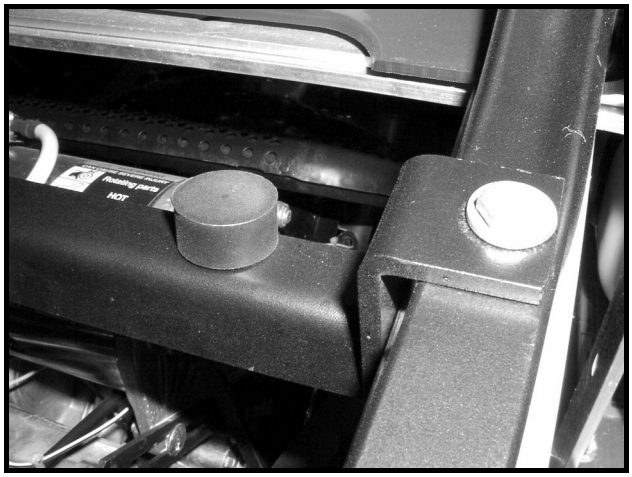


Figure 4-11 Seat Weldment Support

Figure 4-12 Seat Back Body Support

SEAT BACK SUPPORT BRACKET INSTALLATION

1. Align passenger and driver side seat back support brackets with holes in body **(Figure 4-12, Page 4-9)**. **See following NOTE.**

NOTE: *Striker plates should be to the outside of each bracket.*

2. Install bracket bolts to body and tighten hardware to 14.5 ft-lb (19.6 N·m).
3. Position bed support with bumpers onto seat back supports and frame **(Figure 4-11, Page 4-9)**.
4. Install bracket and bed support bolts to frame and tighten to 100 in-lb (11.3 N·m).

REAR BODY AND FENDERS

See General Warning, Section 1, Page 1-1.

NOTE: *The driver side rear fender can be removed without removing any other component. But the passenger side rear fender cannot be removed without either removing the fuel tank, or removing the rear body. It is easier to remove the rear body than to remove the fuel tank.*

REAR BODY REMOVAL

1. Remove the seat from the rear body.
2. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-2.**Remove cargo bed. **See Cargo Bed Removal on page 4-6.**
3. Remove seat back support brackets. **See Seat Back Support Bracket Removal on page 4-9.**
4. Remove the two screws, nuts and washers located at the bottom edge of the seat support panel (in kick-plate just above the floormat) **(Figure 4-13, Page 4-10)**.

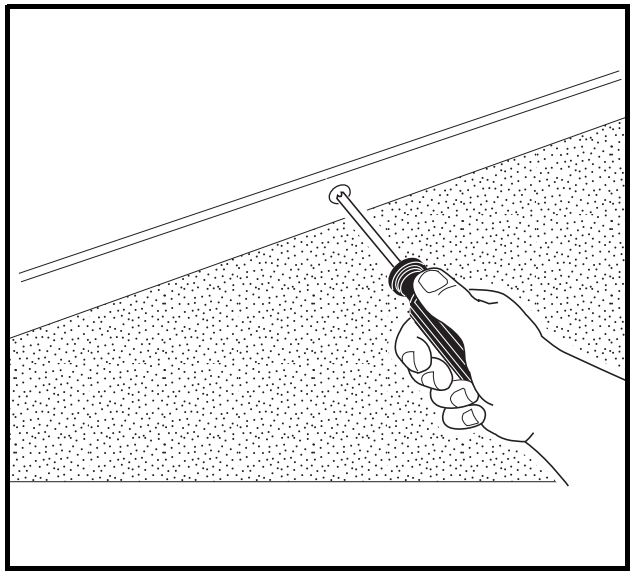


Figure 4-13 Remove Kick-Plate Screws

5. **Electric vehicles:**

   5.1. Disconnect or remove charger receptacle:

      5.1.1. Remove wire ties binding 10-gauge red wire (from charger receptacle to battery) to the vehicle frame. Disconnect the 10-gauge red wire at the positive post of battery no. 1.

      5.1.2. Remove the retaining nut and disconnect the 10-gauge black wire (from the onboard computer) from the receptacle.

      5.1.3. Unplug the fuse holder assembly to disconnect the gray sense lead from the receptacle.

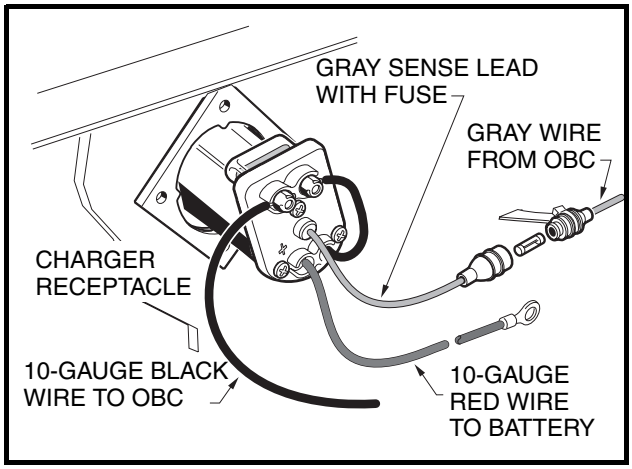


Figure 4-14 PowerDrive Charger Receptacle

6. Disconnect and remove Forward/Reverse switch. **See Forward/Reverse Switch Removal on page 4-11.**
7. **Gasoline Vehicles:**

NOTE: *To remove the rear body, the choke button assembly does not have to be removed from the body. However, adjustment of the choke positioner may be necessary after the rear body is reinstalled.*

8. Remove two bolts, washers and nylon lock nuts from rear fenders at frame locations **(Figure 4-15, Page 4-11)**.
9. Lift rear body and fenders from the vehicle.

Figure 4-15 Rear Fender Frame Bolts

FORWARD/REVERSE SWITCH

Forward/Reverse Switch Removal

1. **Electric vehicles:**
   1.1. Disconnect the four-pin connector (12) and the three-pin connector (13) from the Forward/Reverse switch **(Figure 4-16, Page 4-12)**.

Forward/Reverse Switch Removal, Continued:

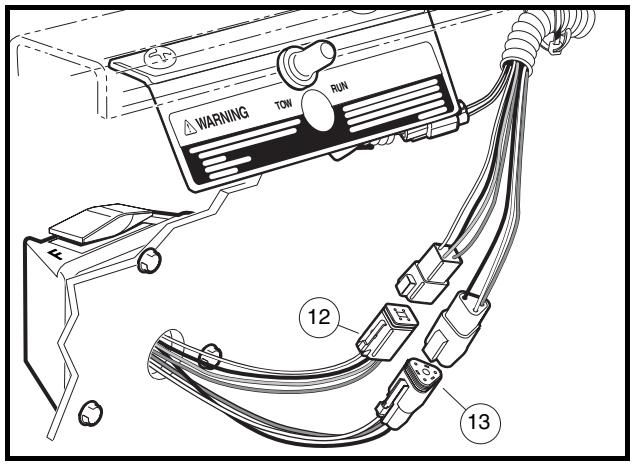


Figure 4-16 Electric Forward/Reverse Switch

2. Remove four screws and nylon lock nuts securing the Forward/Reverse shifter to the rear body.
3. Remove the shifter lever screw, lever and wave washer.
4. Remove the shifter cable from the cable hanger under the driver-side seat hinge.
5. Pull the Forward/Reverse shifter (with wiring and cable assembly still connected) from back surface of body and allow it to rest on engine or frame.
6. **Gasoline vehicles:**
   6.1. Remove two nylon lock nuts from fuel pump and remove fuel pump from back of kick panel, and allow it to rest on engine or frame.
7. Remove Forward/Reverse switch shifter.

Forward/Reverse Switch Installation

1. Position Forward/Reverse switch shifter on back of the body at hole locations.
2. Install screws and lock nuts to Forward/Reverse switch or shifter to 33 in-lb (2.8 N·m).
   2.1. **Gasoline vehicles:** Install Forward/Reverse handle and wave washer and tighten to 14 in-lb (1.6 N·m).
   2.2. Check the choke push rod for position and adjust if necessary.
   2.3. Route shifter cable up into driver side corner of body on onto cable hook.
   2.4. Install fuel pump onto frame support and tighten hardware to 38 in-lb (4.3 N·m).
   2.5. Connect the battery cables, positive (+) cable first, and tighten terminals to 12 ft-lb (16 N·m). Coat terminals with Battery Terminal Protector Spray (CCI P/N 1014305).
   2.6. **Electric vehicles:** Connect the four-pin connector (12) and the three-pin connector (13) to the Forward/Reverse switch.
   2.7. Connect the battery cables, positive (+) cable first, and tighten terminals to 110 in-lb (12.4 N·m). Coat terminals with Battery Terminal Protector Spray (CCI P/N 1014305).

REAR FENDER REMOVAL

NOTE: *The driver side rear fender can be removed without removing any other component. But the passenger side rear fender cannot be removed without either removing the fuel tank, or removing the rear body. It is easier to remove the rear body than to remove the fuel tank.*

1. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-2.**
2. **Driver side rear fender:**
   2.1. Remove the seat.
   2.2. Raise the cargo bed.
   2.3. Remove rear fender frame bolt **(Figure 4-15, Page 4-11)**.
   2.4. Remove the top body and fender bolt.
   2.5. Remove the two outside body and fender bolts and remove the fender from the vehicle.
3. **Passenger side rear fender:**
   3.1. Remove the seat.
   3.2. Remove the cargo bed. **See Cargo Bed Removal on page 4-6.**
   3.3. Remove the seat back support brackets. **See Seat Back Support Bracket Removal on page 4-9.**
   3.4. Remove rear fender frame bolt.
   3.5. Remove the rear body. **See Rear Body Removal on page 4-10.**
   3.6. Place body and fender on a clean flat surface and remove the top body and fender bolt.
   3.7. Remove the two outside body and fender bolts and separate the passenger side fender from the rear body.

REAR FENDER INSTALLATION

NOTE: *If both fenders have been removed attach them to the rear body first, then install the rear body with fenders attached.*

Rear Body and Fenders

NOTE: *Use the floor as a method of keeping the fenders and rear body in alignment for height.*

1. Position the rear body on a large flat surface such as a concrete floor. **See following NOTE.**
2. Attach both fenders to the sides on the rear body and leave bolts loose.
3. Attach both fenders to the top locations on the rear body and snug bolts but do not tighten.
4. Tighten the side bolts on both fenders to 25 in-lb (2.8 N·m).
5. Tighten top bolts on both fenders to 25 in-lb (2.8 N·m).

REAR BODY INSTALLATION

NOTE: *This procedure is easier using two people.*

1. Position rear body with fenders attached onto the vehicle frame.
2. Position front edge of the body behind floor matt back rail and down into the side trim.
3. Install the front edge of the body to the rail with screws and tighten to 50 in-lb (5.6 N·m).
4. Install the rear bolts on both fenders and tighten to 50 in-lb (5.6 N·m).

Rear Body Installation, Continued:

5. **Driver side rear fender:**

NOTE: *If only the driver side fender has been removed, use the following procedure for installation*

5.1. Install fender in reverse order of removal.
5.2. Tighten side bolts to 25 in-lb (2.8 N·m).
5.3. Tighten top bolt to 25 in-lb (2.8 N·m).

FLOOR MAT

See General Warning, Section 1, Page 1-1.

FLOOR MAT REMOVAL

1. Remove the brake and accelerator pedals. **See Section 5 – Accelerator and Brake Pedal Group.**
2. Slide the mat from under the edge of the rear body. Loosen the rear body screws if necessary.
3. Slide the mat away from the trim up under the dash and remove the floor matt.

FLOOR MAT INSTALLATION

1. Reverse the removal procedure to install the floormat. If loosened, tighten rear body screws to 48 in-lb (5.4 N·m).
2. Install the brake and accelerator pedals. **See Section 5 – Accelerator and Brake Pedal Group.**

SECTION 5 – ACCELERATOR AND BRAKE PEDAL GROUP

⚠ DANGER

- **See General Warning, Section 1, Page 1-1.**

⚠ WARNING

- **See General Warning, Section 1, Page 1-1.**

BRAKE PEDAL AND PARK BRAKE

See General Warning, Section 1, Page 1-1.

BRAKE PEDAL REMOVAL

1. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-2.**
2. Place chocks under the rear wheels and lift the front end of the vehicle with a chain hoist or floor jack. Place jack stands under the front cross tube of the vehicle frame and lower the vehicle onto the jack stands. **See following WARNING**.

⚠ WARNING

- **Lift only one end of the vehicle at a time. Use a suitable lifting device (chain hoist or hydraulic floor jack) with 1000 lb. (454 kg) minimum lifting capacity. Do not use lifting device to hold vehicle in raised position. Use approved jack stands of proper weight capacity to support the vehicle and chock the wheels that remain on the floor. When not performing a test or service procedure that requires movement of the wheels, lock the brakes.**

3. Remove the brake pedal assembly.
   - 3.1. Disconnect the equalizer rod (13) from the pedal shaft by removing the clevis pin (14) and bow-tie pin (15) **(Figure 5-1, Page 5-2)**.
   - 3.2. Remove the nuts (5), washers (2), bolts (4) and mounting blocks (23). If the mounting blocks show signs of excessive wear or are damaged, they must be replaced with new ones before installing pedal assembly.
   - 3.3. Remove the nut (12) and brake stop bumper (11).
   - 3.4. Lift the pedal assembly (8) through the floorboard.

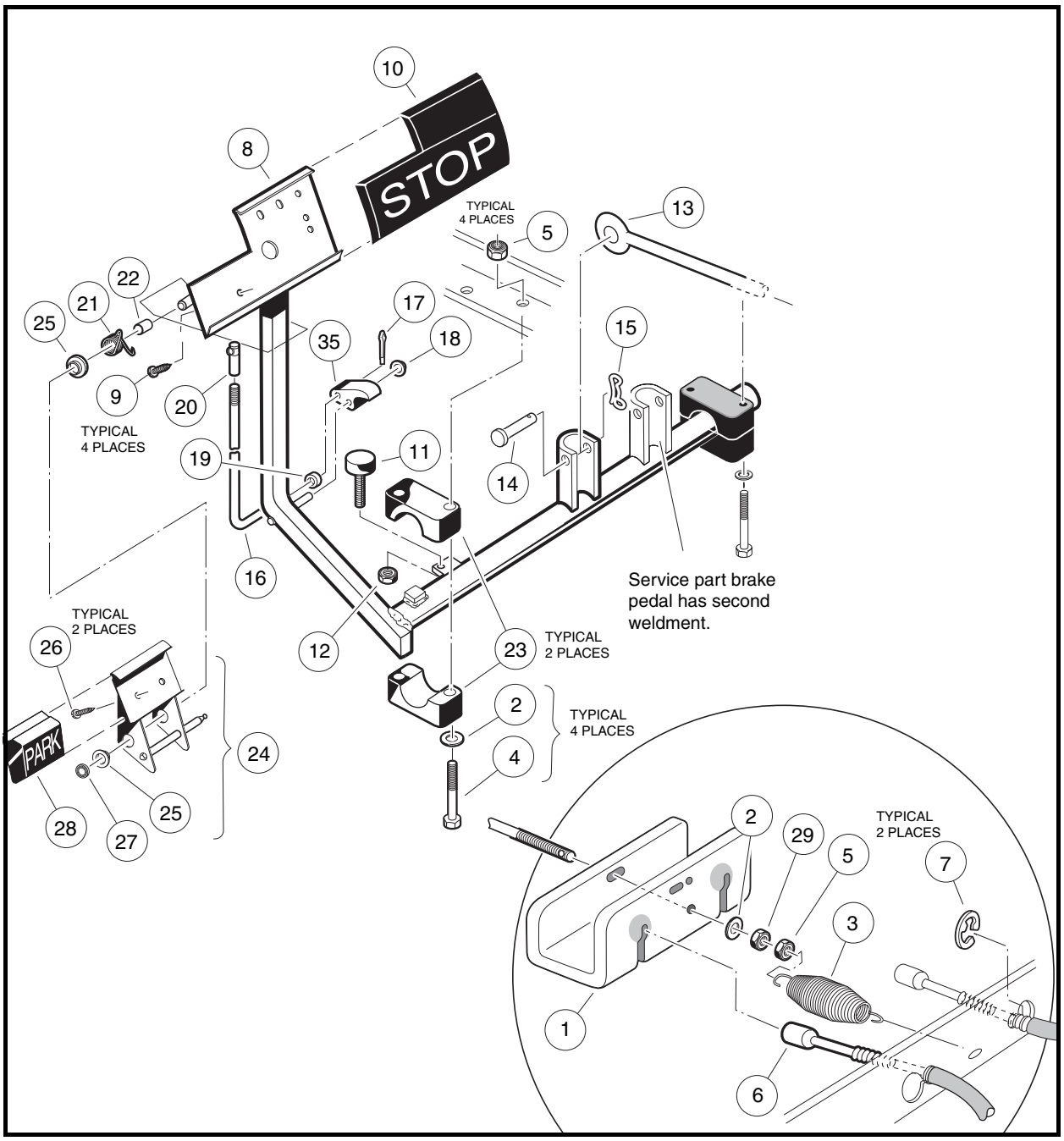


Figure 5-1 Brake and Park Brake Pedal Assembly

BRAKE PEDAL INSTALLATION

1. From the top side of the floorboard, insert the brake pedal assembly through the opening in the floor, and install the brake pedal stop bumper (11) on the brake pedal assembly **(Figure 5-1, Page 5-2)**. Do not tighten the jam nut (12) at this time.
2. Secure the equalizer rod (13) to the brake pedal assembly (8) with the clevis pin (14) and bow-tie pin (15) as shown.
3. Position and attach brake pedal assembly, mounting blocks (23) and washers (2) to vehicle frame as shown. Tighten the bolts and nuts to 113 in-lb (12.8 N·m).

4. Tighten the nut (2) on the equalizer rod (1) so that brake pedal free-play is 1/4 inch to 1/2 inch (6 mm to 13 mm) **(Figure 5-2, Page 5-3). See following NOTE.**

NOTE: *Brake pedal free-play is the distance the brake pedal can be pressed before the brake actuator arm moves.*

5. Tighten the jam nut (3) while holding the adjustment nut (2) in the correct position **(Figure 5-2, Page 5-3).**
6. Adjust the pedal group. Refer to the appropriate adjustment procedure:
   - **Pedal Group Adjustment – Gasoline Vehicle on page 5-11**
   - **Pedal Group Adjustment – Electric Vehicles on page 5-16**

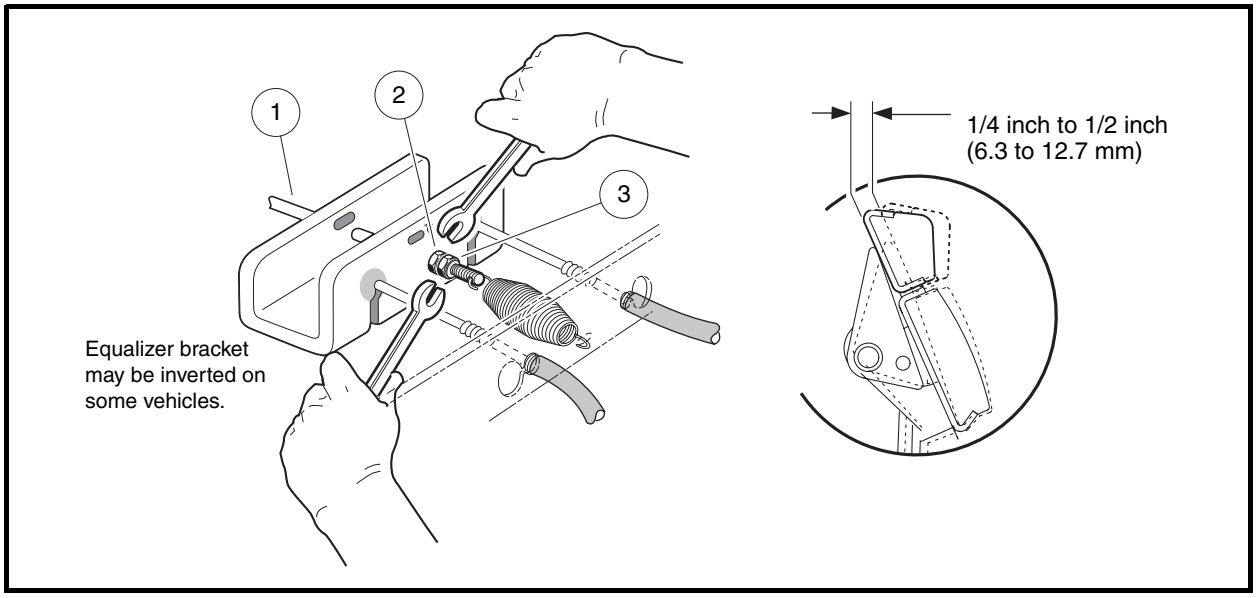


Figure 5-2 Brake Pedal Free-Play Adjustment

PARK BRAKE REMOVAL

1. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-2.**
2. Place chocks under the rear wheels and lift the front end of the vehicle with a chain hoist or floor jack. Place jack stands under the front cross tube of the vehicle frame and lower the vehicle onto the jack stands. **See following WARNING.**

⚠ WARNING

- **Lift only one end of the vehicle at a time. Use a suitable lifting device (chain hoist or hydraulic floor jack) with 1000 lb. (454 kg) minimum lifting capacity. Do not use lifting device to hold vehicle in raised position. Use approved jack stands of proper weight capacity to support the vehicle and chock the wheels that remain on the floor. When not performing a test or service procedure that requires movement of the wheels, lock the brakes.**

3. Remove the park brake assembly.
   3.1. To remove the park brake rod and pawl assembly (16 through 19 and 35), remove the push nut (18) and disconnect the ball joint sleeve (20) from the park brake pedal (24) **(Figure 5-1, Page 5-2). See**

following NOTE.

NOTE: *New push nuts (18) and (27) must be used when reassembling the park brake* ***(Figure 5-3, Page 5-4)****.*

3.2. To remove the park brake pedal (1), remove the push nut (27), disconnect the torsion spring (21) **(Figure 5-3, Page 5-4)** and slide the pedal off of the shaft. **See preceding NOTE**.

3.3. Inspect all parts for wear or damage and replace as necessary.

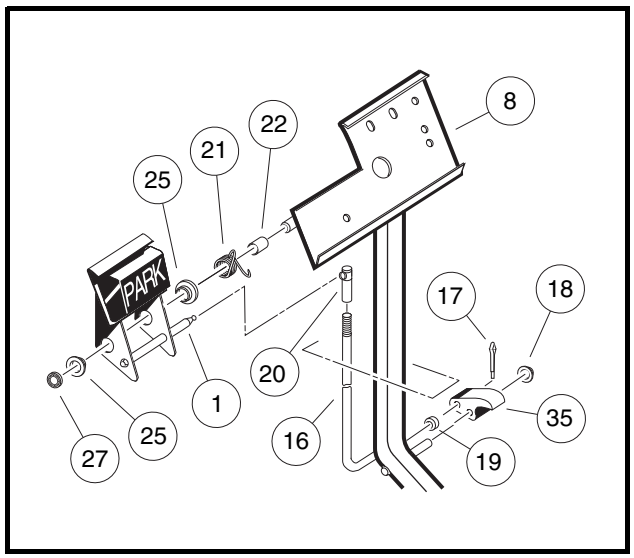


Figure 5-3 Park Brake Assembly

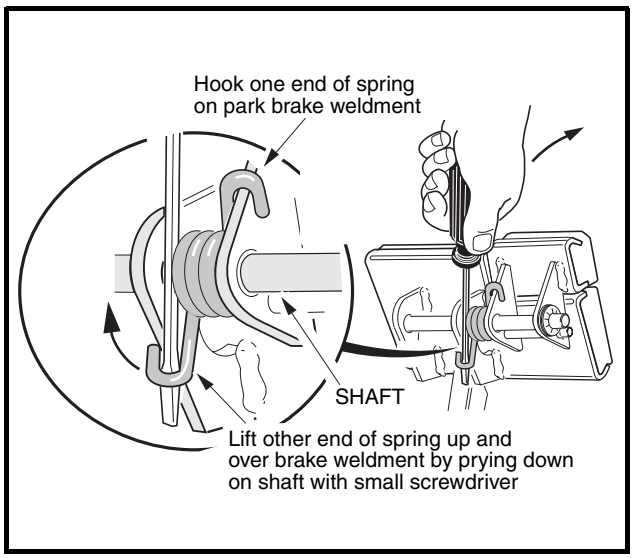


Figure 5-4 Torsion Spring Installation

PARK BRAKE INSTALLATION

1. From the bottom side of the floorboard, insert the park brake rod (16) through the brake pedal assembly opening. Then install the park brake pawl (35) onto the shaft on the brake pedal assembly (8) and also insert the park brake rod (16) into the park brake pawl.
2. Install the push nut (18) onto the park brake pawl shaft.
3. Install the spacer (22) and torsion spring (21) on the park brake pedal shaft on the brake pedal assembly.
4. Install the two bushings (25) in the park brake pedal and position the park brake pedal on the shaft on the brake pedal assembly weldment **(Figure 5-3, Page 5-4)**. Then attach the ends of the torsion spring to the park brake pedal and to the brake pedal weldment as shown **(Figure 5-4, Page 5-4)**.
5. Install the push nut (27) on the park brake pedal shaft **(Figure 5-3, Page 5-4)**.
6. Connect park brake rod (16) ball joint to ball stud on park brake pedal assembly.
7. Adjust park brake ratchet/pawl gap and pawl engagement. Refer to the appropriate adjustment procedure:

- **Pedal Group Adjustment – Gasoline Vehicle on page 5-12, Step 4**
- **Pedal Group Adjustment – Electric Vehicles on page 5-17, Step 4**

ACCELERATOR PEDAL – GASOLINE VEHICLES

See General Warning, Section 1, Page 1-1.

NOTE: *This section pertains to gasoline vehicles. For electric vehicles, proceed to Accelerator Pedal – Electric Vehicles on page 5-8.*

ACCELERATOR PEDAL REMOVAL

1. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-2.**
2. Place chocks under the rear wheels and lift the front end of the vehicle with a chain hoist or floor jack. Place jack stands under the front cross tube of the vehicle frame and lower the vehicle onto the jack stands. **See following WARNING**.

⚠ WARNING

- **Lift only one end of the vehicle at a time. Use a suitable lifting device (chain hoist or hydraulic floor jack) with 1000 lb. (454 kg) minimum lifting capacity. Do not use lifting device to hold vehicle in raised position. Use approved jack stands of proper weight capacity to support the vehicle and chock the wheels that remain on the floor. When not performing a test or service procedure that requires movement of the wheels, lock the brakes.**

3. Disconnect the accelerator rod assembly (17, 18, and 19) **(Figure 5-5, Page 5-6)** at the front and rear ball studs and remove it from the vehicle.
4. Use a 9/16-inch socket and 9/16-inch wrench to remove the nut (23), two washers (25), and bolt (4) securing the accelerator pedal (1) to the pivot rod (6).
5. Remove the nut (10) and ball stud (16) from the accelerator pivot rod assembly (6).
6. Slide the spring retainer (11) off of the accelerator pivot rod.
7. Inspect the pivot support bearing (9) for wear and replace if necessary.
8. Use a marker to mark the position of the park brake ratchet (24) on the accelerator pivot rod (6)**. See following NOTE**.

NOTE: *Failure to mark position of the ratchet could cause it to be installed improperly, resulting in improper adjustment and possible failure of the park brake.*

9. Remove the lock nut (26) from the accelerator pivot shaft **(Figure 5-5, Page 5-6)**.
10. Press the brake pedal slightly and slide the park brake ratchet (24) toward the end of the accelerator pivot rod. Rotate the ratchet and remove it from the pivot rod.
11. Remove the pivot rod (6) and spacer (20) from the accelerator pivot rod supports (21).

Accelerator Pedal Removal, Continued:

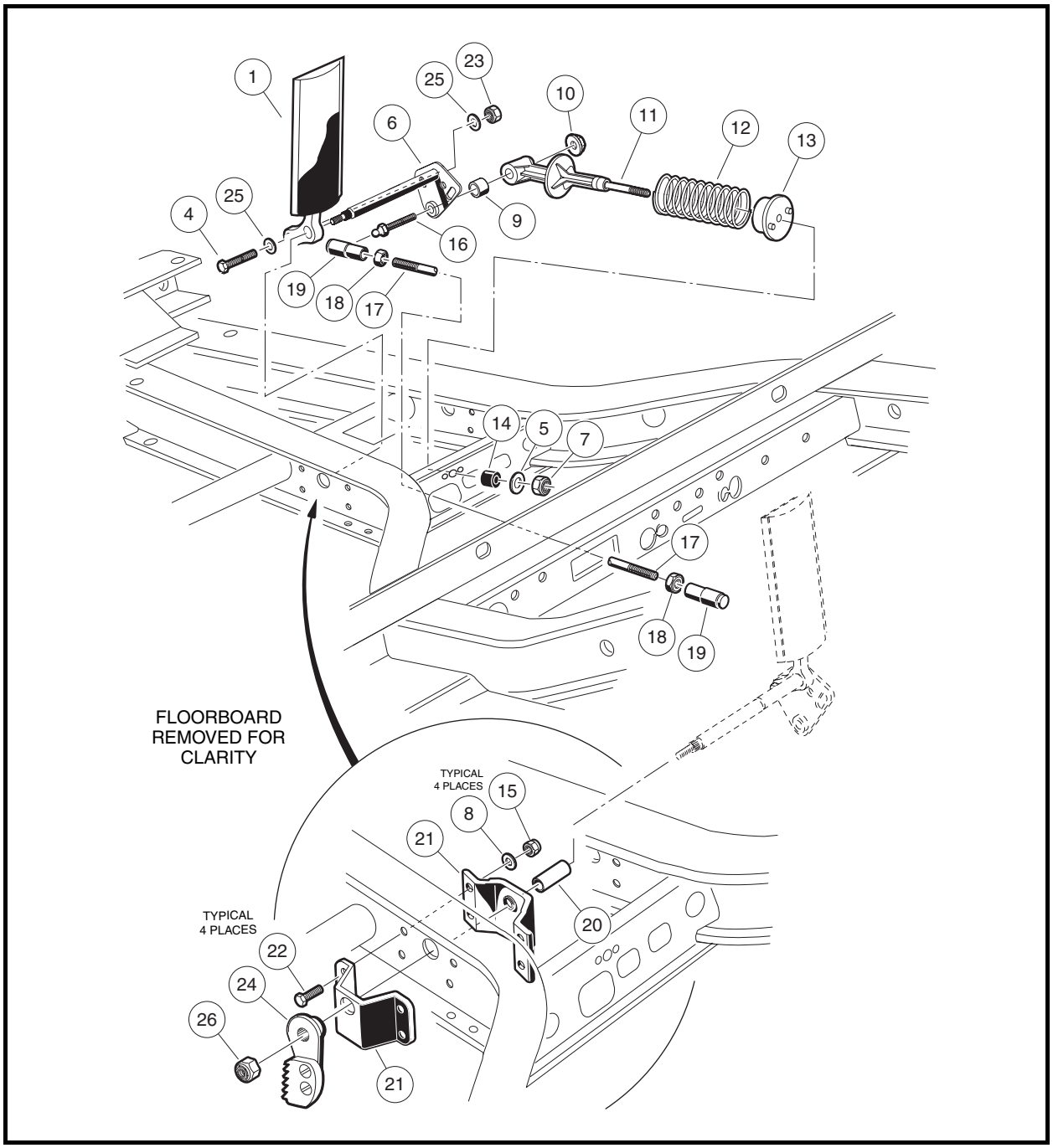


Figure 5-5 Accelerator Pedal Assembly – Gasoline Vehicles

12. Inspect the accelerator pivot rod supports (21) for wear or damage and replace as necessary. If the pivot rod supports do not require replacement, loosen, but do not remove the four bolts (22) and lock nuts (15) to make installation of the pivot rod easier.
13. Remove the accelerator pedal (1) from the vehicle.
14. Inspect all parts for wear and damage. Replace as necessary

ACCELERATOR PEDAL INSTALLATION

1. If the accelerator pivot rod supports were replaced, position the supports (21) on the vehicle frame and install the four bolts (22), flat washers (8), and lock nuts (15). Finger-tighten nuts at this time **(Figure 5-5, Page 5-6)**.
2. Insert the lower end of the accelerator pedal (1) through the floorboard and install the accelerator pivot rod (6) through the uppermost hole in the pedal.
3. Install the plastic spacer (20) on the pivot rod.
4. Insert the pivot rod through the pivot rod supports on the vehicle frame.
5. Tighten the four bolts (22) attaching the pivot rod supports to the frame to 75 in-lb (8.5 N·m).
6. Insert the bolt (4), with washer (25), through the lower hole in the pedal and through the pivot rod. Secure with washer (25) and new lock nut (23) **(Figure 5-5, Page 5-6)**. Finger-tighten lock nut at this time.
7. Install the ball stud (16) through the pivot rod. Install the spring retainer (11) onto the ball stud. Secure these parts with the nut (10). Tighten the nut to 50 in-lb (5.5 N·m).
8. Press the brake pedal slightly, and with the park brake ratchet oriented so that the tip of the ratchet is pointed toward the rear of vehicle, slide the ratchet onto the pivot rod (do not slide the ratchet onto the pivot rod splines). Release the brake pedal and allow the ratchet to rotate until its tip is pointed downward **(Figure 5-6, Page 5-7)**. The ratchet should now rotate freely on the rod.

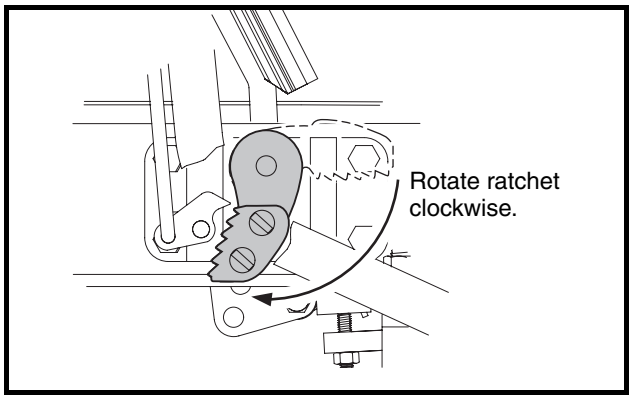


Figure 5-6 Ratchet Installation

9. Rotate ratchet clockwise until it touches the park brake pawl, then slide the ratchet onto the splines of the pivot rod (it may be necessary to push the pivot rod toward the driver-side of the vehicle to make the splines accessible). The ratchet may have to be rotated counterclockwise slightly to align the splines.
10. Move the pivot rod back toward the driver side of the vehicle and line up the match marks on the pivot rod and ratchet. Rotate the pivot rod back and forth slightly to align the splines and slide the ratchet onto the splines.
11. Install the lock nut (26) on pivot rod and tighten the nut to 18 ft-lb (24.5 N·m) **(Figure 5-5, Page 5-6)**.
12. Install the accelerator rod assembly (17, 18, and 19).
13. Adjust the accelerator pedal height. Refer to the appropriate adjustment procedure:
    - **Pedal Group Adjustment – Gasoline Vehicle on page 5-14, Step 5**
    - Adjust the accelerator rod (gasoline vehicles only). **Pedal Group Adjustment – Gasoline Vehicle on page 5-14, Step 6**

ACCELERATOR PEDAL – ELECTRIC VEHICLES

See General Warning, Section 1, Page 1-1.

NOTE: *This section pertains to electric vehicles only. For gasoline vehicles go to Accelerator Pedal – Gasoline Vehicles on page 5-5.*

ACCELERATOR PEDAL REMOVAL

1. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-2.**
2. Place chocks under the rear wheels and lift the front end of the vehicle with a chain hoist or floor jack. Place jack stands under the front cross tube of the vehicle frame and lower the vehicle onto the jack stands. **See following WARNING**.

⚠ WARNING

- **Lift only one end of the vehicle at a time. Use a suitable lifting device (chain hoist or hydraulic floor jack) with 1000 lb. (454 kg) minimum lifting capacity. Do not use lifting device to hold vehicle in raised position. Use approved jack stands of proper weight capacity to support the vehicle and chock the wheels that remain on the floor. When not performing a test or service procedure that requires movement of the wheels, lock the brakes.**

3. Remove the MCOR (2) and drive bar (3) as instructed **(Figure 5-7, Page 5-9)**. **See MCOR Removal, Section 19, Page 19-5.**
4. Use a 9/16-inch socket and 9/16-inch wrench to remove the nut (7), two washers (5), and bolt (4) securing the accelerator pedal (1) to the pivot rod (6) **(Figure 5-7, Page 5-9).**
5. Remove the nut (10) and bolt (8) from the accelerator pivot rod assembly (6).
6. Slide the spring retainer (11) off of the accelerator pivot rod.
7. Inspect the pivot support bearing (9) for wear and replace if necessary.
8. Use a marker to mark the position of the park brake ratchet (24) on the accelerator pivot rod (6)**. See following NOTE.**

NOTE: *Failure to mark position of the ratchet could cause it to be installed improperly, resulting in improper adjustment and possible failure of the park brake.*

9. Remove the lock nut (23) from the accelerator pivot rod **(Figure 5-7, Page 5-9)**.
10. Press the brake pedal slightly and slide the park brake ratchet (24) toward the end of the accelerator pivot rod. Rotate the ratchet and remove it from the pivot rod.
11. Remove the pivot rod (6) and spacer (20) from the accelerator pivot rod supports (21).
12. Inspect the accelerator pivot rod supports (21) for wear and damage and replace as necessary. If the pivot rod supports do not require replacement, loosen (but do not remove) the four bolts (22) and lock nuts (15) to make installation of the pivot rod easier.
13. Remove the accelerator pedal (1) from the vehicle.
14. Inspect all parts for wear and damage. Replace as necessary.

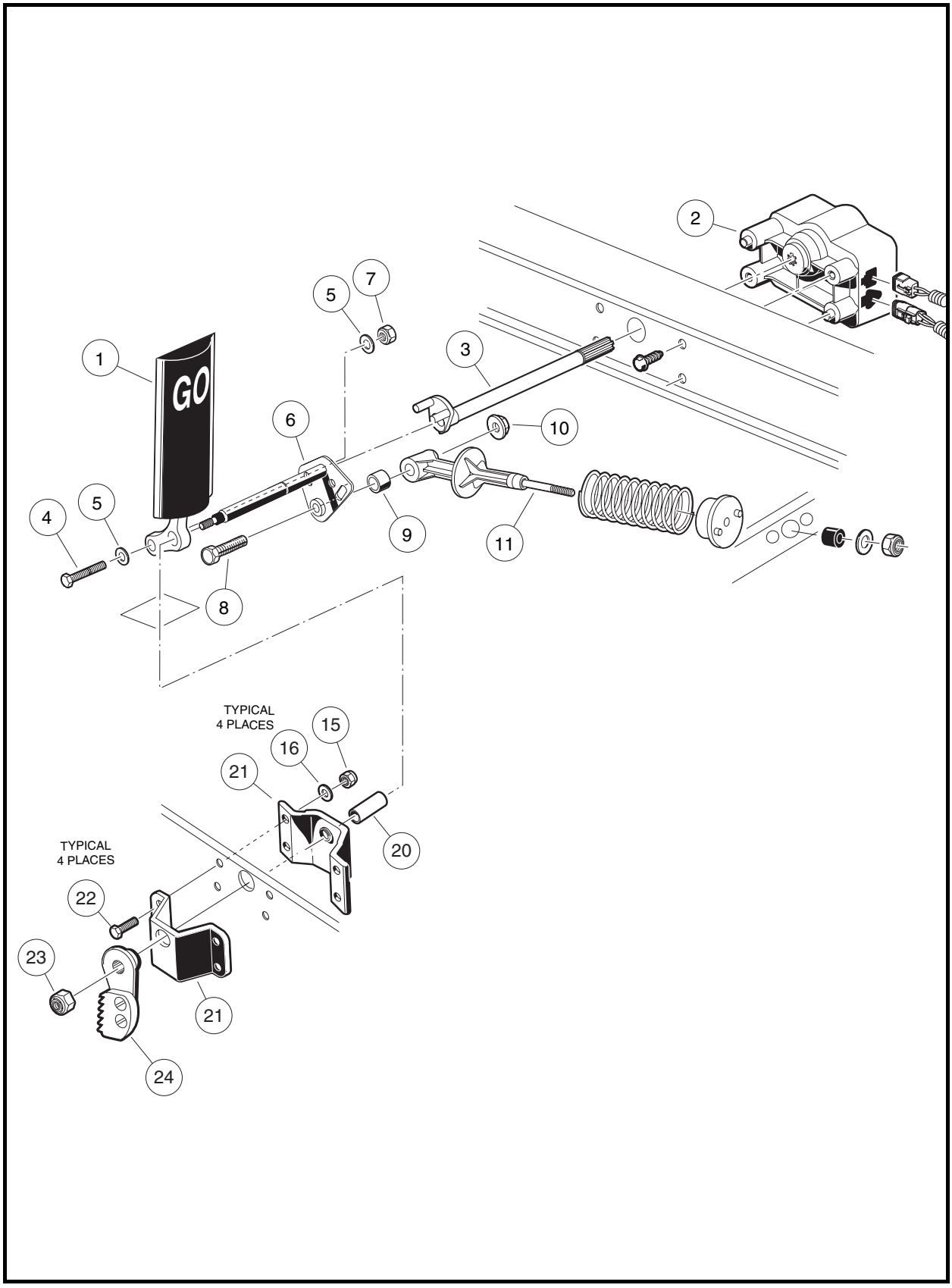


Figure 5-7 Accelerator Pedal – Electric Vehicle

ACCELERATOR PEDAL INSTALLATION

1. If the accelerator pivot rod supports were replaced, position the supports (21) on the vehicle frame and install the four bolts (22), flat washers (16), and lock nuts (15) **(Figure 5-7, Page 5-9)**. Finger-tighten hardware at this time.
2. Insert the lower end of the accelerator pedal (1) through the floorboard and install the accelerator pivot rod (6) through the uppermost hole in the pedal.
3. Install plastic spacer (20) on pivot rod (6).
4. Insert the pivot rod through the pivot rod supports (21) on the vehicle frame.
5. Tighten the four bolts (22) attaching the pivot rod supports to the frame to 75 in-lb (8.5 N·m).
6. Insert the bolt (4), with washer (5), through the lower hole in the pedal and through the pivot rod. Secure with washer (5) and new lock nut (7). Finger-tighten lock nut at this time.
7. Install the bolt (8) through the pivot rod (6) and spring retainer (11). Secure these parts with the nut (10). Tighten the nut to 50 in-lb (5.5 N·m).
8. Press the brake pedal slightly, and with the park brake ratchet oriented so that the tip of the ratchet is pointed toward the rear of the vehicle, slide the ratchet onto the pivot rod (do not slide the ratchet onto the pivot rod splines). Release the brake pedal and allow the ratchet to rotate until its tip is pointed downward **(Figure 5-8, Page 5-10)**. The ratchet should now rotate freely on the rod.

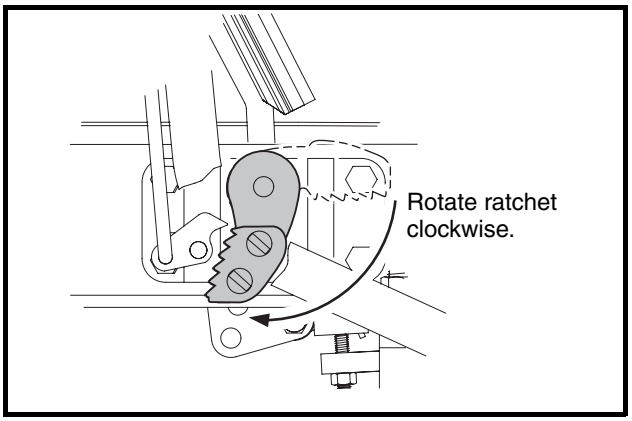


Figure 5-8 Ratchet Installation

9. Rotate the ratchet clockwise until it touches the park brake pawl, then slide the ratchet onto the splines of the pivot rod (it may be necessary to push the pivot rod toward the driver-side of the vehicle to make the splines accessible). The ratchet may have to be rotated counterclockwise slightly to align the splines.
10. Move the pivot rod back toward the driver-side of the vehicle and line up the match marks on the pivot rod and ratchet. Rotate the pivot rod back and forth slightly to align the splines and slide the ratchet onto the splines.
11. Install lock nut (23) on pivot rod **(Figure 5-7, Page 5-9)**. Tighten to 18 ft-lb (24.5 N·m).
12. Install the MCOR (2) and drive bar (3) as instructed. **See MCOR Installation, Section 19, Page 19-5.**
13. Adjust the accelerator pedal height. **See step 5 of Pedal Group Adjustment – Electric Vehicles on page 5-19.**

PEDAL GROUP ADJUSTMENT – GASOLINE VEHICLE

See General Warning, Section 1, Page 1-1.

1. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-2.**
2. Adjust brake pedal height.
   2.1. Chock wheels and release park brake. Lift rear of vehicle and place jack stands under the axle tubes to support the vehicle.
   2.2. To provide slack in the brake cables, loosen the equalizer retaining nuts (2 and 3) on the equalizer rods (1) **(Figure 5-9, Page 5-11)**.

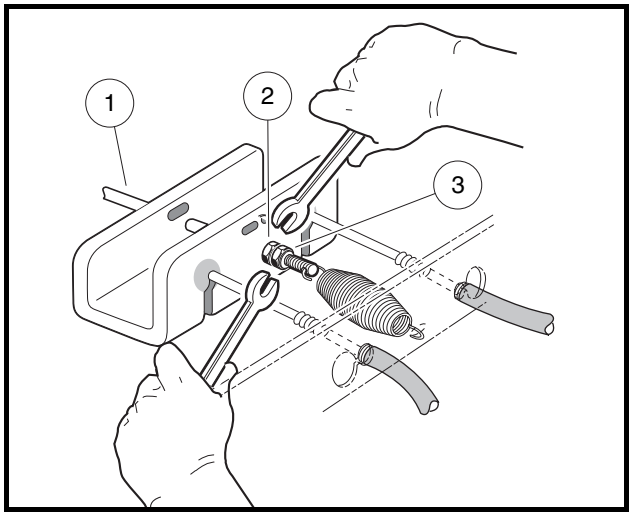


Figure 5-9 Loosen Rear Brake Equalizer Rod Nuts

   2.3. Loosen the brake stop jam nut (31), then relieve pedal pressure on the stop by pushing down slightly on the pedal. Next, adjust the brake stop bumper (22) up or down **(Figure 5-10, Page 5-11)**. Adjusting the bumper upward decreases distance between pedal and floorboard. Adjusting the bumper downward increases distance between pedal and floorboard. Proper brake pedal height is 6 inches (15.2 cm) **(Figure 5-11, Page 5-11)**.
   2.4. Tighten the jam nut (31) to 8 ft-lb (9.5 N·m) **(Figure 5-10, Page 5-11)**.

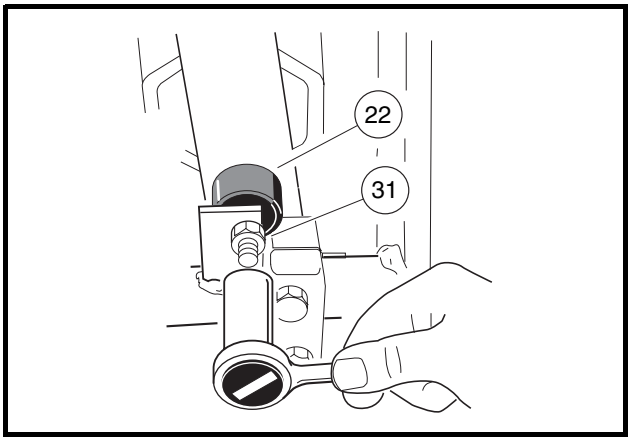


Figure 5-10 Brake Pedal Height Adjustment

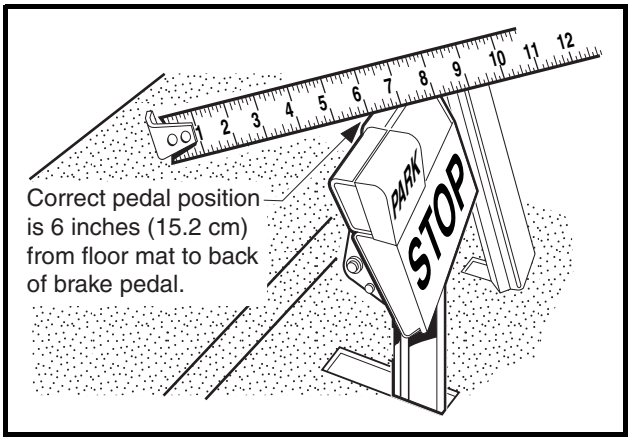


Figure 5-11 Brake Pedal Height Measurement

Pedal Group Adjustment – Gasoline Vehicle, Continued:

3. Adjust brake pedal free play. **See following NOTE.**

NOTE: *Brake pedal free play is the distance the brake pedal can be pressed before the brake actuator arm (at the brake cluster) moves.*

3.1. Measuring perpendicular from the floorboard to the back of the brake pedal, press the brake pedal and measure the distance that the pedal moves before all of the slack is taken out of the brake cables **(Figure 5-11, Page 5-11)**.

3.2. Tighten the nut (2) on the equalizer rod (1) so that the brake pedal free play is 1/4 to 1/2 inch (6.3 to 12.7 mm) **(Figure 5-12, Page 5-12)**.

3.3. Tighten the jam nut (3) while holding the adjustment nut (2) in the correct position**.**

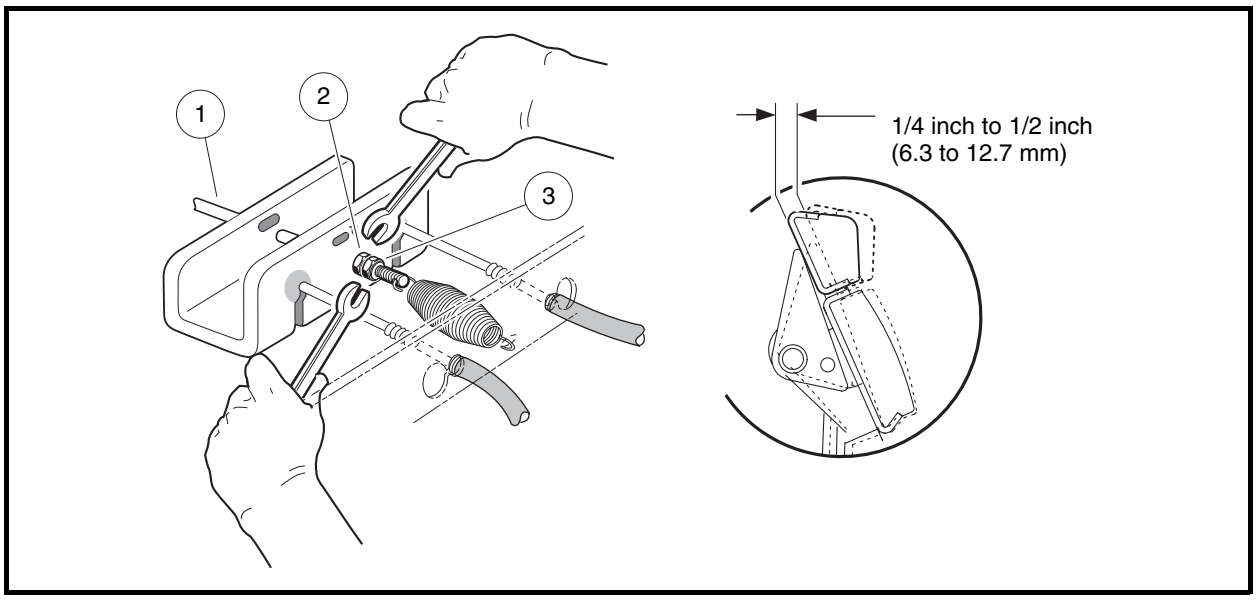


Figure 5-12 Brake Pedal Free-Play Adjustment

4. Adjust park brake ratchet/pawl gap and pawl engagement.

4.1. Inspect the park brake pawl and ratchet for excessive wear, grooves, cracks or chips. If either the pawl or ratchet is damaged, both must be replaced.

4.2. Adjust retaining nut (7) on spring support rod until there is a 0.060 inch (1.5 mm) gap between the pawl and the tips of the ratchet teeth. Use a feeler gauge to verify the gap **(Figure 5-13, Page 5-13)**. The gap should be consistent through range of pawl movement. If the gap is not consistent, loosen the four bolts (6) securing the accelerator pivot rod supports and adjust the supports. If the gap becomes smaller as the park brake pedal is pressed, move the pivot rod supports slightly rearward until the gap is consistent. If the gap becomes larger as the park brake pedal is pressed, move the pivot rod supports slightly forward until gap is consistent. **See following NOTE.**

NOTE: *The accelerator rod must also be checked if the ratchet/pawl gap is adjusted.* ***See step 6 of Pedal Group Adjustment – Gasoline Vehicle on page 5-14.***

The accelerator rod must be disconnected before proceeding to step 4.3.

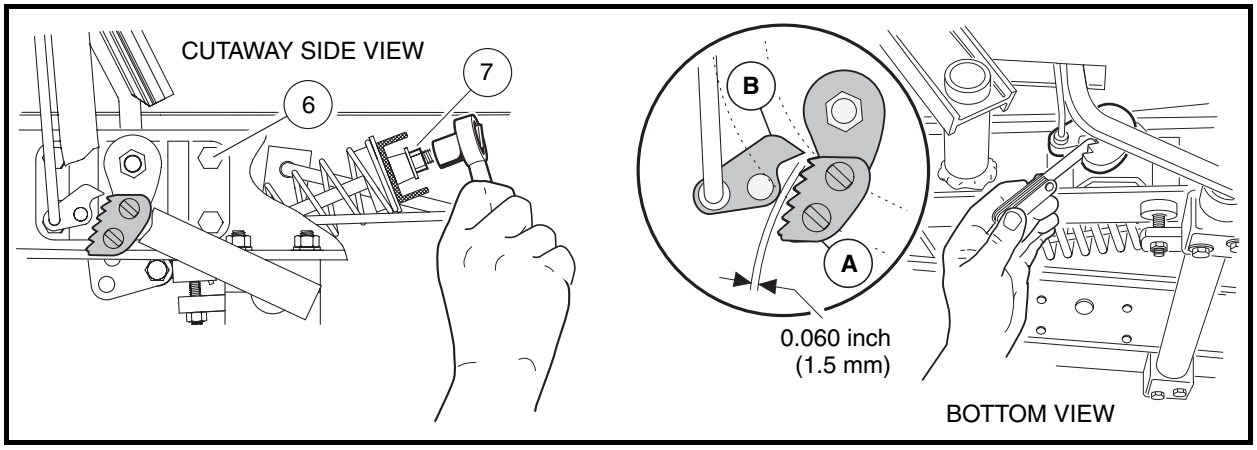


Figure 5-13 Park Brake Ratchet/Pawl Gap Adjustment

4.3. With the park brake unlocked, measure and note the distance from the top of the accelerator pedal to the floorboard, and then lock the park brake **(Figure 5-14, Page 5-13)**.

4.4. With the park brake locked, make sure at least 75% of ratchet tooth length engages the pawl **(Figure 5-15, Page 5-13)**. Tooth engagement should be between the two lines marked on the pawl.

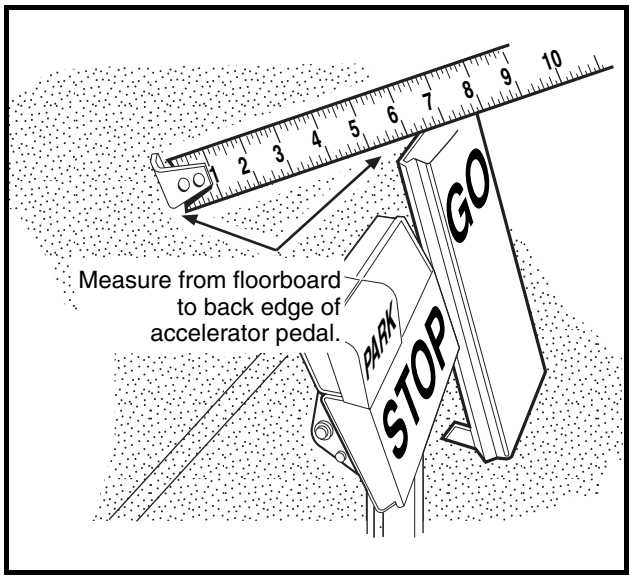


Figure 5-14 Accelerator Pedal Height Measurement

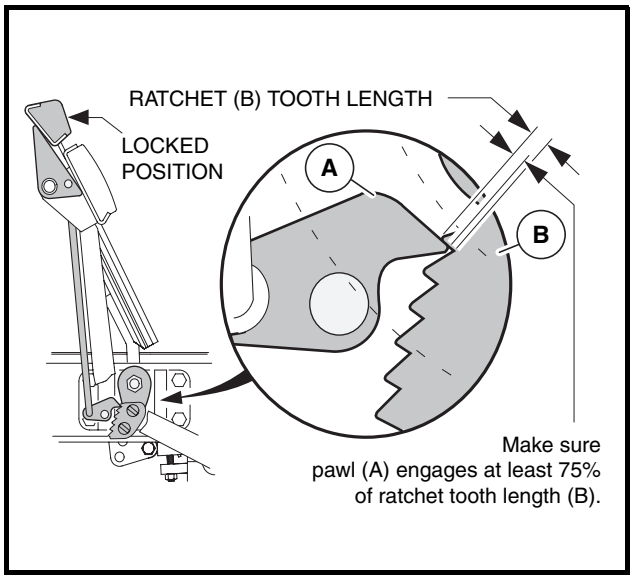


Figure 5-15 Ratchet/Pawl Tooth Engagement

4.5. With park brake still locked, measure the distance from the top of accelerator pedal to floorboard. If the measurement has changed, ratchet tooth engagement is too deep and must be adjusted.

4.6. If ratchet/pawl engagement must be adjusted, disconnect the ball joint at the top of the brake rod and rotate the ball joint sleeve clockwise to increase engagement or counterclockwise to decrease engagement. Reconnect ball joint **(Figure 5-16, Page 5-14)**.

4.7. If the accelerator push rod was disconnected from the accelerator pedal, reconnect it.

4.8. Check for proper brake operation prior to driving the vehicle.

Pedal Group Adjustment – Gasoline Vehicle, Continued:

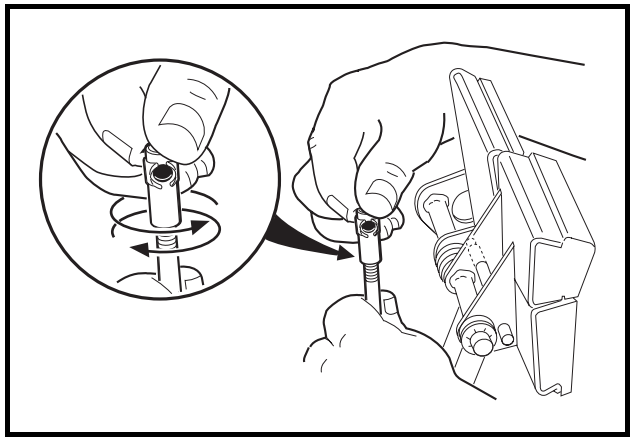


Figure 5-16 Brake Rod Adjustment

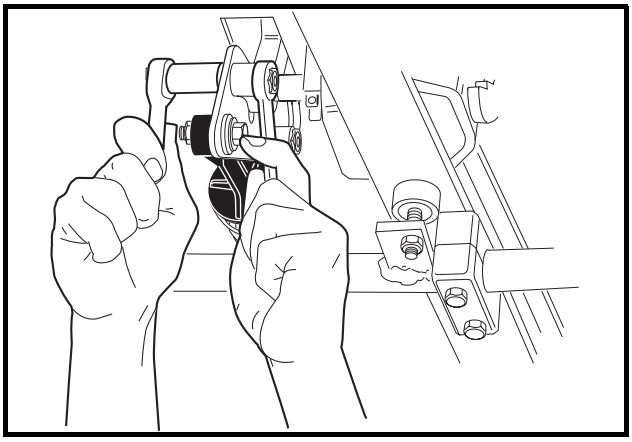


Figure 5-17 Accelerator Pedal Height Adjustment

5. Adjust accelerator pedal height.
   5.1. Loosen the nut and bolt **(Figure 5-17, Page 5-14)** securing the accelerator pedal to the pivot plate.
   5.2. Clamp the accelerator pedal adjustment tool (CCI P/N 101871001) to the accelerator pedal, with the end marked *accelerator pedal height* closest to the floorboard **(Figure 5-18, Page 5-14)**. Press the accelerator pedal until the end of the tool rests against the floorboard; (pedal height should be 5-5/8 inches (14.3 cm). Use a rubber strap to hold pedal in position against the floorboard and then tighten nut to 26 ft-lb (35.3 N·m).

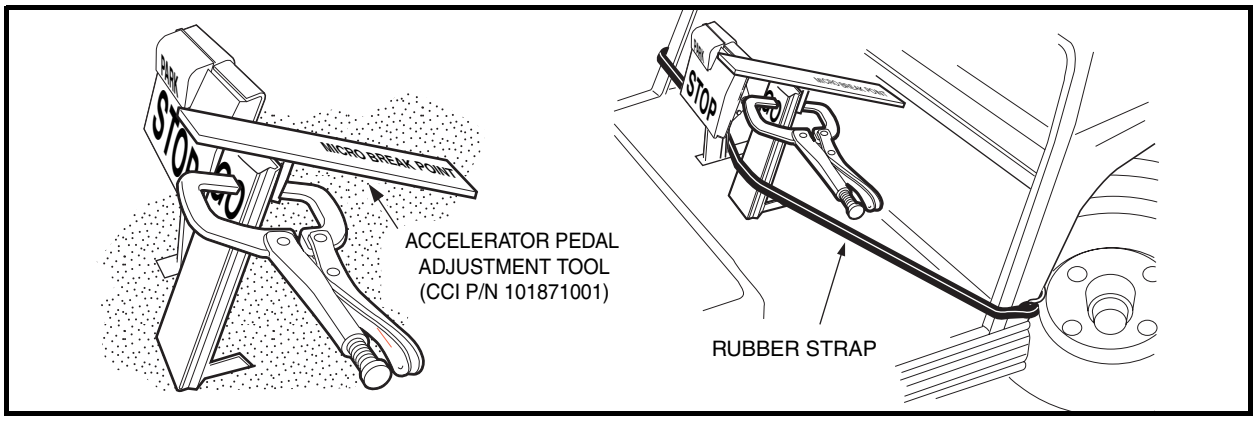


Figure 5-18 Accelerator Pedal Height Adjustment

6. Adjust the accelerator rod. **See following DANGER.**

⚠ DANGER

- **Before servicing, turn the key switch to OFF and place the Forward/Reverse handle in the NEUTRAL position.**
- **To prevent accidentally starting the vehicle, disconnect the battery as instructed in WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1. This will prevent the possibility of the vehicle running over you when you are adjusting the accelerator rod.**

6.1. Remove the electrical box screw and cover. **See preceding DANGER.**

6.2. Loosen the jam nuts (18) and disconnect the accelerator rod (17) at the accelerator pedal. Adjust the length of the rod **(Figure 5-5, Page 5-6)** to obtain an accelerator cable cam position of 14° as shown **(Figure 5-19, Page 5-15). See following CAUTION.**

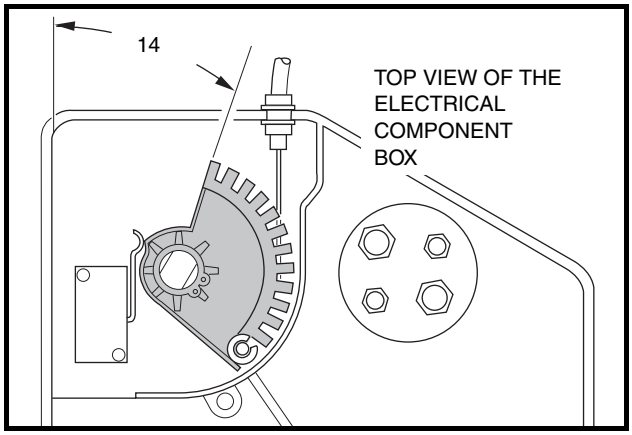


Figure 5-19 Accelerator Cable

⚠ CAUTION

- **After accelerator rod adjustment, make sure that approximately the same number of threads are exposed at each end of the accelerator rod.**
- **If lever on the limit switch in the electrical box is bent, replace limit switch.**
- **When loosening jam nuts on the accelerator rod with one end disconnected, hold the disconnected accelerator rod with locking pliers.**
- **When tightening jam nuts on the accelerator rod, hold the disconnected ball joint with locking pliers.**

6.3. Reconnect the accelerator rod at the accelerator pedal.

6.4. Before tightening jam nuts on accelerator rod, set park brake to first ratchet and pawl position. Press accelerator pedal and make sure the following events occur in the ***exact order shown***:

EVENT	APPROXIMATE PEDAL TRAVEL
Park brake release	2° - 4°
Solenoid activation	4° - 8°
Carburetor throttle actuation	8° - 12°

6.5. If the events above occur as they should, hold the ball joint at each end of the accelerator rod with pliers and tighten the accelerator rod jam nut against it.

6.6. Ensure that the events occur as described in step 6.4 above. **See following NOTE.**

NOTE: *After the accelerator pedal and rod are adjusted, the final governed engine RPM should be set at 2700 (± 30) RPM.*

6.7. Install the electrical box cover and screw.

7. Adjust the brakes. **See Brake Adjustment, Section 6, Page 6-8.**

PEDAL GROUP ADJUSTMENT – ELECTRIC VEHICLES

See General Warning, Section 1, Page 1-1.

1. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-2.**
2. Adjust brake pedal height.
   2.1. Chock wheels and release park brake. Lift rear of vehicle and place jack stands under the axle tubes to support the vehicle.
   2.2. To provide slack in the brake cables, loosen the equalizer retaining nuts (2 and 3) on the equalizer rods (1) **(Figure 5-20, Page 5-16)**.

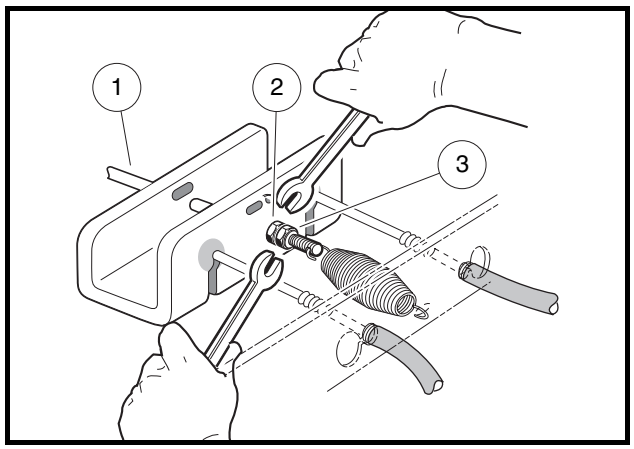


Figure 5-20 Loosen Rear Brake Equalizer Rod Nuts

   2.3. Loosen the brake stop jam nut (31), then relieve pedal pressure on the stop by pushing down slightly on the pedal. Next, adjust the brake stop bumper (22) up or down **(Figure 5-21, Page 5-16)**. Adjusting the bumper upward decreases distance between pedal and floorboard. Adjusting the bumper downward increases distance between pedal and floorboard. Proper brake pedal height is 6 inches (15.2 cm) **(Figure 5-22, Page 5-16)**.
   2.4. Tighten the jam nut (31) to 8 ft-lb (9.5 N·m) **(Figure 5-21, Page 5-16)**.

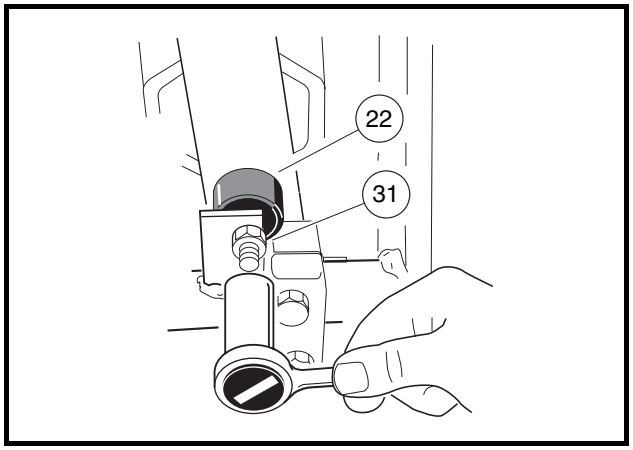


Figure 5-21 Brake Pedal Height Adjustment

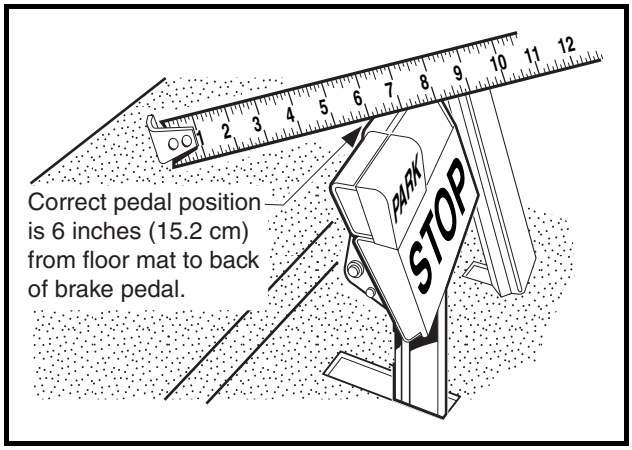


Figure 5-22 Brake Pedal Height Measurement

3. Adjust brake pedal free play. **See following NOTE.**

NOTE: *Brake pedal free play is the distance the brake pedal can be pressed before the brake actuator arm (at the brake cluster) moves.*

3.1. Measuring perpendicular from the floorboard to the back of the brake pedal, press the brake pedal and measure the distance that the pedal moves before all of the slack is taken out of the brake cables **(Figure 5-22, Page 5-16).**

3.2. Tighten the nut (2) on the equalizer rod (1) so that the brake pedal free play is 1/4 to 1/2 inch (6.3 to 12.7 mm) **(Figure 5-23, Page 5-17)**.

3.3. Tighten the jam nut (3) while holding the adjustment nut (2) in the correct position **(Figure 5-23, Page 5-17).**

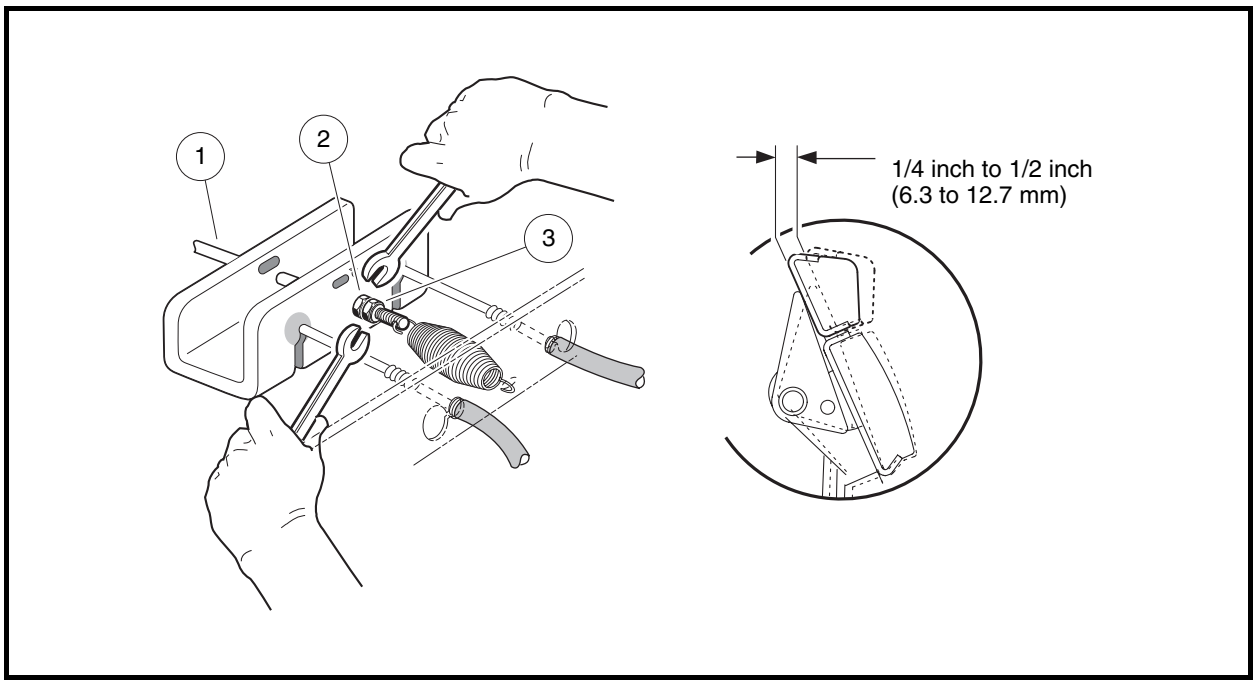


Figure 5-23 Brake Pedal Free-Play Adjustment

4. Adjust park brake ratchet/pawl gap and pawl engagement.

4.1. Inspect the park brake pawl and ratchet for excessive wear, grooves, cracks or chips. If either the pawl or ratchet is damaged, both must be replaced.

4.2. Adjust retaining nut (7) on spring support rod until there is a 0.060 inch (1.5 mm) gap between the pawl and the tips of the ratchet teeth. Use a feeler gauge to verify the gap **(Figure 5-24, Page 5-18)**. The gap should be consistent through range of pawl movement. If the gap is not consistent, loosen the four bolts (6) securing the accelerator pivot rod supports and adjust the supports. If the gap becomes smaller as the park brake pedal is pressed, move the pivot rod supports slightly rearward until the gap is consistent. If the gap becomes larger as the park brake pedal is pressed, move the pivot rod supports slightly forward until gap is consistent.

Pedal Group Adjustment – Electric Vehicles, Continued:

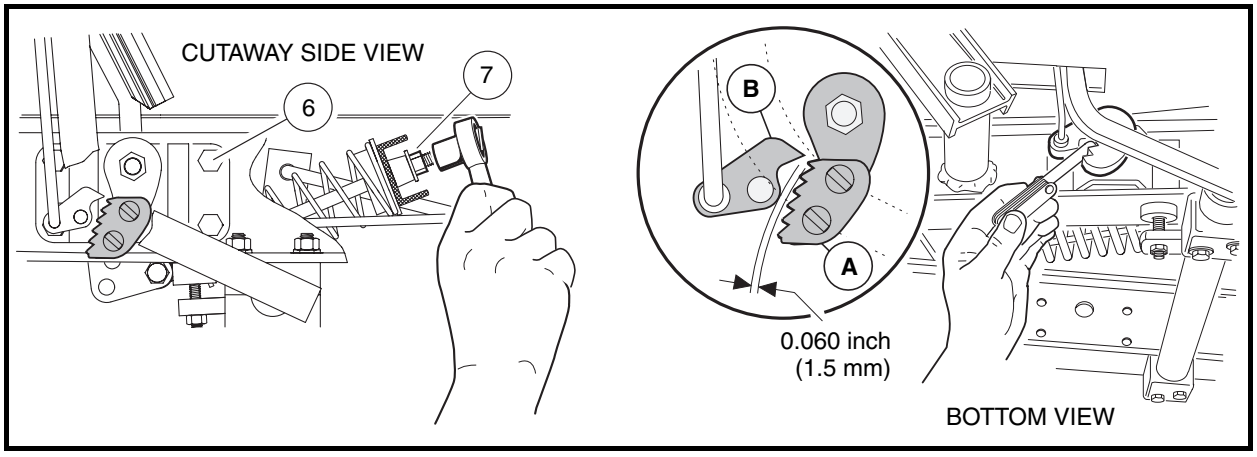


Figure 5-24 Park Brake Ratchet/Pawl Gap Adjustment

4.3. With the park brake unlocked, measure and note the distance from the top of the accelerator pedal to the floorboard, and then lock the park brake **(Figure 5-25, Page 5-18)**.

4.4. With the park brake locked, make sure at least 75% of ratchet tooth length engages the pawl **(Figure 5-26, Page 5-18)**. Tooth engagement should be between the two lines marked on the pawl.

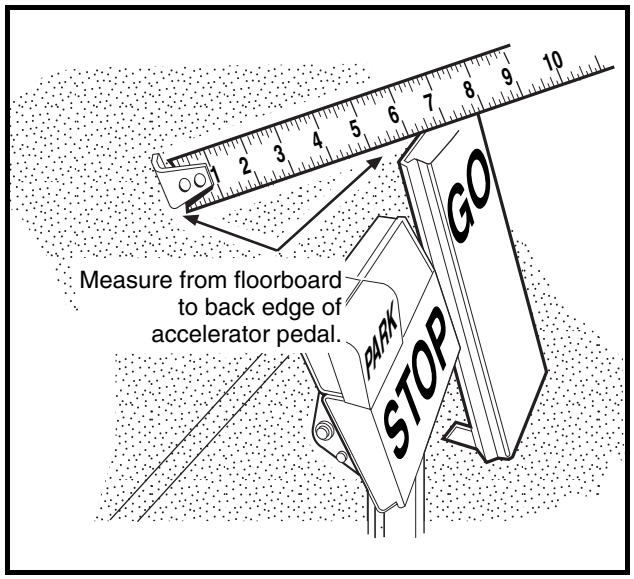


Figure 5-25 Accelerator Pedal Height Measurement

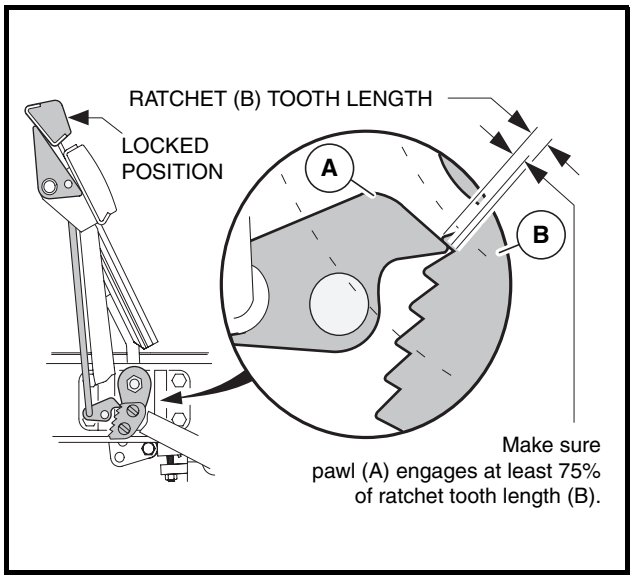


Figure 5-26 Ratchet/Pawl Tooth Engagement

4.5. With park brake still locked, measure the distance from the top of accelerator pedal to floorboard. If the measurement has changed, ratchet tooth engagement is too deep and must be adjusted.

4.6. If ratchet/pawl engagement must be adjusted, disconnect the ball joint at the top of the brake rod and rotate the ball joint sleeve clockwise to increase engagement or counterclockwise to decrease engagement. Reconnect ball joint **(Figure 5-27, Page 5-19)**.

4.7. Check for proper brake operation prior to driving the vehicle.

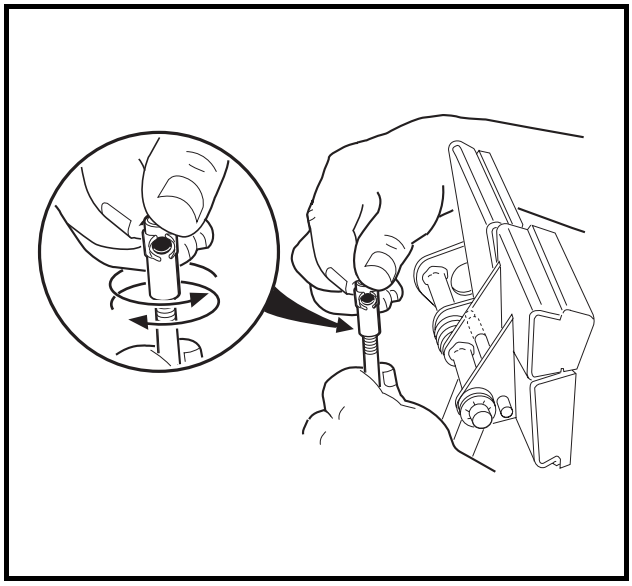


Figure 5-27 Brake Rod Adjustment

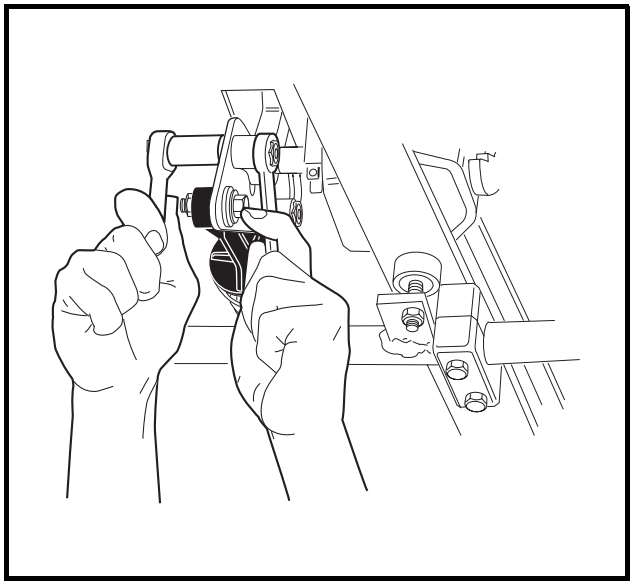


Figure 5-28 Accelerator Pedal Height Adjustment

5. Adjust accelerator pedal height.
   5.1. Loosen the nut and bolt **(Figure 5-28, Page 5-19)** securing the accelerator pedal to the pivot plate.
   5.2. Clamp the accelerator pedal adjustment tool (CCI P/N 101871001) to the accelerator pedal, with the end marked *accelerator pedal height* closest to the floorboard **(Figure 5-29, Page 5-19)**. Press the accelerator pedal until the end of the tool rests against the floorboard; pedal height should be 5-5/8 inches (14.3 cm). Use a rubber strap to hold pedal in position against the floorboard and then tighten nut to 26 ft-lb (35.3 N·m).
6. Adjust the brakes. **See Brake Adjustment, Section 6, Page 6-8.**

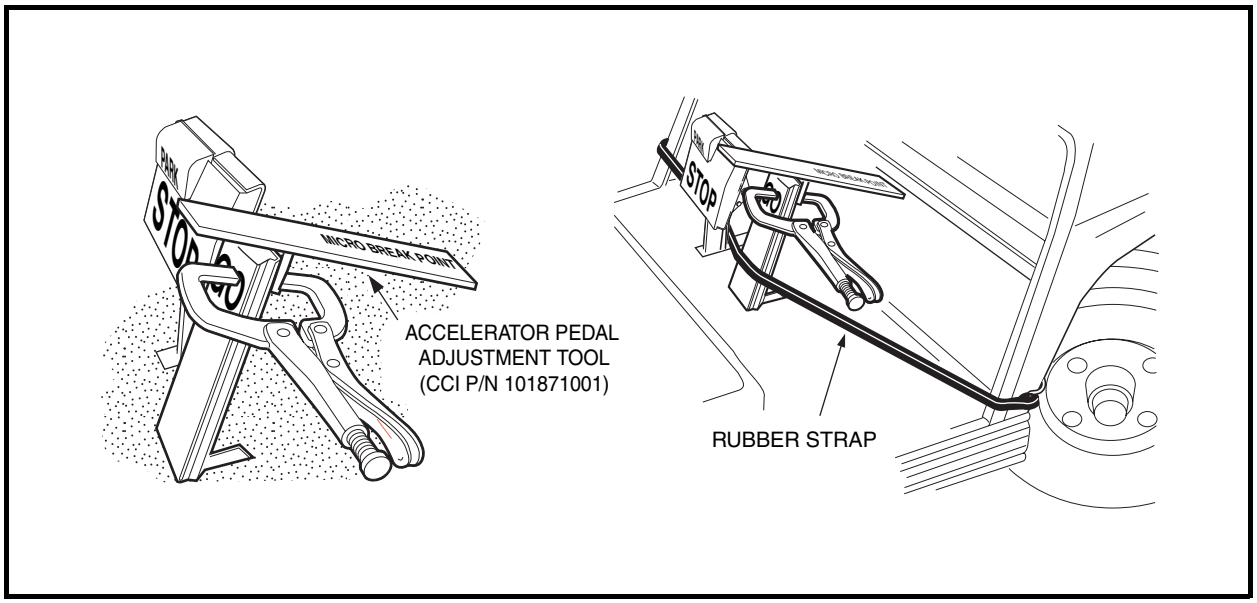


Figure 5-29 Accelerator Pedal Height Adjustment

SECTION 6 – WHEEL BRAKE ASSEMBLIES

⚠ DANGER

- **See General Warning, Section 1, Page 1-1.**

⚠ WARNING

- **See General Warning, Section 1, Page 1-1.**
- **Some aftermarket brake shoes contain asbestos fiber, and asbestos dust is created when these brake mechanisms are handled. Wear approved eye and respiratory protection when disassembling and cleaning brake mechanisms. Inhalation of asbestos could result in severe personal injury or death. Do not use compressed air or aerosol sprays to clean the brake mechanism. Clean brake mechanism using the negative pressure enclosure/hepa vacuum system or low pressure/wet cleaning method per OSHA/29 CFR - 1910.1001.**

BRAKE SHOE REMOVAL

See General Warning, Section 1, Page 1-1. See also Warning on Page 6-1.

1. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-2.**
2. Place chocks at the front wheels. Loosen, but do not remove lug nuts on rear wheels and lift the rear of the vehicle with a chain hoist or floor jack. Place jack stands under the axle tubes to support the vehicle.
3. Loosen the equalizer retaining nuts (2 and 3) on the equalizer rod (1) to loosen the brake cable **(Figure 6-1, Page 6-2)**.
4. Remove the rear wheels and then the brake drums. If the brake drums were easily removed, proceed to step 6. **See following CAUTION and NOTE.**

⚠ CAUTION

- **Worn or damaged brake drums cannot be machined to refinish them. Replace as necessary.**

NOTE: *When servicing vehicles with severely worn brake shoes and when the drums cannot be removed by normal methods, proceed to step 5 to minimize damage to the brake cluster and brake components.*

5. Remove brake drums and badly worn brake shoes.

   5.1. On the back of each brake cluster assembly, locate the heads of two brake shoe retainer pins. It may be necessary to remove sealant material around the head of each pin.

Brake Shoe Removal, Continued:

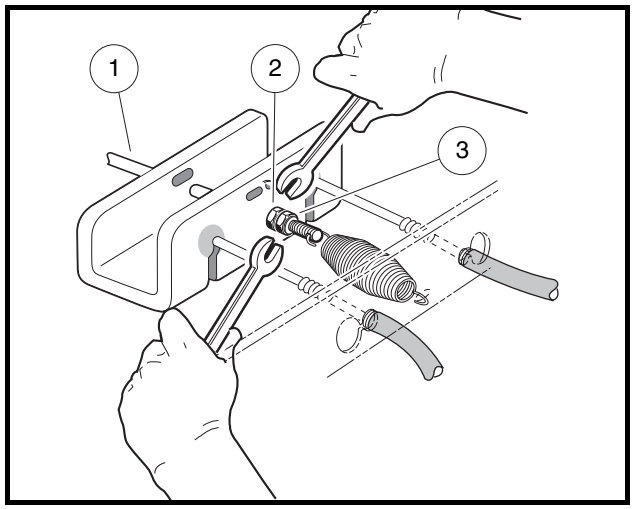


Figure 6-1 Loosen Equalizer Retaining Nuts

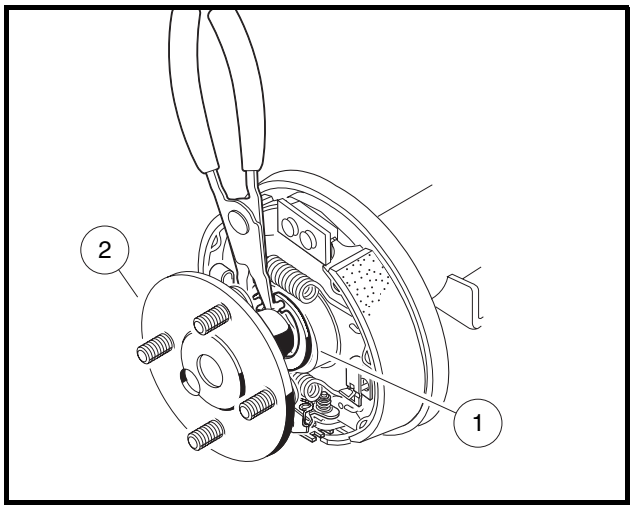


Figure 6-2 Remove Axle Retaining Ring

5.2. Insert a 1/2 inch x 5/8 inch cold chisel under the head of each pin and shear them off as illustrated **(Figure 6-3, Page 6-2)**. This will release the shoes from the backing plate, allowing them to pivot away from the inside of the brake drum, which should then allow the brake drum to be pulled free. After completing step 6, skip step 7. **See following NOTE.**

NOTE: *Although step 6 allows easier access to the brake shoes, it is not imperative to do so in order to remove the brake shoes.*

6. Remove the axle.

6.1. Using 90° snap ring pliers (CCI P/N 1012560), remove the axle retaining ring (1) **(Figure 6-2, Page 6-2)**.

6.2. Pull the axle shaft (2) from the axle tube **(Figure 6-2, Page 6-2)**.

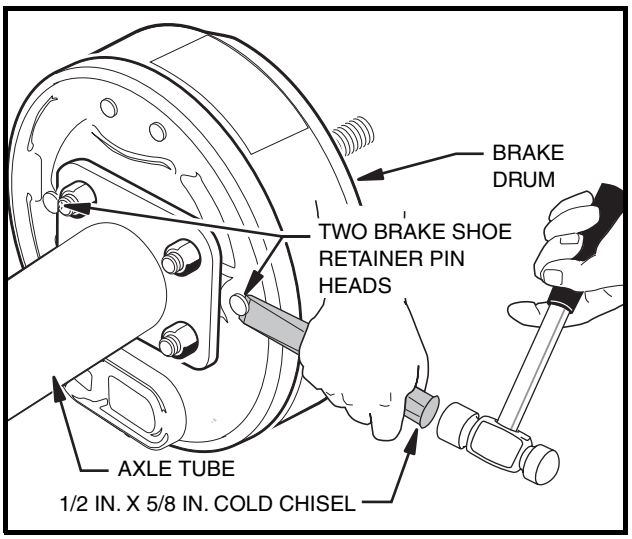


Figure 6-3 Shoe Retainer Pins

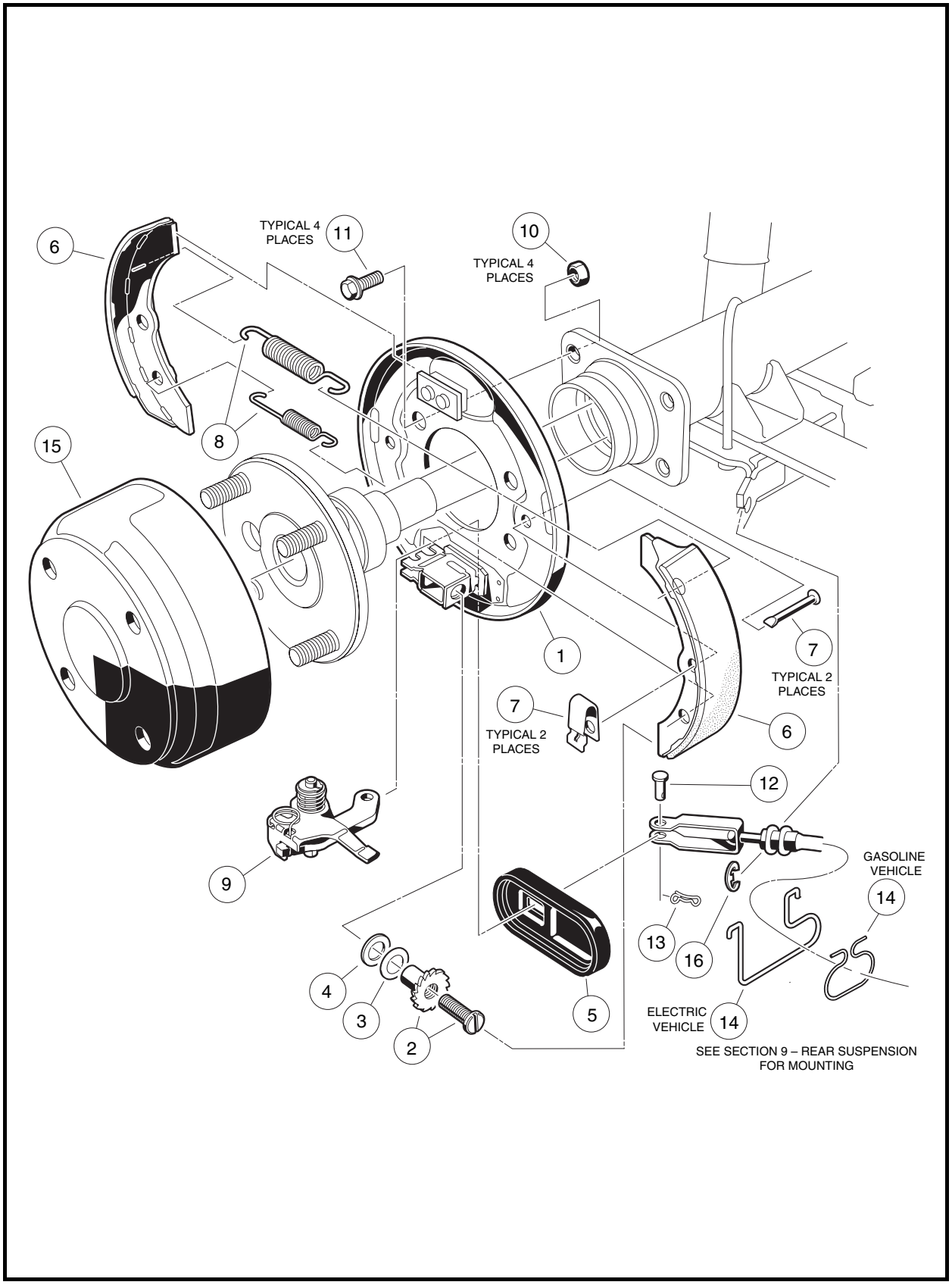


Figure 6-4 Self-adjusting Wheel Brake Assembly

Brake Shoe Removal, Continued:

7. Using needle nose pliers, turn the clip retainer pin (1) 90° to remove the shoe retainer clip (2) **(Figure 6-5, Page 6-4)**. **See following CAUTION.**

⚠ CAUTION

- **The brake shoes are under pressure and can release suddenly when brake shoe retainers are removed.**

8. Grasp both brake shoes and pull them, together with the springs, out of the brake assembly as shown **(Figure 6-6, Page 6-4)**.

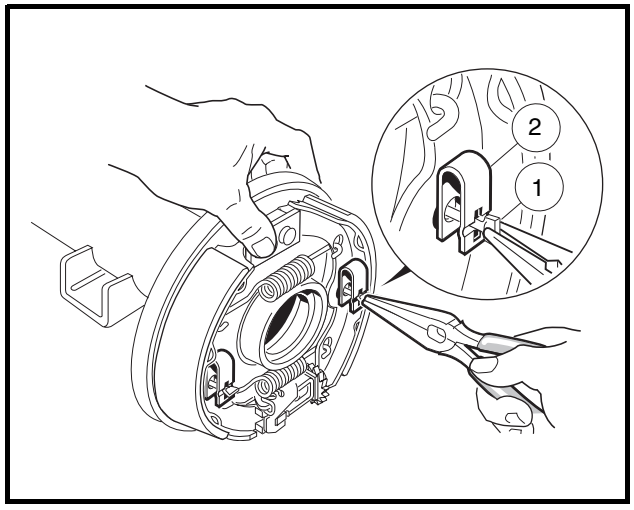


Figure 6-5 Remove Shoe Retainer Clip

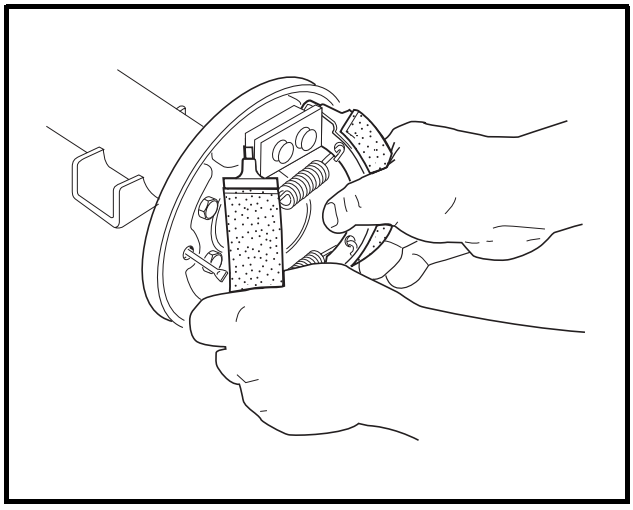


Figure 6-6 Remove Brake Shoes

9. Remove adjuster wheel (1) with two washers (2 and 3) from the backing plate **(Figure 6-7, Page 6-4)**.

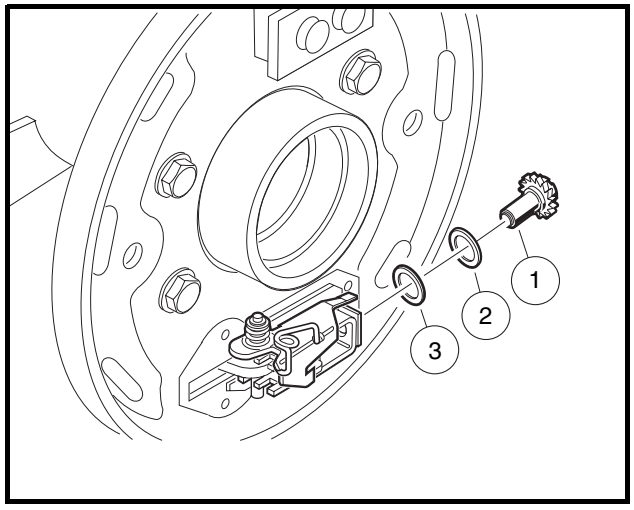


Figure 6-7 Remove Adjuster Wheel

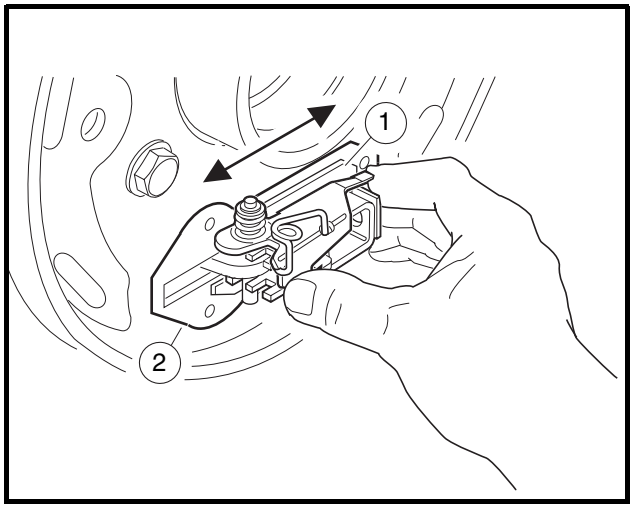


Figure 6-8 Lubricate Slide and Slide Plate

BRAKE ASSEMBLY CLEANING

See General Warning, Section 1, Page 1-1. See also Warning on Page 6-1.

1. Carefully clean the brake backing plate and all of its mechanical components.
2. Remove the rubber boot from backing plate and wipe with a clean damp cloth.
3. Lubricate the slide (1) and slide plate (2) with dry moly lubricant (CCI P/N 1012151) on both sides of the backing plate **(Figure 6-8, Page 6-4)**. After lubricating, work the slide back and forth to ensure that it slides smoothly and easily. Reinstall rubber boot onto backing plate. **See following WARNING.**

⚠ WARNING

- **Apply grease carefully when performing the following steps. Do not allow any grease to get onto the friction surfaces of the brake shoe pads. Failure to heed this warning could cause diminished brake performance, possibly resulting in property damage or severe personal injury.**

4. Use a small brush to carefully apply a light coat of white lithium NLGI #2 grease (Dow Corning BR2-Plus or equivalent) on each of the six raised bosses on the brake backing plate **(Figure 6-9, Page 6-5)**. **See preceding WARNING.**
5. Use a small brush to carefully apply a light coat of white lithium NLGI #2 grease (Dow Corning BR2-Plus or equivalent) to each end of both brake shoes and into the slots in the brake shoe mounting block as shown **(Figure 6-10, Page 6-5)**. **See preceding WARNING.**

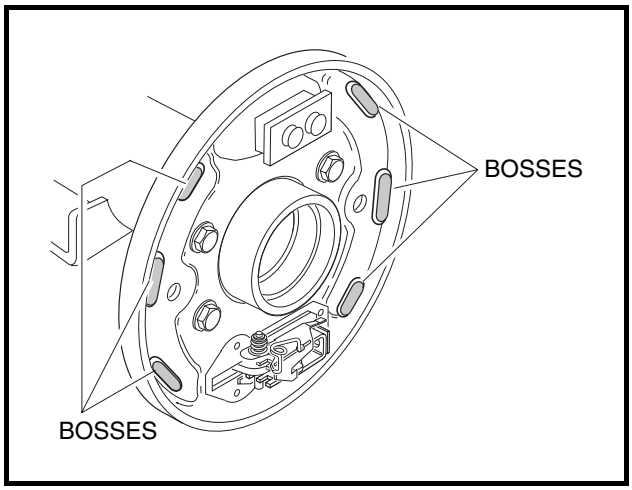


Figure 6-9 Apply Grease On Bosses

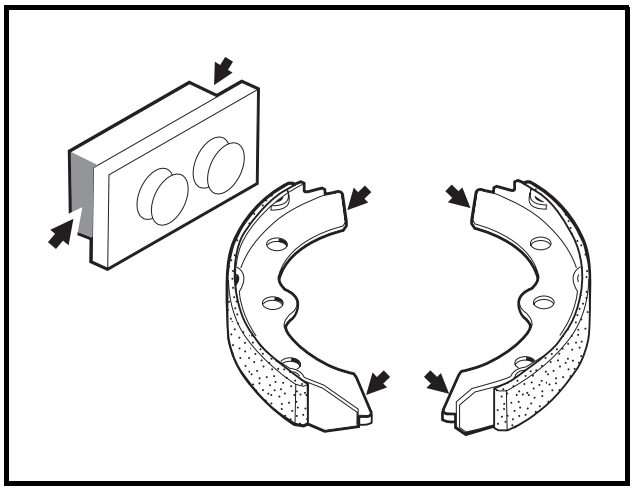


Figure 6-10 Apply Grease To Brake Shoes and Slots

6. Use a small brush to carefully apply a light coat of white lithium NLGI #2 grease (Dow Corning BR2-Plus or equivalent) to the brake adjuster assembly, adjuster wheel shoe slots, and the shaft of the adjuster wheel as shown **(Figure 6-11, Page 6-6)**. **See preceding WARNING.**
7. Install the adjuster wheel (1) and two washers (2 and 3) into the adjuster assembly **(Figure 6-7, Page 6-4)**.

Brake Assembly Cleaning, Continued:

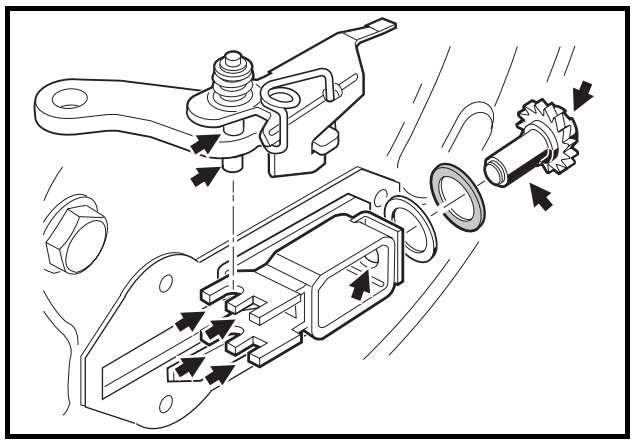


Figure 6-11 Apply Grease To Brake Adjuster

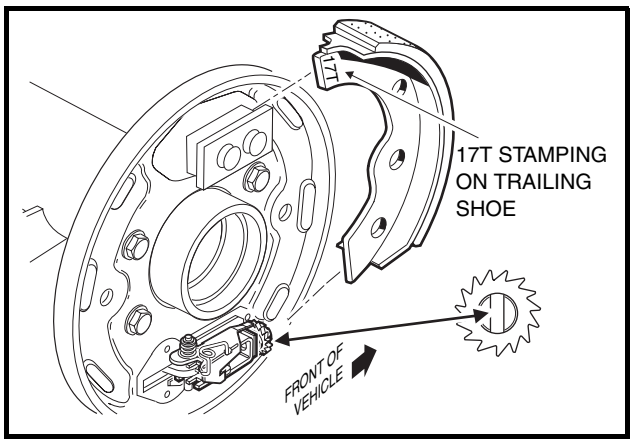


Figure 6-12 Install Adjuster Wheel, Trailing Shoe

BRAKE SHOE INSTALLATION

See General Warning, Section 1, Page 1-1. See also Warning on Page 6-1.

1. Turn the adjusting wheel screw so that the shoe slot is vertical, then position the trailing shoe in the slots in the shoe mounting block and adjuster assembly **(Figure 6-12, Page 6-6)**. **See following NOTE**.

NOTE: *The trailing shoe has 17T stamped into the tip of the shoe flange **(Figure 6-12, Page 6-6)**. The leading shoe is stamped 17L. When installing the shoes, the stamping on both shoes should be oriented to the top of the brake assembly. When installing the shoes on the passenger side of the vehicle, the side of the trailing shoe flange marked 17T should be facing out and be visible. On the driver side, the 17L on the leading shoe should be facing out and be visible.*

*When installed on the backing plate, the **leading** shoe (stamped 17L) is **always** oriented toward the **rear** of the vehicle.*

2. Install the shoe retainer clip, using pliers to compress the clip (1) while turning the retainer pin (2) into position **(Figure 6-13, Page 6-6)**.
3. Attach the springs onto the trailing shoe already installed. Then hold the leading shoe next to the trailing shoe, correctly oriented, and attach the springs to it **(Figure 6-14, Page 6-6)**.

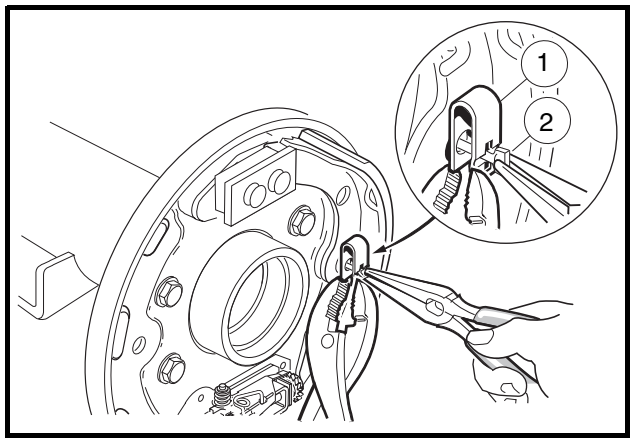


Figure 6-13 Install Trailing Shoe Retainer Clip

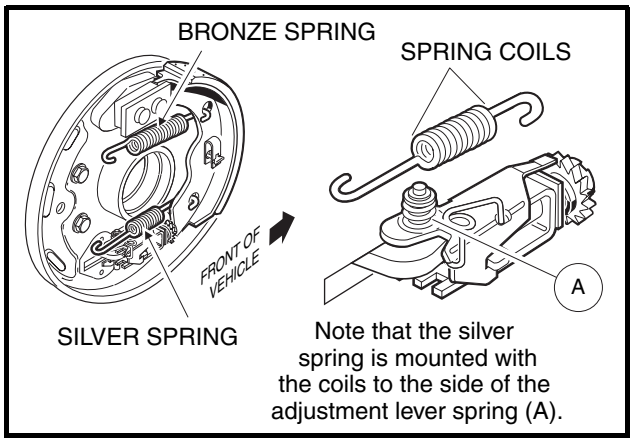


Figure 6-14 Attach Springs

4. While maintaining spring attachment on both shoes, position tips of leading shoe in the mounting slots and then push shoe into place. Hold shoe in position and install retaining clip **(Figure 6-15, Page 6-7)**.

5. After the shoes are installed, move them together up and down and side to side to make sure that they will easily slide approximately 1/4 to 3/8 inch (6.3 to 9.5 mm) without binding **(Figure 6-16, Page 6-7)**.

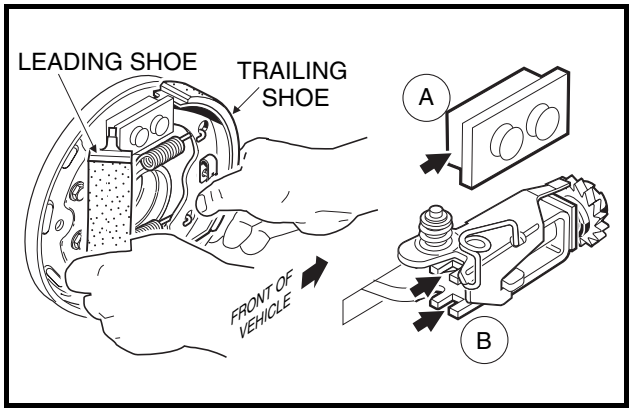


Figure 6-15 Install Leading Shoe

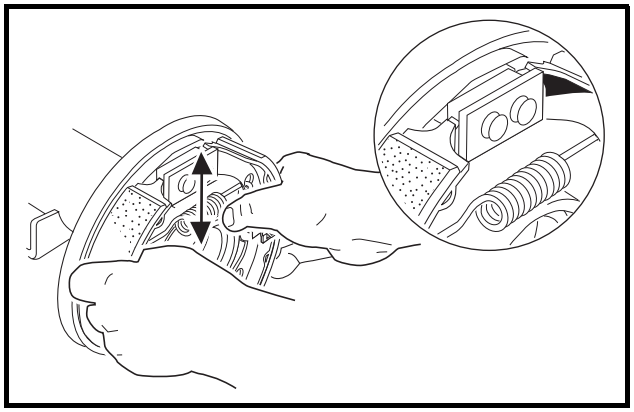


Figure 6-16 Check Shoe Positions

6. Place a flatblade screwdriver under the adjusting arm and raise the arm off of the adjusting wheel. While holding the arm up, turn the wheel upward until it stops **(Figure 6-17, Page 6-7)**. Remove the screwdriver.

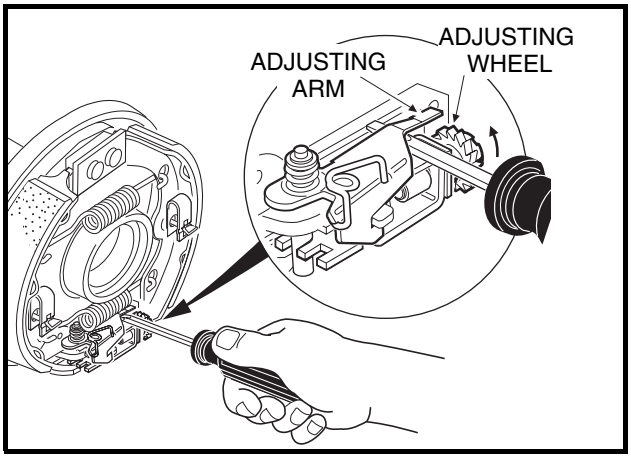


Figure 6-17 Set Adjusting Wheel

7. Install the axle shaft (2) into the axle tube and install the retaining ring (1) **(Figure 6-2, Page 6-2)**. **See following WARNING and CAUTION.**

⚠ WARNING

- **Be sure retaining ring is properly seated in groove. If ring is not properly installed, the axle assembly will separate from the transaxle and damage the axle assembly and other components. Loss of control of the vehicle could result in severe personal injury or death.**

Brake Shoe Installation, Continued:

⚠ CAUTION

- **Before installing axle shaft, clean any residual oil from the exposed end of the axle tube and from the oil seal area.**

8. Install the brake drum, and make sure that it is properly seated. **See following NOTE.**

NOTE: *If drum installation is difficult, the brake shoes may need to be adjusted vertically in the mounting slots.*

9. After the drum is installed, make sure the axle and drum turn freely and then install the wheel. **See Wheel Installation, Section 8, Page 8-1.**

BRAKE ADJUSTMENT

See General Warning, Section 1, Page 1-1. See also Warning on Page 6-1.

1. When cleaning or repair on both wheels is complete, and with the brake cable still loose, lower the vehicle to the floor.
2. Make the brake shoe and drum adjustment by pressing and releasing the brake pedal repeatedly until an audible clicking can no longer be heard.
3. Adjust brake pedal free play.
   - **For gasoline vehicles: See Pedal Group Adjustment – Gasoline Vehicle, Section 5, Page 5-11.**
   - **For electric vehicles: See Pedal Group Adjustment – Electric Vehicles, Section 5, Page 5-16.**

BRAKE CLUSTER REMOVAL AND INSTALLATION

See General Warning, Section 1, Page 1-1. See also Warning on Page 6-1.

Brake Cluster Removal

1. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-2.**
2. Place chocks at the front wheels and loosen the lug nuts on the rear wheels. Lift the rear of the vehicle with a chain hoist or floor jack. Place jack stands under the axle tubes to support the vehicle. **See General Warning, Section 1, Page 1-1.**
3. Loosen the equalizer retaining nuts (2 and 3) on the equalizer rod (1) to loosen the brake cable **(Figure 6-1, Page 6-2)**.
4. Remove lug nuts and rear wheels and then the brake drums. **See following NOTE.**

NOTE: *When servicing vehicles with self-adjusting brakes with badly worn brake shoes and when the drums cannot be removed by normal methods, perform Step 5 of Brake Shoe Removal on page 6-1, then continue with this procedure.*

Although step 5 ***– Removing the Axle*** *allows easier access to the brake shoes, it is not imperative to do so in order to remove the brake shoes.*

5. Remove the axle.
   5.1. Using 90° snap ring pliers (CCI P/N 1012560), remove the axle retaining ring (1) **(Figure 6-2, Page 6-2)**.

5.2. Pull the axle shaft (2) from the axle tube **(Figure 6-2, Page 6-2)**.

6. Remove bow-tie pin (13) and clevis pin (12) from brake cable **(Figure 6-4, Page 6-3)**.
7. Remove four bolts (11) and lock nuts (10) that mount the brake assembly to the transaxle **(Figure 6-4, Page 6-3)**.
8. Remove brake assembly from transaxle.

BRAKE CLUSTER INSTALLATION

1. Install in reverse order of disassembly. Use new bow-tie pins when installing brake cables. **See following CAUTION.**

⚠ CAUTION

- **Before installing axle shaft, clean any residual oil from the exposed end of the axle tube and from the oil seal area.**

2. Be sure bolts (11) (CCI P/N 1014153) and new lock nuts (10) (CCI P/N 1013924) are used to mount the brake assembly **(Figure 6-4, Page 6-3)**.
3. Torque bolts to 30 ft-lb (40.6 N·m).
4. Install the rear axle onto the transaxle.
   4.1. Insert the splined end of the axle shaft into the axle tube. Be careful not to damage the seal on the inside of the axle tube hub. Advance the shaft through to the bearing on the shaft, and rotate it to align the shaft splines with the splined bore of the differential gear. Continue advancing the shaft until the bearing on the axle is firmly seated within the axle tube hub seal.
   4.2. Use a 90° internal snap ring pliers (.090 tip) to attach the internal retaining ring into the axle tube hub so that it seats against the axle bearing assembly and into the machined slot in the inside wall of the axle tube hub.
   4.3. Place a 1/4 to 3/8 - inch (6 - 10 mm) diameter rod against the retaining ring and tap lightly at four or five locations to ensure it is properly seated. **See following WARNING.**

⚠ WARNING

- **Be sure retaining ring is properly seated in groove. If ring is not properly installed, the axle assembly will separate from the transaxle and damage the axle assembly and other components. Loss of control of the vehicle could result in severe personal injury or death.**

5. Tighten lug nuts on rear wheels, using crisscross pattern, to 55 ft-lb (74.6 N·m). **See Wheel Installation, Section 8, Page 8-1.**
6. Adjust the brakes. **See Brake Adjustment on page 6-8.**

BRAKE CABLE REMOVAL AND INSTALLATION

See General Warning, Section 1, Page 1-1. See also Warning on Page 6-1.

Brake Cable Removal

1. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-2.**
2. Place chocks at the front wheels.
3. Release the park brake if engaged and loosen equalizer retaining nuts (1) on equalizer rod (2) to slightly loosen the brake cables (3) **(Figure 6-18, Page 6-10)**.

Brake Cable Removal, Continued:

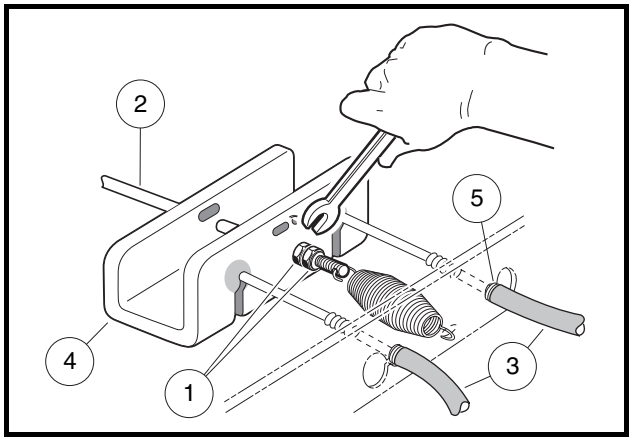


Figure 6-18 Loosen Brake Cables

4. Rotate the brake cable upward and pull cable end through hole in top of equalizer (4).
5. Remove E-clip from cable at vehicle frame (5) **(Figure 6-18, Page 6-10)**. Remove cable from frame.
6. Remove bow-tie pin (1) and the clevis pin (2) from the brake lever on each wheel and pull the clevis (3) away from the lever. **(Figure 6-19, Page 6-10)**.
7. Remove E-clip (4) from cable at the cable support bracket (5). Remove cable from bracket.
8. Note routing of cable through hanger for installation of new cable. Pull cable from vehicle.

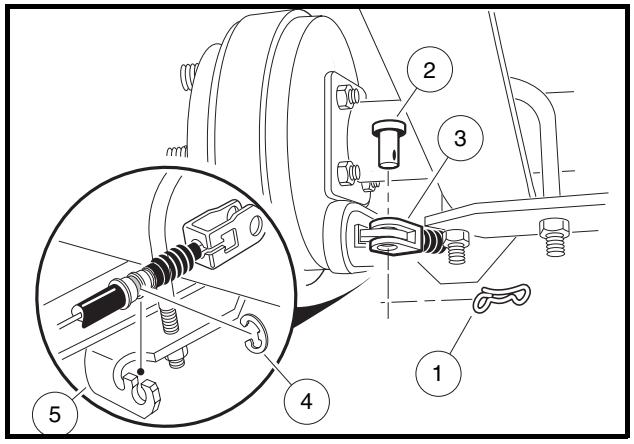


Figure 6-19 Disconnect Cables at Rear Brakes

Brake Cable Installation

1. Place the end of the new cable into the equalizer (4) **(Figure 6-18, Page 6-10)**. Secure the cable to the vehicle frame with new E-clip. Route cable through hanger in the same manner as before.
2. At the rear wheel brake, connect the cable to the brake actuator arm using new clevis pin (2) and new bow-tie pin (1) **(Figure 6-19, Page 6-10)**.
3. Place the cable in the cable support bracket (5) and secure with new E-clip (3).
4. Adjust the brakes. **See Brake Adjustment on page 6-8.**

SECTION 7 – STEERING AND FRONT SUSPENSION

⚠ DANGER

- **See General Warning, Section 1, Page 1-1.**

⚠ WARNING

- **See General Warning, Section 1, Page 1-1.**

GENERAL INFORMATION

Steering is controlled through a rack and pinion steering assembly that is connected by a steering column to a steering wheel. No manual adjustment to the rack and pinion gear assembly is required. A spring loaded self-adjusting mechanism is incorporated into the assembly.

STEERING WHEEL

See General Warning, Section 1, Page 1-1.

STEERING WHEEL REMOVAL

1. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-2.**
2. Remove the two mounting screws (30) and plate (28) **(Figure 7-3, Page 7-3)**.
3. Match mark the steering wheel (25) and steering shaft (19) so when the steering wheel is removed it can be placed back in exactly the same position on steering column shaft.
4. Loosen the steering wheel nut (27) and back it off approximately 1/4 inch (6 mm). Do not remove the nut.
5. Use the steering wheel puller (CCI P/N 102061201) to remove steering wheel.
   - 5.1. Place the puller anvil (4) through the top opening of the steering wheel **(Figure 7-1, Page 7-2)**.
   - 5.2. Insert the anvil feet through the two slots in the base plate (marked "B") (5) as shown **(Figure 7-1, Page 7-2)**.
   - 5.3. Rotate the anvil screw (6) clockwise until the base plate contacts the bottom of the steering wheel where it attaches to the steering column **(Figure 7-2, Page 7-2)**.
   - 5.4. Using a 1/2 inch drive air impact wrench, tighten the anvil screw (6) until the steering wheel breaks free from the steering shaft.
   - 5.5. Remove the steering wheel puller.

Steering Wheel Removal, Continued:

5.6. Remove the steering wheel nut (27) and the steering wheel (25) from the steering column (20) **(Figure 7-3, Page 7-3)**.

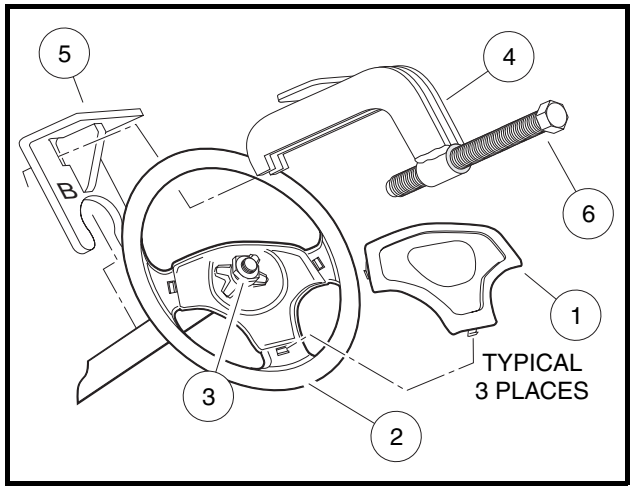


Figure 7-1 Steering Wheel Puller

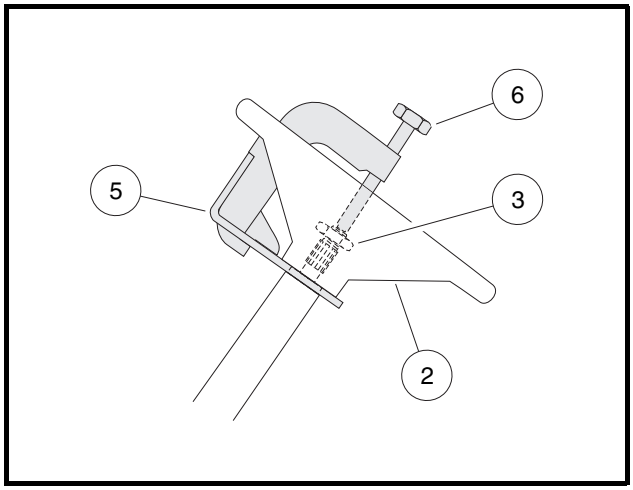


Figure 7-2 Steering Wheel Puller

STEERING WHEEL INSTALLATION

NOTE: *To minimize corrosion and to make future removal of the steering wheel easier, apply a small amount of oil or anti-seize compound to steering shaft splines and taper before installing the steering wheel.*

1. Install the steering wheel (25) on the splines of the steering shaft (19). Be sure to align the match marks placed on the wheel and steering column in step 3 above **(Figure 7-3, Page 7-3)**.
2. Install the steering wheel nut (27) and tighten to 13 ft-lb (17.6 N·m).
3. Install the scorecard plate (28) and plate mounting screws (30) **(Figure 7-3, Page 7-3)**. Tighten screws to 16 in-lb (1.8 N·m).

STEERING COLUMN

See General Warning, Section 1, Page 1-1.

STEERING COLUMN REMOVAL

1. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-2.**
2. Remove the steering wheel. **See Steering Wheel Removal on page 7-1.**
3. Remove the front body as instructed in Section 4 – Body and Trim.

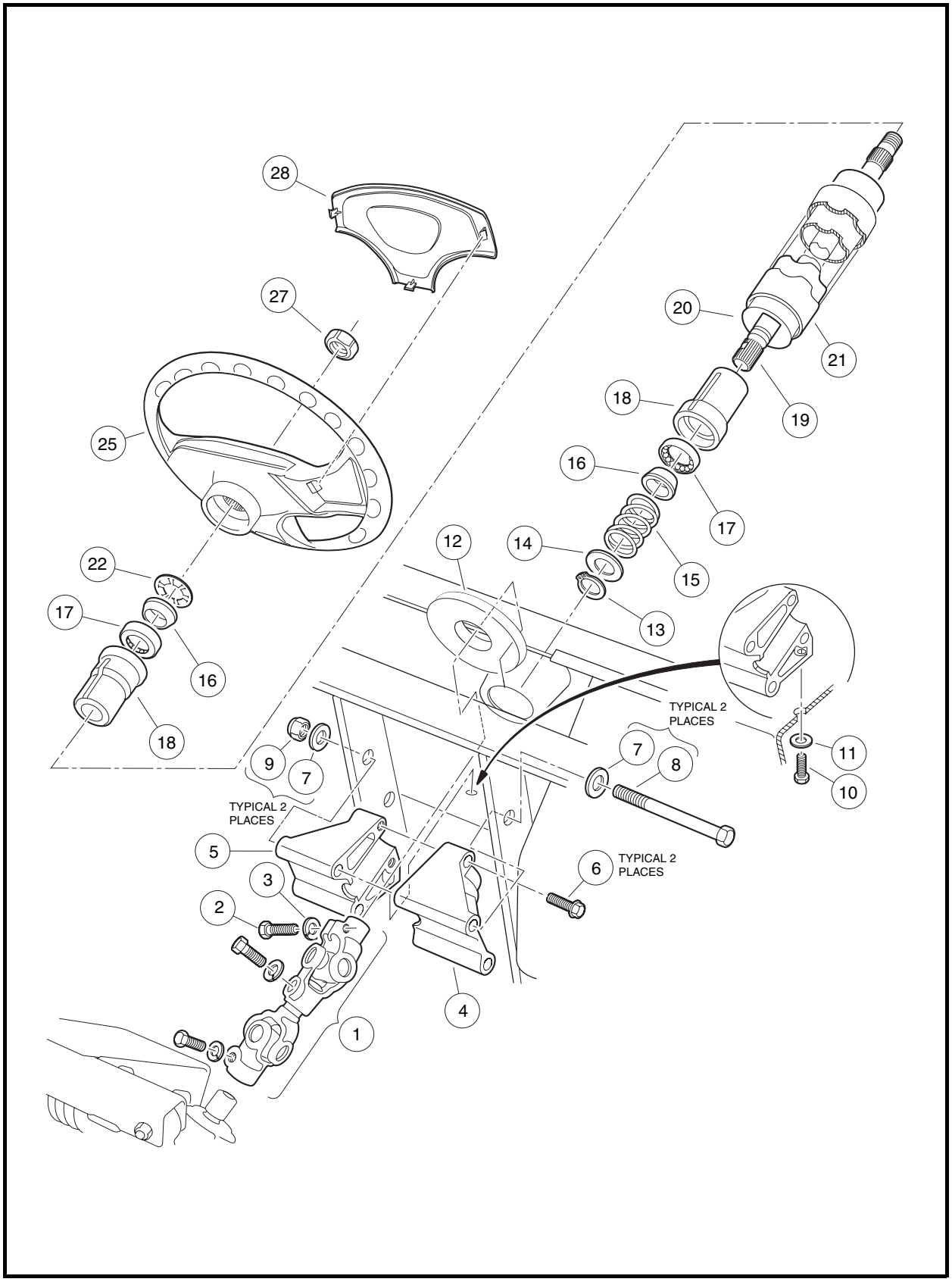


Figure 7-3 Steering Column

Steering Column Removal, Continued:

4. Remove the instrument panel.
   4.1. Remove the plastic panel screws from the instrument panel.
   4.2. Pull dash panel from the dash.
   4.3. Disconnect the wires from the electrical components mounted on the dash panel. Do not allow wires to touch.
   4.4. Slide dash panel up and away from the steering column.
5. Remove the dash. **See Dash Removal, Section 4, Page 4-4.**
6. Remove the upper bolt (2) and lock washer (3) from the universal joint **(Figure 7-3, Page 7-3).**
7. Remove the nuts (9), bolts (8 and 10), and washers (7 and 11) from the steering column mount (4 and 5).
8. Remove the steering column from the vehicle.

STEERING COLUMN DISASSEMBLY

1. Remove screws (6) and mount (4 and 5) from steering column. Remove boot (12) **(Figure 7-3, Page 7-3)**.
2. While supporting steering column (21) on a workbench, remove snap ring (13) from shaft.**See following NOTE.**

NOTE: *Do not allow the steering shaft to slide out of the steering tube when removing the snap ring.*

3. Remove the washer (14), spring (15) and wedge (16). **See following NOTE.**

NOTE: *Use a new seal, retaining rings and new bearings for reassembly.*

4. Slide the shaft out of the tube to expose the retaining ring (22). Use pliers to twist the retaining ring (22) until it breaks off, then remove the wedge (16)**.**
5. Remove the shaft (19) from the bottom of the tube (20).
6. Use steering shaft (19) to push bearing seat (18) out from the opposite end of the steering tube (20).
7. Insert a flat blade screwdriver between the bottom of the outer race of the bearing (17) and the bottom lip of the bearing seat (18) and remove the bearing (17).

STEERING COLUMN ASSEMBLY

1. Insert bearing seat (18) into both ends of steering tube (20). Place a block of wood on bearing seat and tap lightly on block until bearing seat (18) is fully seated in steering tube (20) **(Figure 7-4, Page 7-5)**.
2. Press the bearing (17) all the way into the bearing seat (18) using a steering column bearing press tool (CCI P/N 1014264) or a metal tube approximately six inches (15.2 cm) long with a maximum outer diameter of 1-3/16 inches (3.3 cm) and a minimum inside diameter of 7/8 inch (2.2 cm). Be sure the bearing is installed in the bearing seat as shown **(Figure 7-4, Page 7-5)** so the wedge (16) will ride against the inner race of the bearing.

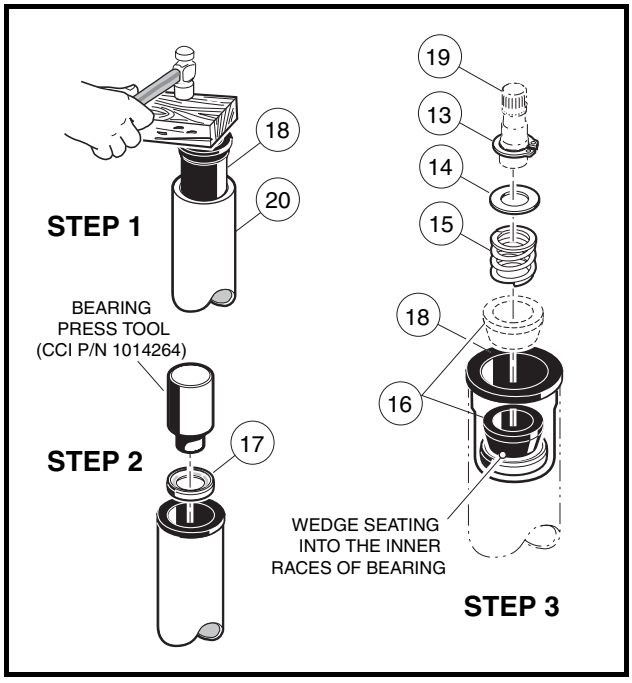


Figure 7-4 Steering Shaft – Bottom End

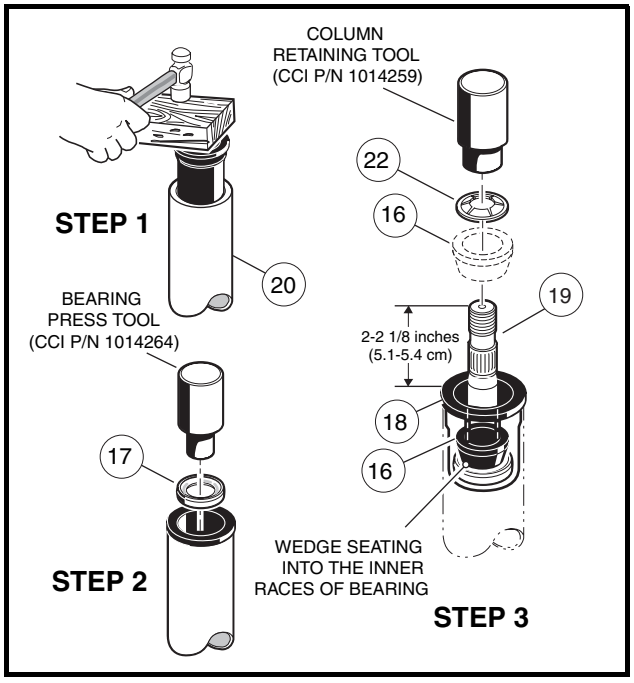


Figure 7-5 Steering Shaft – Top End

3. Install the wedge (16), spring (15), washer (14), and snap ring (13) onto the bottom end of the steering shaft (19) **(Figure 7-4, Page 7-5)**.
4. Insert the shaft (19) from the bottom of the steering tube (20) **(Figure 7-3, Page 7-3)**.
5. Turn the assembly over and place the shaft (19) on a bench. Install the wedge (16) and retaining ring (22) onto the top of the shaft **(Figure 7-5, Page 7-5)**. Be sure the prongs on the retaining ring face up and away from the wedge. Use a steering column retaining ring tool (CCI P/N 1014259) to seat the retaining ring to the proper depth. Support end of tube while pressing. If you do not have the recommended tool, use the same tube as was used in step 2 to press the retaining ring onto the top of the shaft. The retaining ring should be pressed onto the shaft until 2 to 2-1/8 inches (5.1-5.4 cm) of the shaft extends from the top of the bearing seat in the steering tube **(Figure 7-5, Page 7-5)**.

STEERING COLUMN INSTALLATION

1. Install boot (12). Reinstall mount (4 and 5) onto the end of the steering column. Tighten bolts (6) to 20 ft-lb (27 N·m) **(Figure 7-3, Page 7-3)**.
2. For ease of assembly and to prevent corrosion, apply a light coat of anti-seize or lubricating compound to both splined ends of the steering shaft.
3. Position the steering column assembly in the vehicle while inserting the steering column shaft into the upper universal joint (1). The flat portion of the steering shaft spline (19) must be aligned with the bolt hole in the universal joint (1) before sliding the spline into the universal joint. While holding the steering column in place, attach it to the frame using bolts (8) washers (7) and nuts (9) **(Figure 7-3, Page 7-3)**. Thread the nuts onto the bolts but do not tighten them.
4. Reinstall washer (11) and screw (10). Tighten to 20 ft-lb (27 N·m).
5. Install the bolt (2) and lock washer (3) on the upper universal joint and finger-tighten.
6. Tighten the two nuts (9) and bolts (8) to 17 ft-lb (23 N·m).
7. Tighten the bolt (2) on the upper universal joint to 15 ft-lb (20 N·m).

Steering Column Installation, Continued:

8. Check the other two bolts on the universal joint (1) to ensure that they are properly tightened to 15 ft-lb (20 N·m) **(Figure 7-3, Page 7-3)**.
9. Reinstall dash pocket and related hardware.
10. Reinstall instrument panel in reverse order of disassembly. Make sure the instrument panel is properly seated and fastened into place.
11. Install front body and bumper. **See Section 4 – Body and Trim.**

STEERING ADJUSTMENT

See General Warning, Section 1, Page 1-1.

1. Turn the steering wheel all the way to the right. Note the distance between the passenger-side spindle stop (2) and passenger-side A-plate (3) **(Figure 7-6, Page 7-7).** The internal stop on the rack must reach its limit of travel against rack and pinion housing at exactly the same time the spindle stops against the passenger-side A-plate (with vehicle wheels turned to the right). If simultaneous contact occurs, steering is in correct adjustment; Proceed to step 4. If simultaneous contact does not occur, proceed to step 2.
2. Loosen the nuts (27 and 29) and turn the drag link (28) **(Figure 7-8, Page 7-8)** to adjust the drag link rod. Adjust the link rod with the steering wheel turned all the way to the right, so the passenger-side spindle stop lightly touches the passenger-side A-Plate. The internal stop on the rack must reach its limit of travel at the same time the spindle stops against the passenger-side A-plate (with vehicle wheels turned to the right). **See following CAUTION.**

CAUTION

- **The drag link has both left and right-hand threads. The end of the drag link toward the spindle has left-hand threads, and the end toward the rack has right-hand threads. To prevent damage to threaded parts, care should be taken when servicing the drag link.**

3. When all adjustments have been completed, tighten the nuts (27 and 29) on the drag link assembly with an open end wrench. Tighten nuts to 21 ft-lb (28.4 N·m) **(Figure 7-8, Page 7-8)**. **See following CAUTION.**

CAUTION

- **When tightening the nuts (27 and 29), make sure the drag link (28) does not turn (Figure 7-8, Page 7-8).**

4. Straighten wheels and then turn steering wheel from lock to lock. Wheels should turn smoothly and easily. If steering wheel does not turn smoothly and easily, inspect steering assemblies; e.g., ball joints (23) **(Figure 7-8, Page 7-8)** and (6 and 13) **(Figure 7-19, Page 7-17)**, spindle bushings (3 and 4) **(Figure 7-20, Page 7-18)**, wave washers (20) **(Figure 7-20, Page 7-18)**, and rack assembly (17) **(Figure 7-8, Page 7-8)**. Also inspect front suspension assemblies; e.g., A-Plates (1) **(Figure 7-19, Page 7-17)** urethane bushings (2) **(Figure 7-19, Page 7-17)** and leaf springs (6) **(Figure 7-20, Page 7-18)**. Replace components as necessary.

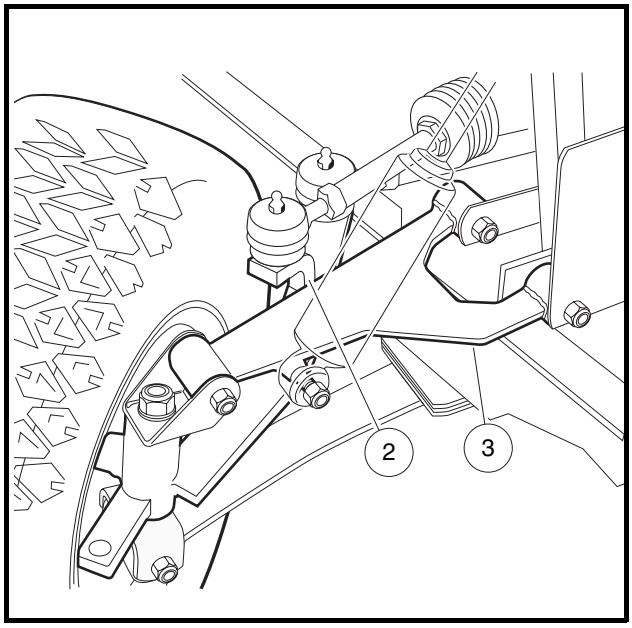


Figure 7-6 Adjust Steering Alignment

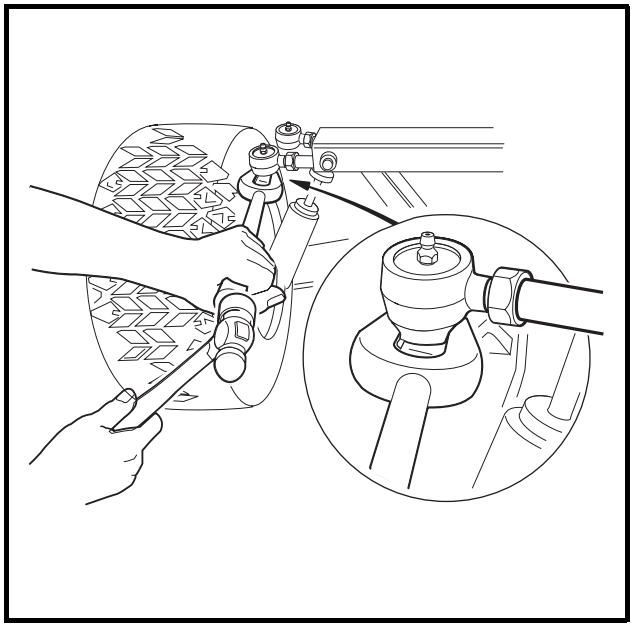


Figure 7-7 Ball Joint Tool

RACK AND PINION

See General Warning, Section 1, Page 1-1.

RACK AND PINION REMOVAL

1. Remove the front body as instructed in Section 4 – Body and Trim**.**
2. Remove the cotter pin (22) and ball joint retaining nut (25) **(Figure 7-8, Page 7-8)**.
3. Using a ball joint removal tool, remove the ball joint (23) **(Figure 7-8, Page 7-8)** from the spindle assembly. **See Figure 7-7, Page 7-7.**
4. Remove the bolts (30), washers (31), and lock nuts (32) from the steering rack assembly mounting bracket **(Figure 7-8, Page 7-8)**.
5. Remove the bolt (2) and flat washer (3) on the upper universal joint, then remove the rack assembly and universal joint from the vehicle **(Figure 7-3, Page 7-3)**.

RACK AND PINION DISASSEMBLY

CAUTION

- **The ball joint (23) (Figure 7-8, Page 7-8) has left-hand threads.**

1. Remove ball joint (23) and inspect it for excessive wear **(Figure 7-8, Page 7-8)**.
2. Remove the drag link (28) **(Figure 7-8, Page 7-8)**.
3. Remove both bellows clamps (2) (plastic wire ties).
4. Remove the hex nut (29) and slide off the dust seal bellows (1).
5. Remove the retaining ring (21), then slide off dust seal bellows (20).

Rack and Pinion Disassembly, Continued:

6. Remove the rack screw lock nut (15), rack guide screw (16), rack guide pressure spring (14), and the rack guide (13).
7. Remove the universal joint assembly from the pinion (8) by fully removing the bolt and then sliding off the universal joint.
8. If necessary, remove the dust seal (12)**. See following NOTE.**

NOTE: *If the dust seal (12) is removed, replace with a new one* ***(Figure 7-8, Page 7-8)****.*

9. Using snap ring pliers, remove the internal snap ring (11) **(Figure 7-8, Page 7-8).**
10. Install the universal joint onto the pinion and place a large open end wrench under the universal joint **(Figure 7-9, Page 7-9)**. Use the wrench as a lever to pull the pinion from the housing.

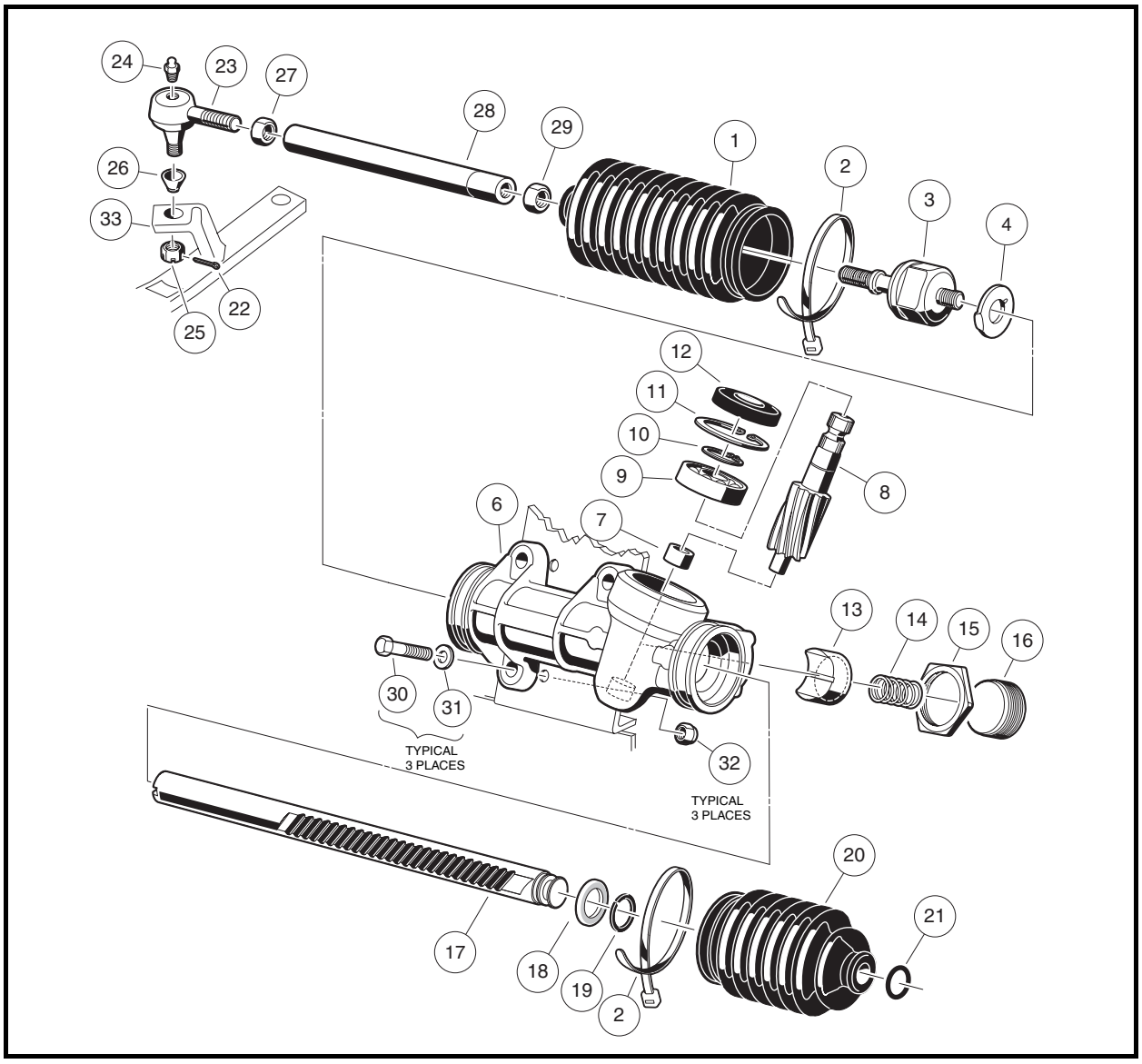


Figure 7-8 Steering Gear

Rack and Pinion Disassembly, Continued:

11. If the ball bearing (9) has been damaged, remove the external snap ring (10) **(Figure 7-8, Page 7-8)** and press the bearing off **(Figure 7-10, Page 7-9)**.

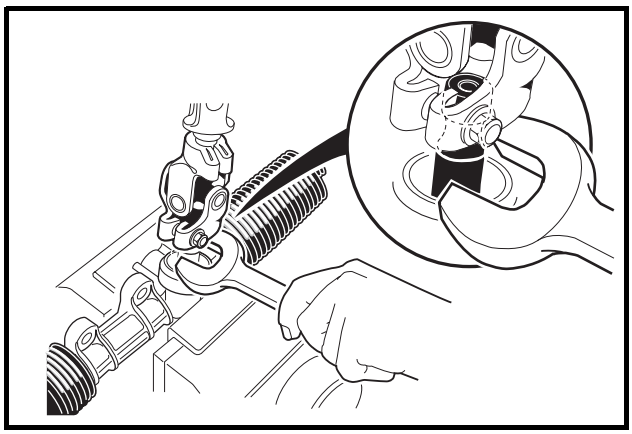


Figure 7-9 Remove Pinion from Housing

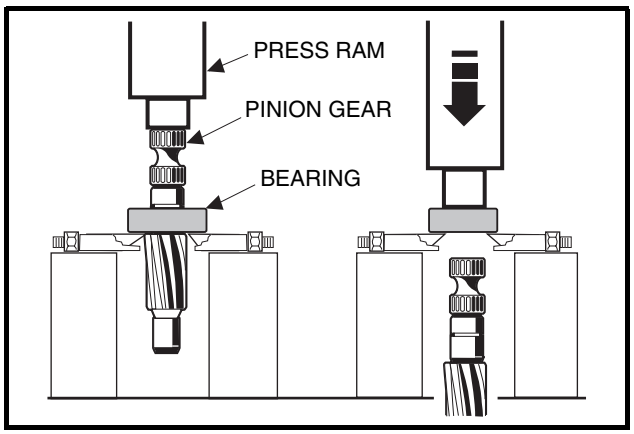


Figure 7-10 Remove Bearing from Pinion

12. Remove retaining ring (19) and stop washer (18), then remove rack (17) from housing (6) **(Figure 7-8, Page 7-8)**.

13. If the inner ball joint (3) is excessively worn, remove the ball joint and tab washer (4) from the rack **(Figure 7-11, Page 7-9)**.

    13.1. Secure the rack in a vise using wood blocks between the rack and the jaws of the vise to protect the rack from damage **(Figure 7-11, Page 7-9)**.

    13.2. Loosen and remove the inner ball joint with a wrench.

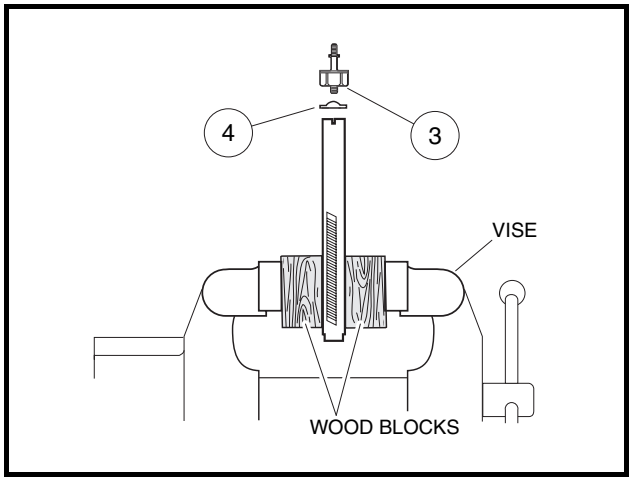


Figure 7-11 Secure Rack in Vise

14. Inspect the bushing inside the steering box assembly (6) for excessive wear. If wear is excessive, replace the steering box assembly (CCI P/N 101878302) **(Figure 7-8, Page 7-8)**.

RACK AND PINION ASSEMBLY

1. Install a new tab washer (4) and an inner ball joint (3) **(Figure 7-11, Page 7-9)**. Install the ball joint onto the rack by securing the rack in a vise using wood blocks between the rack and the jaws of the vise to protect the rack from damage. Tighten the ball joint to 60 ft-lb (81 N·m).
2. Bend the edges of the tab washer (4) up against the ball joint (3).
3. Apply a liberal amount of EP grease to the teeth of the rack (17), then slide the rack through the housing (6). Install the stop washer (18) and retaining ring (19) to the end of the rack **(Figure 7-8, Page 7-8)**. **See following CAUTION.**

CAUTION

- **In step 4, do not press against the outer race of the bearing.**

4. If the bearing (9) was removed, grease and press on a new bearing, exerting all pressure on the inner race. **(Figure 7-8, Page 7-8)**
5. Install the external snap ring (10).
6. If the needle bearing (7) is damaged, the steering box assembly (CCI P/N 101878302) must be replaced.
7. Install pinion (8) and bearing (9) assembly into the housing (6) **(Figure 7-8, Page 7-8)**. Make sure the rack gear teeth will mesh with the gear teeth on the pinion. The rack may need to be rotated slightly while lightly tapping on the pinion-bearing assembly with a rubber mallet. **See following CAUTION**.

CAUTION

- **Do not force the pinion-bearing assembly into the housing. The gear teeth or the small bearing could be damaged.**

8. Install the internal snap ring (11) **(Figure 7-8, Page 7-8)**.
9. Use a socket to apply pressure evenly, and press in a new dust seal **(Figure 7-12, Page 7-10)**.

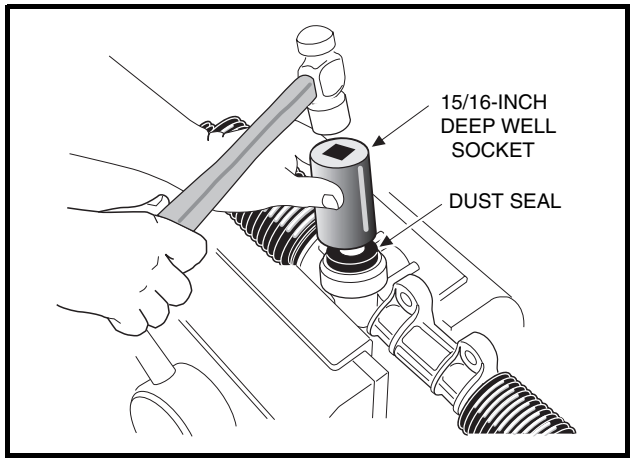


Figure 7-12 Press In Dust Seal

10. Apply a small amount of grease to the rack guide (13) where it comes into contact with the rack (17) **(Figure 7-8, Page 7-8)**.
11. Place a few drops of Loctite® 222 on the threads of the screw (16) **(Figure 7-8, Page 7-8)**.

12. Install the rack guide (13), pressure spring (14), and screw (16). The screw should be threaded in until a rotational torque of 10 in-lb (1.13 N·m) is achieved **(Figure 7-8, Page 7-8)**.

    12.1. Reposition the rack and pinion in a vise.

    12.2. Insert a 3/8 inch deep well socket into the steering column end of the universal joint (2) and tighten the bolt (1) to 15 ft-lb (20.3 N·m) **(Figure 7-14, Page 7-11)**.

    12.3. Use a torque wrench connected to the 3/8 inch deep well socket to measure the resistance of the rack and pinion. Rotational resistance should measure 7 to 15 in-lb (.8 to 1.7 N·m).

    12.4. If measured resistance does not equal 7 to 15 in-lb, loosen the lock nut (15) and tighten the screw (16) until it bottoms out, then back the screw off one quarter turn. Tighten the lock nut to 28 ft-lb (38 N·m) **(Figure 7-13, Page 7-11)**. **See following NOTE.**

NOTE: *When tightening the lock nut (15), make sure the screw (16) does not change adjustment **(Figure 7-13, Page 7-11)**.*

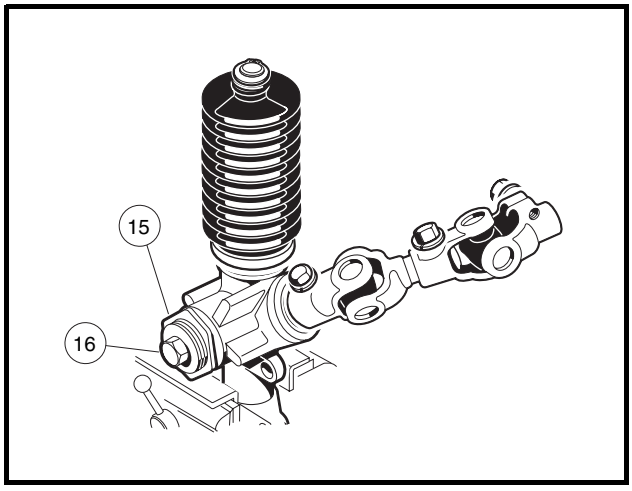


Figure 7-13 Rack and Pinion Adjustment

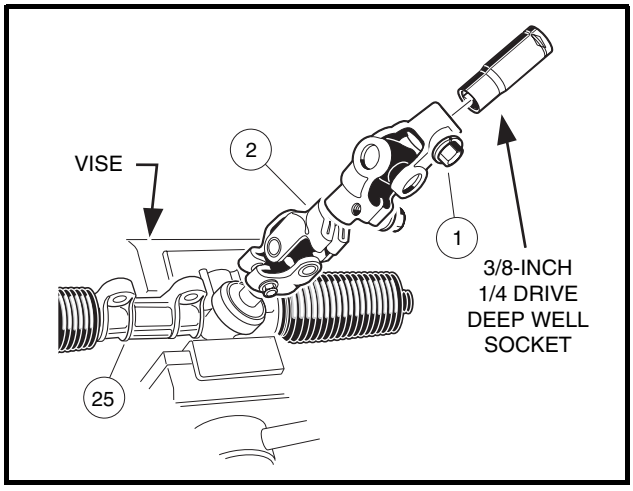


Figure 7-14 Rack and Pinion Resistance

13. Install the dust seal bellows (20) and retaining ring (21) **(Figure 7-8, Page 7-8)**.

14. Install the dust seal bellows (1) and hex nut (29).

15. Install the universal joint on the pinion. Tighten the bolt to 15 ft-lb (20 N·m).

16. Install new bellows clamps (wire ties) (2).

17. Install the drag link (28) by fully threading the grooved end onto the inner ball joint (3). **See following CAUTION.**

CAUTION

- **The ball joint (23) (Figure 7-8, Page 7-8) has left-hand threads.**
- **The tie rod and drag link have right-hand threads on one end and left-hand threads on the other end. Right-hand threads are identified by a groove in the tie rod or drag link.**

18. Install the ball joint (23). **See preceding CAUTION.**

RACK AND PINION INSTALLATION

1. Position the steering gear box assembly on the shock and gear support and install the bolts (30), washers (31), and nuts (32). Do not tighten the mounting bolts **(Figure 7-8, Page 7-8)**.
2. For ease of assembly and to prevent corrosion, apply a light coat of anti-seize and lubricating compound to the splined end of the steering column shaft.
3. Align the flat portion of the steering shaft spline with the bolt hole in the universal joint and then slide the shaft into the upper universal joint. Install the bolt and lock washer on the upper universal joint and tighten to 15 ft-lb (20 N·m).
4. Tighten the steering rack mounting bolts (30) to 22 ft-lb (29.8 N·m) **(Figure 7-8, Page 7-8)**.
5. Adjust the steering. **See Steering Adjustment on page 7-6.**

TIE ROD AND DRAG LINK

See General Warning, Section 1, Page 1-1.

TIE ROD AND DRAG LINK REMOVAL

1. Using locking pliers to hold tie rod and drag link, loosen jam nuts (7 and 12) on tie rod ball joints **(Figure 7-19, Page 7-17)**, and loosen jam nuts (27 and 29) on the drag link **(Figure 7-8, Page 7-8)**.
2. Remove the cotter pin (22) and ball joint retaining nut (25) **(Figure 7-8, Page 7-8)**.
3. Remove the cotter pins (22) and ball joint retaining nuts (20) **(Figure 7-20, Page 7-18)**.
4. Use a ball joint removal tool to remove ball joints (13 and 6) **(Figure 7-19, Page 7-17)** and (23) **(Figure 7-8, Page 7-8)** from the spindles.
5. Remove the ball joints from the tie rod (11) **(Figure 7-19, Page 7-17)**.
6. Remove drag link (28) from inner ball joint assembly (3) and drag link ball joint (23) **(Figure 7-8, Page 7-8)**.

TIE ROD AND DRAG LINK INSTALLATION

1. Thread ball joints (6 and 13) into tie rod (11) to a depth of 1/2 inch (12.5 mm) **(Figure 7-19, Page 7-17)**. **See following WARNING and CAUTION.**

⚠ WARNING

- **The ball joints must be threaded into the rod at least 5/16 of an inch (8 mm). Failure to thread ball joints in deep enough may cause a ball joint to separate from the rod during adjustment or while being operated, possibly resulting in loss of vehicle control and severe personal injury.**

CAUTION

- **The tie rod and drag link have right-hand threads on one end and left-hand threads on the other end. Right-hand threads are identified by a groove in the tie rod or drag link.**

2. Install ball joint ends (6 and 13) into the left and right-hand spindle arms (23), then install the retaining nuts (20) and cotter pins (22) **(Figure 7-19, Page 7-17)**.

3. Thread the drag link rod (28) all the way onto the threaded stud of the inner ball joint assembly (3) (right-hand threads) **(Figure 7-8, Page 7-8)**.
4. Thread the ball joint (23) into the drag link rod (28) (left-hand threads) to full thread depth **(Figure 7-8, Page 7-8)**.
5. Install the ball joint (23) on the spindle arm riser (33), then install the retaining nut (25) **(Figure 7-8, Page 7-8)**. Tighten nut to 21 ft-lb (28.4 N·m), then install a new cotter pin (22).
6. Adjust wheel toe-in **(see page 7-14)** and steering **(see page 7-6)**.

FRONT SUSPENSION

See General Warning, Section 1, Page 1-1.

LUBRICATION

Five grease fittings are provided (one in each spindle housing, one in the ball joint on each end of the tie rod, and one in the ball joint of the steering drag link). Lubricate these fittings at the recommended interval with the proper lubricant. **See Periodic Lubrication Schedules, Section 10, Page 10-4. See following CAUTION.**

CAUTION

- **To ensure proper lubrication of the front suspension and steering linkages, raise front of vehicle to lubricate. See General Warning, Section 1, Page 1-1.**

WHEEL ALIGNMENT

Wheel alignment is limited to equalizing the camber angle of each front wheel and adjusting toe-in of the front wheels. There is also a drag link adjustment to equalize the turning radius in both directions. **See Steering Adjustment on page 7-6. See following NOTE.**

NOTE: *Prior to making any front suspension adjustments, inspect components for wear or damage and repair or replace as necessary.*

Camber Adjustment

1. Check each front wheel with a framing square. From the floor (or ground), they should be perpendicular with a framing square **(Figure 7-15, Page 7-14)**.
2. Loosen, but do not remove, the four bolts (30) that secure the leaf spring (6) to the bottom spring plate (29) **(Figure 7-20, Page 7-18). See also Figure 7-16, Page 7-14**.
3. Loosen, but do not remove, the hex nut (8) on the adjustment eccentric (7) **(Figure 7-16, Page 7-14)** in the center of the spring. **See also Figure 7-20, Page 7-18.**
4. Use a 7mm deep-well socket to rotate the eccentric **(Figure 7-16, Page 7-14)**.
5. After adjusting camber, tighten the four spring retaining bolts (30) **(Figure 7-20, Page 7-18)** to 23 ft-lb (31 N·m). Then roll the vehicle forward one full tire revolution and recheck the camber. **See also Figure 7-15, Page 7-14**.
6. Tighten the hex nut (8) on the adjustment eccentric (7) to 10 ft-lb (13.5 N·m) **(Figure 7-20, Page 7-18) See also Figure 7-16, Page 7-14**.

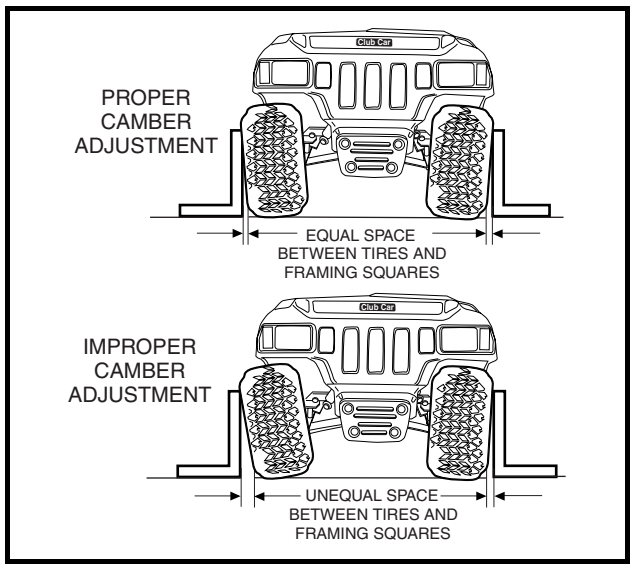


Figure 7-15 Check Camber

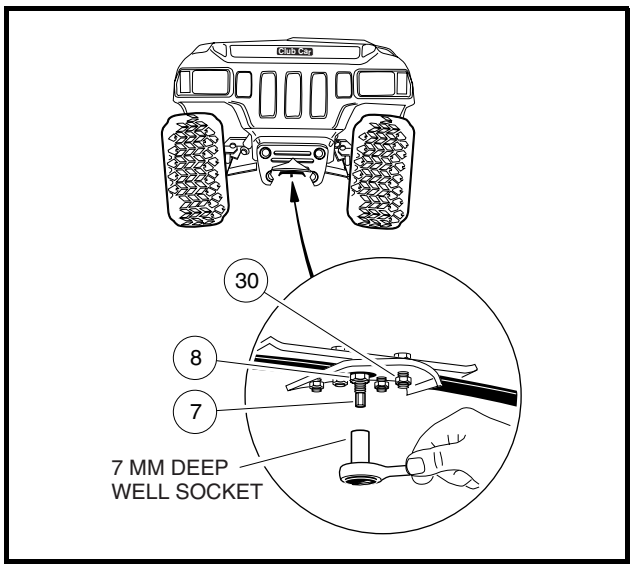


Figure 7-16 Adjust Camber

Toe-in Adjustment

1. On a level surface, roll the vehicle forward, then stop. Make sure the front wheels are pointed straight ahead. Do not turn the steering wheel again during this procedure.
2. On each front tire, mark (as closely as possible) the center of the tread face that is oriented toward the rear of the vehicle. The marks should be even with the bottom surfaces of the vehicle frame I-beams.
3. Measure the distance between the marks on the rear-facing surfaces of the tires, and then roll the vehicle **forward** one and one-half wheel revolutions until the marks appear on the forward facing surfaces of the tires at about the same height from the floor **(Figure 7-17, Page 7-14)**.

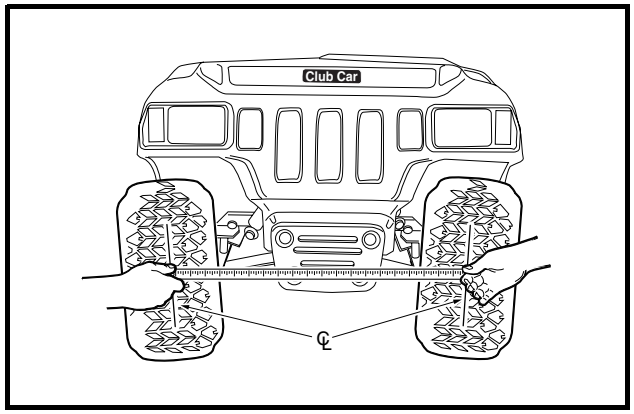


Figure 7-17 Check Toe-In

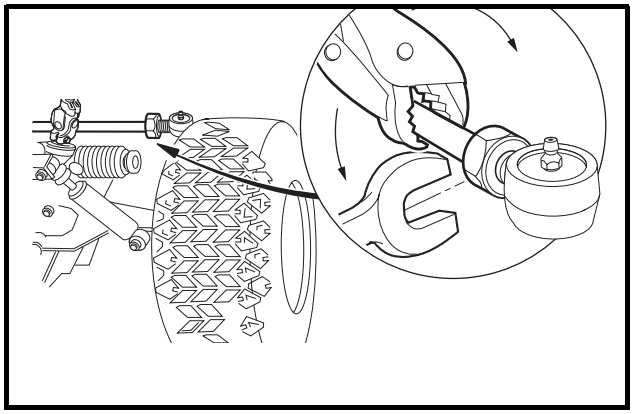


Figure 7-18 Adjust Toe-In

4. Measure the distance between the marks on the forward-facing surfaces of the tires **(Figure 7-17, Page 7-14)**. **See following NOTE.**

NOTE: *The front measurement must be less than the rear measurement.*

5. Subtract the measurement on the front of the tires from the measurement on the rear of the tires. The difference is the toe-in. Proper toe-in is 1/8 to 3/8 of an inch (3.2 to 9.5 mm).

6. If adjustment is necessary, loosen the jam nut on each tie rod ball joint and rotate the tie rod to increase or decrease toe-in **(Figure 7-18, Page 7-14)**. **See following CAUTION.**

CAUTION

- **The tie rod has right-hand threads on one end and left-hand threads on the other end. Right-hand threads are identified by a groove in the tie rod.**

7. Tighten nuts (loosened in step 6) to 21 ft-lb (28 N·m) and recheck toe-in.
8. After toe-in adjustment is made and with wheels in the straight ahead position, the steering wheel should be at the center of its travel. There should be equal travel to the left and right. **See following NOTE.**

NOTE: *If the minimum turning radius is not the same for both left and right turns, adjust the steering* ***(see Steering Adjustment on page 7-6)****.*

If the vehicle is equipped with the permanent towing or deluxe onboard towing option, adjust by loosening the ball joint hex nut on the tow assembly and rotating the steering arm to achieve 16 -1/2 inches (42 cm) from centerline of right front tire to the closest edge of the hole in towing lug.

FRONT SUSPENSION COMPONENTS

See General Warning, Section 1, Page 1-1.

TAPERED LEAF SPRING REMOVAL

1. Loosen lug nuts on both front wheels and raise front of vehicle with a chain hoist or floor jack. Place jack stands under the front cross tube of the vehicle frame and lower the vehicle onto the jack stands. **See General Warning, Section 1, Page 1-1.**
2. Remove both front wheels.
3. Remove the nuts (14) and bolts (25) from the bottom of each kingpin (26) **(Figure 7-20, Page 7-18)**.
4. Remove the four bolts (30), four nuts (36), four lock washers (37), and bottom spring plate (7).
5. Remove tapered leaf spring (6) and three spacer plates (1).
6. Check the condition of the urethane bushings (27) and steel bushings (28). Replace any that are worn or damaged.

TAPERED LEAF SPRING INSTALLATION

1. Install urethane bushings (27) and steel bushings (28) into leaf spring eyes **(Figure 7-20, Page 7-18)**.
2. Install spacer plates (1), tapered leaf spring (6), bottom spring plate (7), four bolts (30), four lock washers (37), and four nuts (36). Using a crisscross pattern sequence, tighten bolts to 23 ft-lb (31 N·m).
3. Install spring in kingpins (26) with bolts (25) and nuts (14). Tighten to 23 ft-lb (31 N·m).
4. Install the wheels and finger-tighten the lug nuts.
5. Lower the vehicle and finish tightening lug nuts (using a crisscross pattern) to 55 ft-lb (74.6 N·m).
6. Adjust camber and toe-in as instructed on page 7-13.

KINGPIN AND STEERING SPINDLE REMOVAL

1. Remove the front hub. **See Front Wheel Bearings and Hubs on page 7-19.**
2. Remove cotter pins (22) and nuts (20), then remove ball joints from the spindles **(Figure 7-19, Page 7-17).** Remove drag link ball joint. **See also Tie Rod and Drag Link Removal on page 7-12**.
3. Remove the nut (17) and lock washer (if present) from the top of the kingpin (26) **(Figure 7-20, Page 7-18)**.
4. Raise the upper clevis (16) from the kingpin **(Figure 7-20, Page 7-18)**.
5. Remove the thrust washer (19).
6. Slide the spindle (38) off the kingpin (26).
7. Remove the wave washer (20) and inspect it**.** If the washer is broken or has a wave bottom to wave crest height dimension of less than 0.040 inch (0.10 cm), it must be replaced.
8. Remove bolt (25) and nut (14) from bottom of kingpin (26) and remove kingpin.
9. Inspect the kingpin and spindle. If either is worn or damaged, it must be replaced.
10. Inspect the bushings (3 and 4). If the bushings are worn or damaged, remove them and press in new ones. **See following NOTE.**

NOTE: *If the bushings are replaced, ream new bushings to 0.750-0.752 (3/4 inch) (19.05-19.10 mm) in diameter. The reamer should be long enough to ream both bushings from one direction.*

KINGPIN AND STEERING SPINDLE INSTALLATION

1. Inspect all parts and replace them as necessary.
2. Install the kingpin (26) over the leaf spring eye. Insert the bolt (25) and install the nut (14) **(Figure 7-20, Page 7-18)**. Tighten the bolt to 23 ft-lb (31 N·m).
3. Install the wave washer (20) on the kingpin.
4. Slide the spindle (38) with bushings (3 and 4) over the kingpin (26).
5. Install the thrust washer (19), upper plate clevis (16), and nut (17). If lock washer was present, do not reinstall. Tighten the nut to 40 ft-lb (54.2 N·m) **(Figure 7-20, Page 7-18)**.
6. Attach the ball joints (6 and 13) to the spindle arm (23), install and tighten the nut (20), and install the cotter pin (22) **(Figure 7-19, Page 7-17)**.
7. Install the drag link ball joint. **See Tie Rod and Drag Link Installation on page 7-12.**
8. Install front hub and wheel. **See Front Hub Installation on page 7-20.**

DELTA A-PLATE REMOVAL

1. Loosen lug nuts on both front wheels and raise front of the vehicle with a chain hoist or floor jack. Place jack stands under the front cross tube of the vehicle frame and lower the vehicle onto the jack stands.
2. Remove wheel.
3. Remove bolts (10 and 24), A-Plate straps (14), and nuts (5) **(Figure 7-19, Page 7-17)**.
4. Remove the lower shock absorber mounting nut (9), then slide the shock absorber free of the Delta A-Plate.
5. Remove the Delta A-Plate (1).
6. Inspect the bushings (2) and sleeves (3 and 4) in the Delta A-Plate and replace them if necessary.

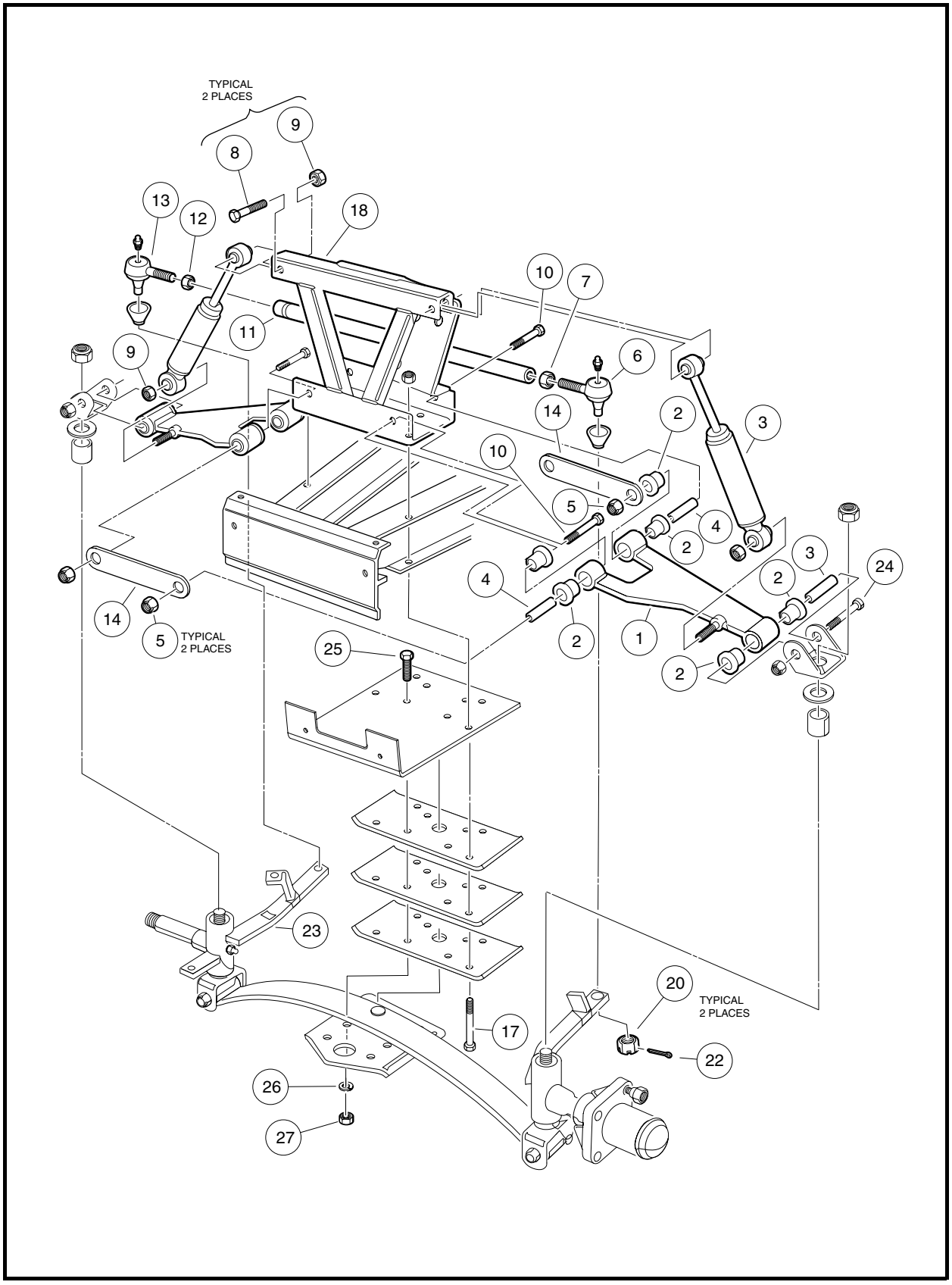


Figure 7-19 Upper Front Suspension Assembly

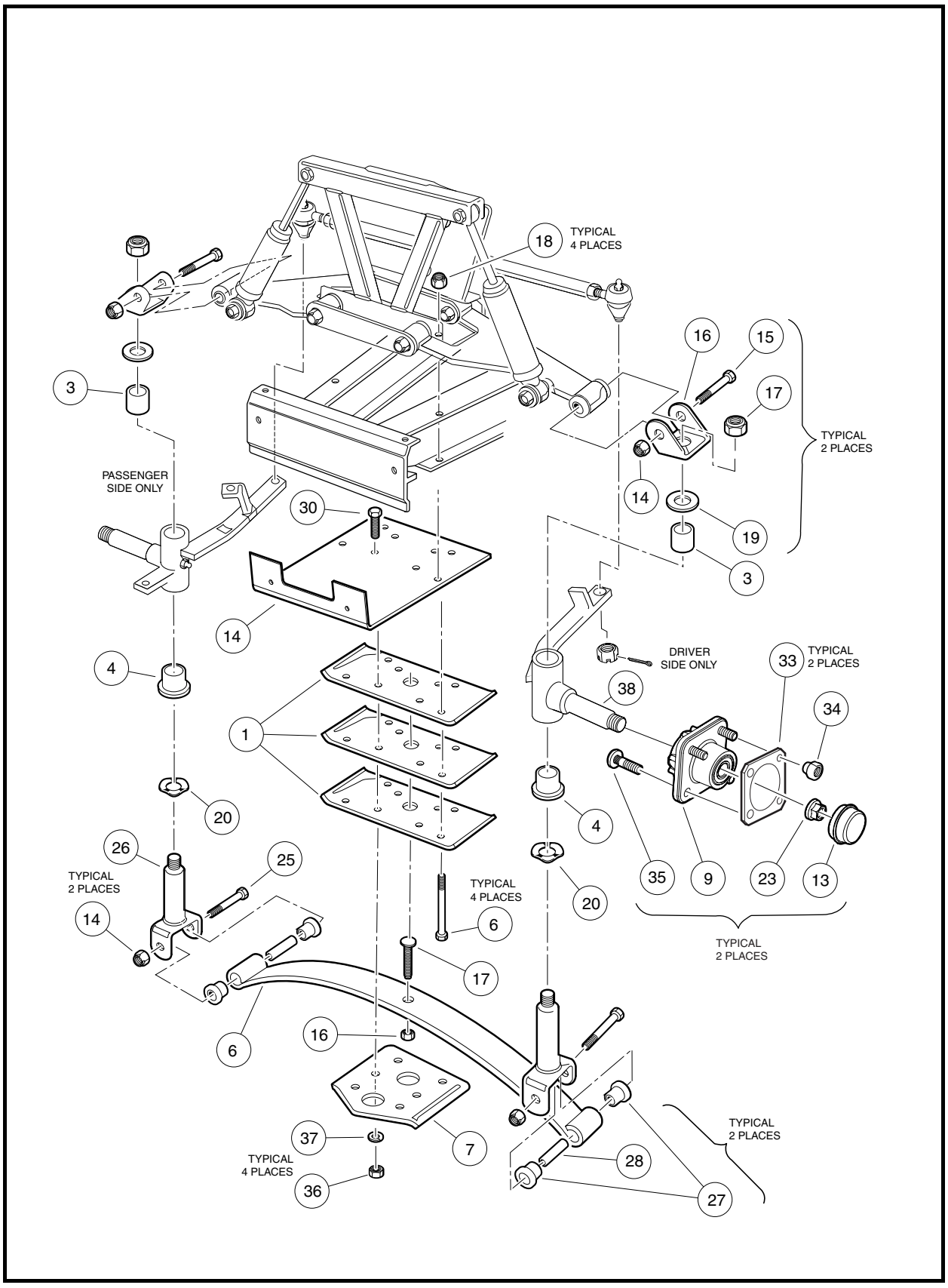


Figure 7-20 Lower Front Suspension Assembly

DELTA A-PLATE INSTALLATION

1. Install the A-Plate in reverse order of removal. Tighten the A-Plate suspension bolts (10 and 24) to 20 ft-lb (27 N·m) **(Figure 7-19, Page 7-17)**.
2. Tighten shock absorber mounting nut (9) to 20 ft-lb (27.1 N·m).
3. Install the wheels and adjust the wheel alignment as instructed on page 7-13.

SHOCK ABSORBER REMOVAL

1. Inspect the shock absorbers for fluid leakage at the point where the shaft enters the shock absorber body. Leaking shock absorbers should be replaced.
2. Remove the nut (9) attaching the shock absorber to the A-Plate **(Figure 7-19, Page 7-17)**.
3. Remove the nut (9) and bolt (8) attaching the shock absorber to the shock and gear support.
4. Remove the shock absorber.

SHOCK ABSORBER INSTALLATION

NOTE: *When installing shock absorbers, make sure front shocks have identical part numbers and rear shocks have identical part numbers.*

1. Install the shock absorber by reversing the removal procedure.
2. Tighten the nuts to 20 ft-lb (27 N·m).

FRONT WHEEL BEARINGS AND HUBS

See General Warning, Section 1, Page 1-1.

NOTE: *The hubs used on this vehicle contain sealed bearings that cannot be serviced or replaced. If the bearings are worn or damaged, the entire hub must be replaced.*

FRONT WHEEL FREE PLAY INSPECTION

1. Raise the front of the vehicle.
2. Use your hands to attempt to rock the wheel and hub assembly back and forth on the spindle. If there is any observable movement of the wheel and hub on the spindle, the hub bearing is worn and the hub assembly must be replaced. **See Front Hub Removal on page 7-19.**

FRONT HUB REMOVAL

1. Remove the front wheels. **See Wheel Removal, Section 8, Page 8-1.**
2. Remove dust cap (1) and lock nut (2) **(Figure 7-21, Page 7-20)**.
3. Slide the hub assembly (3) off of the spindle shaft (4).
4. Lightly sand spindle shaft to clean away any light rust.

5. Inspect the surface of the spindle shaft for surface damage. It should be clean and smooth. If severe pitting from rust or corrosion has occurred, replace the spindle assembly. **See Kingpin and Steering Spindle Removal on page 7-16.**

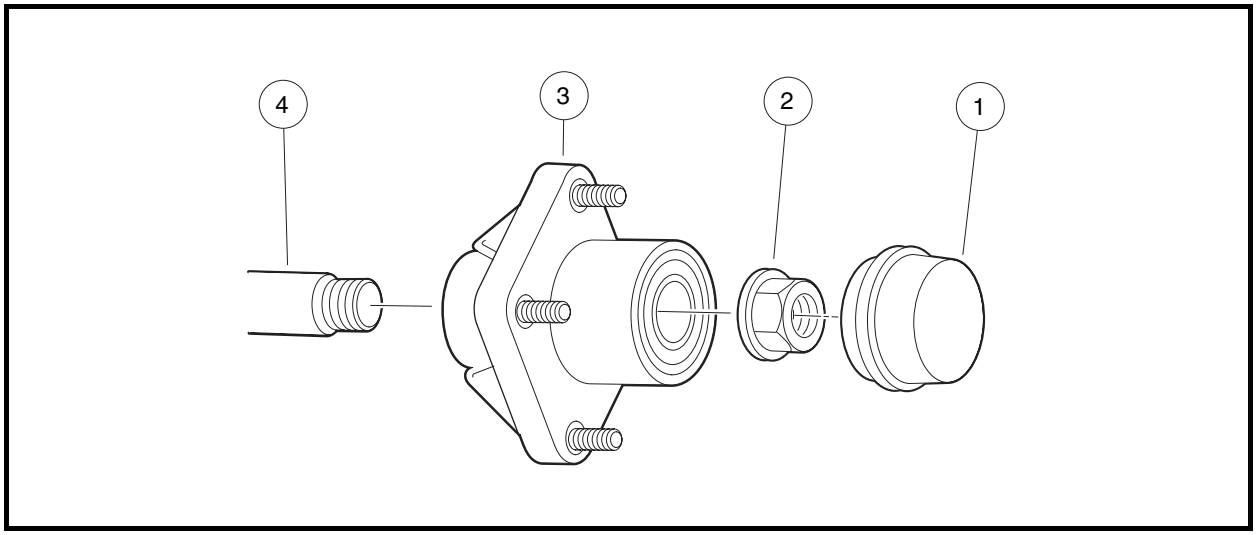


Figure 7-21 Front Wheel Hub

FRONT HUB INSTALLATION

1. Clean and apply a light coat of anti-seize lubricant to the spindle shaft.
2. Slide the hub assembly (3) onto the spindle shaft **(Figure 7-21, Page 7-20)**.
3. Install a new flanged lock nut and tighten to 36 ft-lb (50 N·m).
4. Rotate the hub. The hub should rotate smoothly without binding, side play, or any indication of rough spots during rotation.
5. Install the dust cap (1) using a rubber mallet and tapping lightly around the edge of the cap.
6. Repeat the procedure for the opposite wheel.
7. Install wheels and finger-tighten lug nuts.
8. Lower the vehicle and finish tightening lug nuts, using a crisscross pattern, to 55 ft-lb (74.6 N·m).

SECTION 8 – WHEELS AND TIRES

⚠ DANGER

- **See General Warning, Section 1, Page 1-1.**

⚠ WARNING

- **See General Warning, Section 1, Page 1-1.**

GENERAL INFORMATION

Maximum tire life and good vehicle handling qualities are directly related to proper wheel and tire care.

- Keep tires properly inflated. **See Section 2 – Vehicle Specifications.**
- Keep lug nuts properly tightened.
- Keep the front end aligned and adjusted.

WHEELS

See General Warning, Section 1, Page 1-1.

WHEEL REMOVAL

1. Slightly loosen the lug nuts on the wheel to be removed.
2. Raise the end of the vehicle from which the wheel is to be removed. Make sure that the wheels are off the ground. **See General Warning, Section 1, Page 1-1.**
3. Remove the lug nuts and remove the wheel.

WHEEL INSTALLATION

1. Install wheel(s), and use a crisscross pattern to tighten the lug nuts until they are snug.
2. Lower the vehicle and use a crisscross pattern to finish tightening lug nuts to 55 ft-lb (74.6 N·m).

TIRES

See General Warning, Section 1, Page 1-1.

TIRE REMOVAL

NOTE: *Tire must be removed or installed from the valve stem side of the rim.*

1. Remove the tire and wheel assembly from the vehicle as instructed above.
2. Remove the valve cap and valve core and allow air to escape from the tire.

Tire Removal, Continued:

3. If possible, use a tire machine to remove the tire from the rim.
   3.1. If a tire machine is not available, loosen both tire beads by applying pressure to the tire side walls and pushing the tire bead away from the rim flange and into the rim well **(Figure 8-1, Page 8-2, Detail A)**.
   3.2. With the valve stem side of the wheel up, use a tire tool to carefully start the upper bead over the edge of the wheel rim (**Figure 8-1, Page 8-2, Detail B)**. **See following CAUTION.**

CAUTION

- **To avoid damage to the tire, do not use excessive force when starting the bead over the edge of the rim.**

   3.3. When top bead is free of the rim, pull the bead from the bottom side of the rim up into the upper part of the rim well. Insert the tire tool under the lower bead as shown (**Figure 8-1, Page 8-2, Detail C)** and carefully pry the lower bead over the rim flange.
   3.4. Once the lower bead is started over the rim flange, the tire can be removed from the rim by hand.

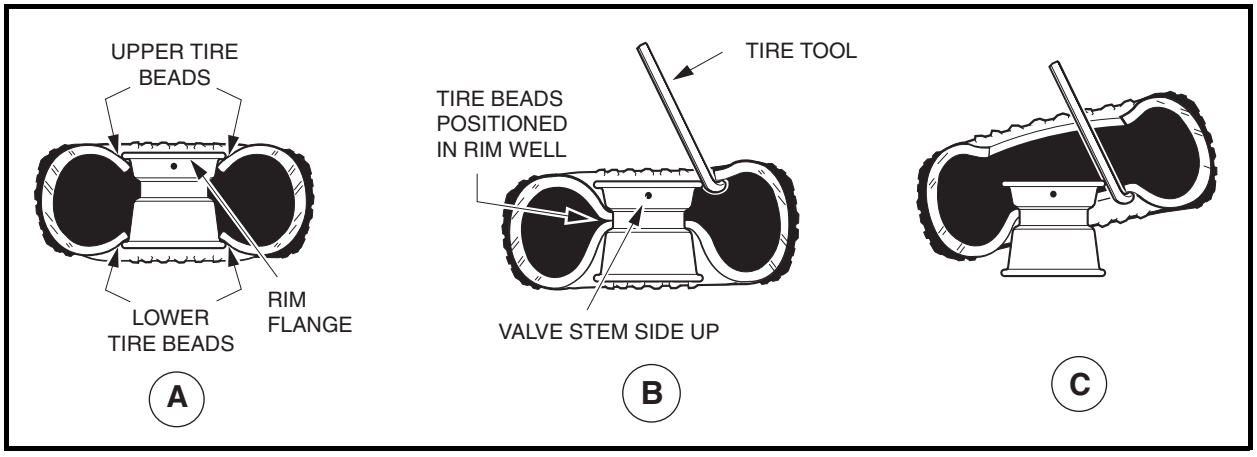


Figure 8-1 Tire Removal

TIRE REPAIR

1. Determine the location and cause of the air leak:
   1.1. Remove the wheel. **See Wheel Removal on page 8-1.** Inflate the tire to no more than 20 psi (1.38 Bars).
   1.2. Immerse the tire in water and then mark the point where bubbles are formed by escaping air.
   1.3. Determine the cause of the air leak. **See following NOTE.**

NOTE: *An air leak could be due to a punctured casing, faulty valve core, improperly seated valve stem, or improperly seated tire bead.*

Small holes in the casing can be plugged using a standard automotive tubeless tire repair kit available at auto supply stores.

2. When the cause of the air leak has been determined, remove tire from the rim and repair as required. **See Tire Removal on page 8-1.**

TIRE INSTALLATION

⚠ WARNING

- **While mounting or inflating tire, keep hands, fingers, etc. from exposed areas between the tire bead and rim.**

1. Clean both tire beads to remove dirt or other foreign matter.
2. Where the tire beads seat, clean the wheel rim with a wire brush. Wipe away any debris with a clean cloth. **See following NOTE.**

NOTE: *Because tubeless tires require a perfect seal in order to seat, keeping the tire and rim clean is very important.*

3. Apply a liberal amount of tire-mounting lubricant (soap and water solution) to both tire beads and rim flanges.
4. Install the tire on the rim from the valve stem side. If there is no tire machine available, use a rubber mallet and tire iron.
5. Remove the valve core, and position tire so that both beads are on the rim flange narrow bead seats.
6. Place tire and wheel assembly against wall in upright position and push it against wall while inflating tire to 30-35 psi (2.07-2.42 Bars). The three-point contact (wall, floor, and hand) will help ensure that beads snap into place and form a proper seal as tire is inflated **(Figure 8-2, Page 8-3)**. **See following WARNING.**

⚠ WARNING

- **Do not use a compressed air source with pressure over 100 psi (6.90 Bars). Due to low pressure requirements of a small tire, over-inflation could be reached almost instantly with a high pressure air supply. Over-inflation could cause tire to explode, possibly resulting in severe personal injury.**

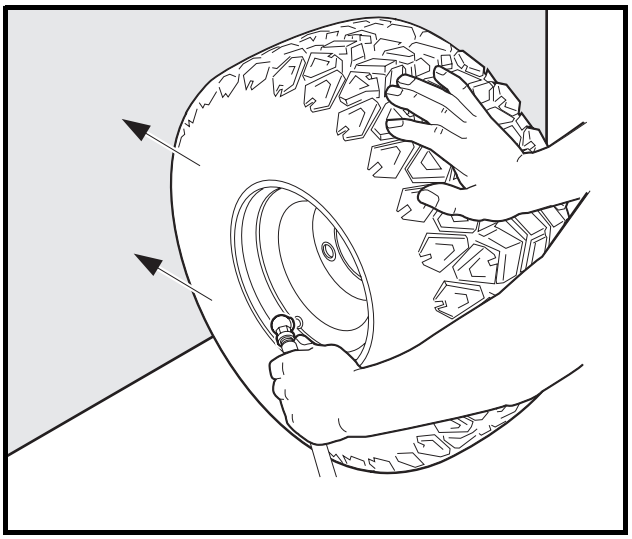


Figure 8-2 Inflate Tire

Tire Installation, Continued:

7. Quickly remove the air nozzle and install the valve core.
8. Adjust air pressure in tire to recommended pressure. **See Section 2 – Vehicle Specifications.**
9. Immerse the wheel and tire assembly in water to make sure there are no leaks.

SECTION 9 – REAR SUSPENSION

⚠ DANGER

- **See General Warning, Section 1, Page 1-1.**

⚠ WARNING

- **See General Warning, Section 1, Page 1-1.**

GENERAL INFORMATION

The rear suspension of this vehicle is completely independent. It consists of two leaf springs controlled by two shock absorbers mounted between the springs and the vehicle frame.

SHOCK ABSORBERS

See General Warning, Section 1, Page 1-1.

SHOCK ABSORBER REMOVAL AND INSPECTION

1. Check shock absorbers (7) for damage or fluid leakage at the point where the shaft enters the shock absorber body. Replace damaged or leaking shock absorbers **(Figure 9-1, Page 9-2)**.
2. To remove a shock absorber, remove the nut (5), cup washers (9) and rubber bushings (10) from the stem at the top of the shock absorber.
3. Remove the nut (5), cup washers (9), and rubber bushings (10) from lower mounting stem.
4. Compress the shock absorber to remove it.

SHOCK ABSORBER INSTALLATION

1. To install, reverse the removal procedure.
2. On the upper and lower shock absorber mounting stems, tighten the nuts until the rubber bushing expands to the size of the cup washer.

LEAF SPRINGS

See General Warning, Section 1, Page 1-1.

LEAF SPRING REMOVAL

1. Loosen, but do not remove, lug nuts on tire and wheel assembly on the side from which the spring is to be removed. Place chocks at the front wheels and lift the rear of the vehicle with a chain hoist or floor jack. Position jack stands under the frame crossmember between the spring mount and the side stringer, just forward of each rear wheel. Lower the vehicle to let the jack stands support the vehicle **(Figure 9-2, Page 9-3)**. **See following WARNING**.

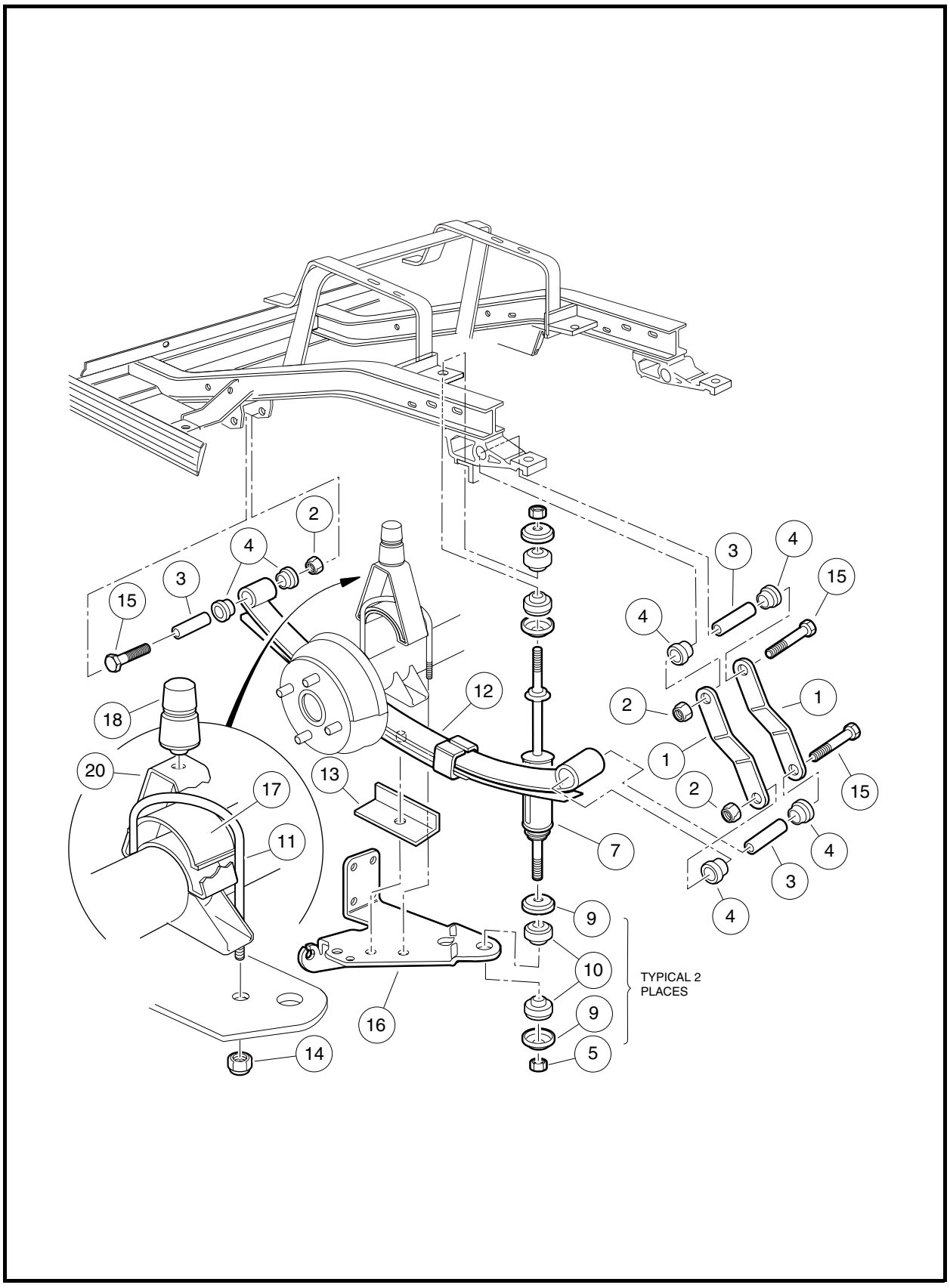


Figure 9-1 Rear Suspension Assembly and Mounting

Leaf Spring Removal, Continued:

⚠ WARNING

- **Lift only one end of the vehicle at a time. Use a suitable lifting device (chain hoist or hydraulic floor jack) with 1000 lb. (454 kg) minimum lifting capacity. Do not use lifting device to hold vehicle in raised position. Use approved jack stands of proper weight capacity to support the vehicle and chock the wheels that remain on the floor. When not performing a test or service procedure that requires movement of the wheels, lock the brakes.**

2. Place a floor jack under the transaxle differential casing to support (but not lift) the drivetrain. Raise it just enough to relieve tension on the shock absorbers without compressing them.
3. Remove the tire and wheel assembly on the side from which the spring is to be removed.
4. Remove the bow-tie pin (1) and the clevis pin (2) at the brake lever and brake cable connection and pull the clevis (3) away from the lever **(Figure 9-3, Page 9-3)**. Detach the brake cable from the shock mount bracket (16) **(Figure 9-1, Page 9-2).**
5. Remove the nut (5), cup washers (9), and rubber bushings (10) from the lower mounting stem of the shock absorber.
6. Remove the nuts (14) and the U-bolt (11) securing the spring to the jounce bumper bracket (11) and spacer (15) to the transaxle. Remove the shock mount bracket (16), angle bracket (13) and the U-bolt.
7. Remove the nut (2) and bolt (15) attaching the rear spring to the lower end of the shackle brackets (1).
8. Remove the nut (2) and bolt (15) attaching the front of the spring to the vehicle frame and remove the spring.
9. Inspect the bushings (4) and spacers (3) in the spring eyes and replace them if they are worn or damaged.

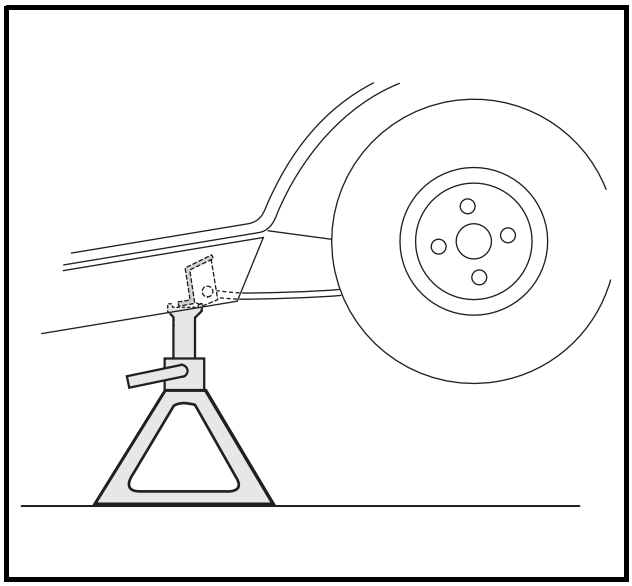


Figure 9-2 Support Vehicle on Jack Stands

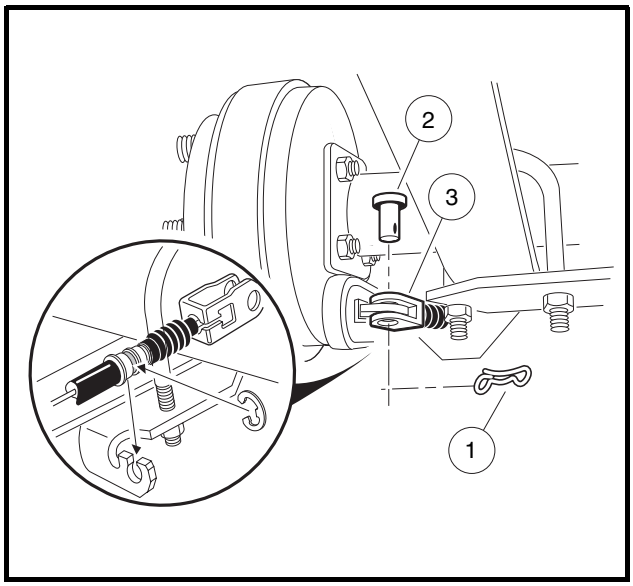


Figure 9-3 Disconnect Brake Cable

LEAF SPRING INSTALLATION

1. To install the springs, reverse the removal procedure. **See following CAUTION.**

CAUTION

- **When positioning the spring on the transaxle, be sure to insert the locating bolt on the spring in the locating hole in the transaxle saddle.**

2. Tighten the nuts on the U-bolts to 25 ft-lb (34 N·m).
3. Tighten nylon lock nuts (2) on spring mounting bolts (15) to 15 ft-lb (20.3 N·m) **(Figure 9-1, Page 9-2)**.
4. Tighten the nuts until the rubber bushing expands to the size of the cup washer.

SECTION 10 – PERIODIC MAINTENANCE

GENERAL INFORMATION

See General Warning on page 1-1.

To ensure trouble-free vehicle performance, it is very important to follow an established preventive maintenance program (regularly scheduled service). Regular and consistent vehicle maintenance can prevent vehicle down-time and expensive repairs that result from neglect. Any vehicle not functioning correctly should be removed from use until it is properly repaired. This will prevent further damage to the vehicle and avoid the possibility of injury due to unsafe conditions.

Contact your local authorized distributor/dealer to perform all repairs and semiannual and annual periodic service.

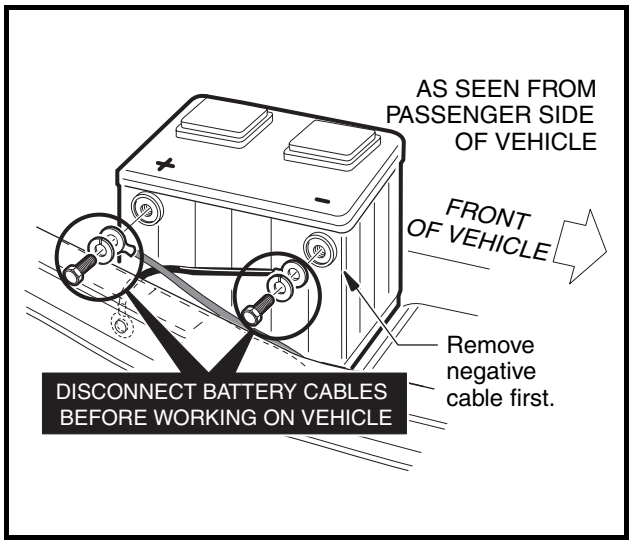


Figure 10-1 Battery Cable Removal

PERIODIC SERVICE SCHEDULES

See General Warning, Section 1, Page 1-1.

⚠ WARNING

- **Service, repairs, and adjustments must be made per instructions in the maintenance and service manual.**

NOTE: *If the vehicle is constantly subjected to heavy use or severe operating conditions, the preventive maintenance procedure should be performed more often than recommended in the periodic service and lubrication schedules.*

Both the Periodic Service Schedule and Periodic Lubrication Schedule must be followed to keep vehicle in optimum operating condition.

PERIODIC SERVICE SCHEDULE – ELECTRIC VEHICLES

REGULAR INTERVAL	SERVICE	
Daily service by owner	Batteries	Charge batteries (after each use only).
Weekly service by owner	Batteries	Check electrolyte level. Add water if necessary. **See page 20-3.**
Monthly service by owner or trained technician	Batteries	Wash battery tops and clean terminals with baking soda/water solution.
	Tires	Check air pressure and adjust if necessary. **See Section 2 – Vehicle Specifications.**
	General vehicle	Wash battery compartment and underside of vehicle.
Semiannual service by trained technician only (or every 50 hours of operation, whichever comes first)	Brake system	Check brake shoes; replace if necessary. **See Brake Shoe Removal, Section 6, Page 6-1.**
		Lubricate brake slides per Lubrication Schedule. **See Brake Assembly Cleaning, Section 6, Page 6-5.**
		Check brake cables for damage; replace if necessary.
	Electrical wiring and connections	Check for tightness and damage.
	Forward/Reverse switch	Check condition of contacts and wire connections. Make sure connections are tight.
Semiannual service by trained technician only (or every 50 hours of operation, whichever comes first) continued	Front wheel alignment and camber	Check and adjust as required. **See Front Wheel Free Play Inspection, Section 7, Page 7-19.**
Annual service by trained technician only (or every 100 hours of operation, whichever comes first)	Motor controller output regulator (MCOR)	Check for loose hardware, cracks and other damage.
	Batteries	If batteries are not performing as expected, see **See Section 20 – Batteries: Electric VEhicles.**.

PERIODIC SERVICE SCHEDULE – GASOLINE VEHICLES

REGULAR INTERVAL	SERVICE	
Monthly service by owner or trained technician	Engine	Check engine oil level; change if necessary. **See Periodic Lubrication Schedules on page 10-4.**
		Check engine cooling air intake; clean if necessary. Visually inspect the unshrouded area around engine exhaust for grass and debris, and clean if necessary.
	Tires	Check air pressure and adjust as necessary. **See Section 2 – Vehicle Specifications.**
	General vehicle	Wash engine compartment and underside of vehicle. Do not wash engine when hot.
Semiannual service by trained technician only (or every 50 hours of operation, whichever comes first)	Battery	Clean terminals and wash dirt from casing; check electrolyte level. **See Battery – Gasoline Vehicles on page 10-9.**
	Front wheel alignment and camber	Check and adjust if necessary. **See Front Wheel Free Play Inspection, Section 7, Page 7-19.**
	Electrical wiring and connections	Check for tightness and damage.
	Brake system	Check brake shoes; replace if necessary.
		Lubricate brake slides. **See Periodic Lubrication Schedules on page 10-4.**
		Check brake cables for damage; replace if necessary.
Annual service by trained technician only (or every 100 hours of operation, whichever comes first)	Engine	Check for leaks around gaskets, fill plugs, etc.
		Inspect, clean and regap spark plug; replace if necessary.
	Engine air intake system	Check air filter element; clean or replace if necessary.
		Check clamps for tightness; check hose for cracks.
	General vehicle	Check for loose hardware and tighten if necessary.
Two year service by trained technician only (or every 200 hours of operation, whichever comes first)	Fuel filters	Replace. Dispose of used filters properly.

⚠ WARNING

- **If any problems are found during scheduled inspection or service, do not operate the vehicle until repairs are made. Failure to make necessary repairs could result in fire, property damage, severe personal injury, or death.**

PERIODIC LUBRICATION SCHEDULES

PERIODIC LUBRICATION SCHEDULE – ELECTRIC VEHICLES

REGULAR INTERVAL	SERVICE	LUBRICATION POINTS	RECOMMENDED LUBRICANT
Semiannually by owner or trained technician (or every 50 hours of operation, whichever comes first)	Brake pedal shaft bearings	1	Dry Moly Lube (CCI P/N 1012151)
	Brake linkage and pivots	2	Dry Moly Lube (CCI P/N 1012151)
	Accelerator pivot rod supports	3	Dry Moly Lube (CCI P/N 1012151)
	Charger receptacle	4	WD-40
	Brake slides	5	Dry Moly Lube (CCI P/N 1012151)
	Front suspension (5 fittings)	6	Chassis Lube – EP NLGI Grade 2
Annually by trained technician only (or every 100 hours of operation, whichever comes first)	Check/fill transaxle to plug level	7	22 oz. (0.67 L) SAE 30 WT. API Class SE, SF, or SG Oil (or higher)

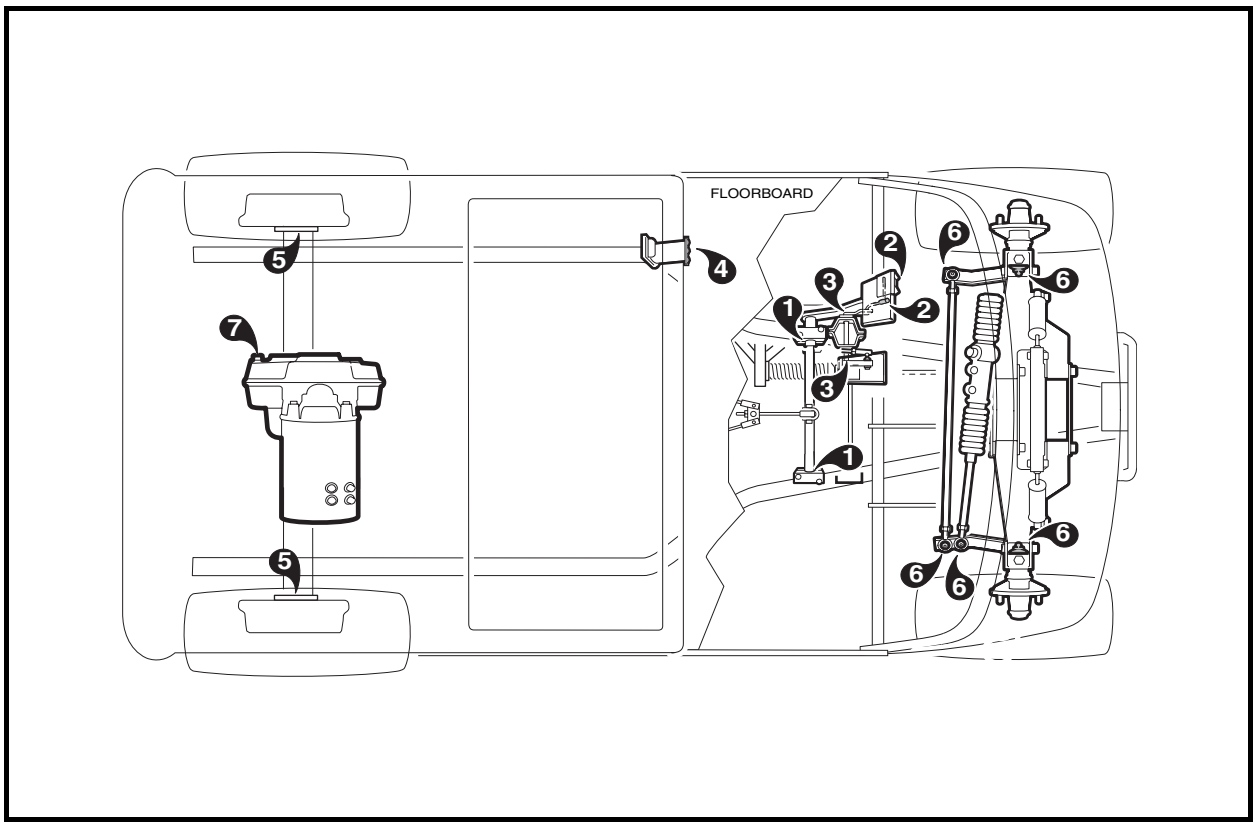


Figure 10-2 Lubrication Points – Electric Vehicles

PERIODIC LUBRICATION SCHEDULE – GASOLINE VEHICLES

REGULAR INTERVAL	SERVICE	LUBRICATION POINTS	RECOMMENDED LUBRICANT
Semiannually by owner or trained technician (or every 50 hours of operation, whichever comes first)	Brake pedal shaft bearings	1	Dry Moly Lube (CCI P/N 1012151)
	Brake linkage and pivots	2	Dry Moly Lube (CCI P/N 1012151)
	Accelerator push rod pivots, mounts, and shifter cable pivots	3	Dry Moly Lube (CCI P/N 1012151)
	Front suspension (5 fittings)	4	Chassis Lube (EP NLGI Grade 2)
	Brake slides	5	Dry Moly Lube (CCI P/N 1012151)
Annually by trained technician only (or every 100 hours of operation, whichever comes first)	Check/fill unitized transaxle to plug level	6	27 oz. (0.8 L) 80-90 WT. API Class GL-3 or 80-90 WT. AGMA Class EP Gear Lube
First change 100 hours – additional change every 200 hours of operation, or annually, whichever comes first.	Change engine oil and oil filter	7	22 oz. (0.67 L) without filter; 38 oz. (1.12 L) with filter

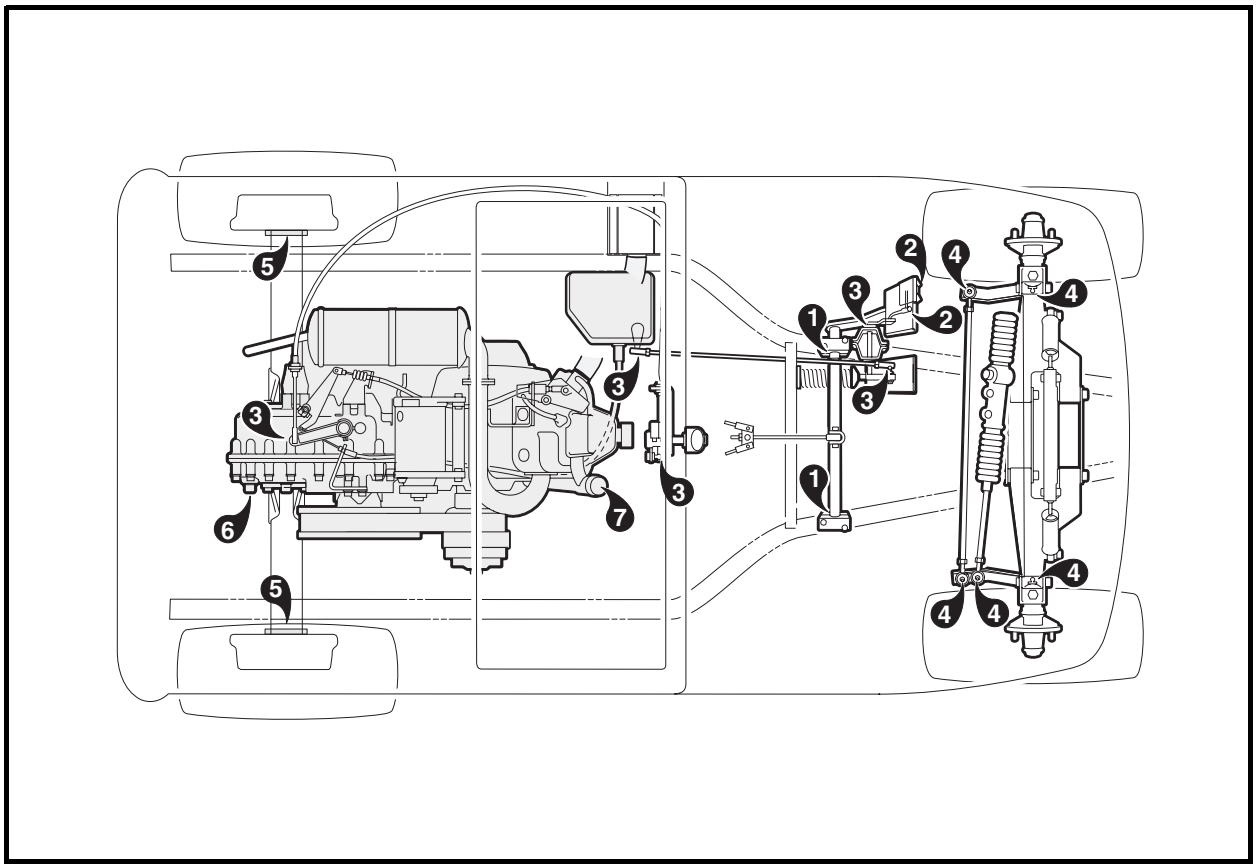


Figure 10-3 Lubrication Points – Gasoline Vehicles

BATTERIES – ELECTRIC VEHICLES

See General Warning, Section 1, Page 1-1.

⚠ DANGER

- **Battery – Explosive gases! Do not smoke. Keep sparks and flames away from the vehicle and service area. Ventilate when charging or operating vehicle in an enclosed area. Wear a full face shield and rubber gloves when working on or near batteries..**
- **Charge batteries in a well-ventilated area only. Batteries emit hydrogen while being charged. Hydrogen is an explosive gas and must never exceed a level of 2% of the air.**
- **Battery – Poison! Contains acid! Causes severe burns. Avoid contact with skin, eyes, or clothing. Antidotes:**
  - **External: Flush with water. Call a physician immediately.**
  - **Internal: Drink large quantities of milk or water followed with milk of magnesia or vegetable oil. Call a physician immediately.**
  - **Eyes: Flush with water for 15 minutes. Call a physician immediately.**

⚠ WARNING

- **Wear safety glasses or approved eye protection when servicing the vehicle. Wear a full face shield and rubber gloves when working on or near batteries.**
- **Use insulated tools when working near batteries or electrical connections. Use extreme caution to avoid shorting of components or wiring.**

CAUTION

- **On all electric vehicles, turn off all accessories before charging batteries.**

NOTE: *Recycle or dispose of discarded batteries in accordance with local, state, and federal regulations.*

The batteries in electric vehicles are 12-volt, deep-cycle batteries, specially built for electric vehicle application. Automotive batteries should never be used.

New batteries will not deliver their full capabilities until they have been discharged and recharged 20 to 50 times. To obtain the maximum service life from new batteries, restrict vehicles with new batteries to one hour of operation between charges for the first two months vehicle is in service. Batteries should be fully charged before first use of new vehicle, before first use of a vehicle after storage, and before use each day.

BATTERY CARE

See Battery Care, Section 20, Page 20-2.

BATTERY CHARGER – ELECTRIC VEHICLES

See Battery Charger, Section 20, Page 20-4.

CHARGING BATTERIES

⚠ WARNING

- **Be sure all wire connections at the receptacle and the fuse link are clean and tight.**
- **Do not rock or bend the plug. To connect the charger plug to the vehicle receptacle, grasp the plug handle and push the plug straight into the receptacle (Figure 10-4, Page 8).**
- **Do not pull on the DC cord (Figure 10-5, Page 10-8). Do not twist, rock or bend the plug. To disconnect the charger plug from the vehicle receptacle, grasp the plug by the handle and pull the plug straight out of the receptacle.**
- **Do not connect a charger to the receptacle if the charger cord, plug, or the vehicle receptacle is broken, damaged in any manner, or does not make a good electrical connection. Fire or personal injury can result. Have it replaced by a qualified service person immediately.**
- **Failure to follow these instructions could result in damage to the charger cord, the plug, and (or) the vehicle receptacle.**
- **Do not use a charger if:**
  - **The plug is too loose or does not make a good connection.**
  - **The plug and receptacle feel hotter than normal during charge.**
  - **The plug pins or receptacle contacts are bent or corroded.**
  - **The plug, receptacle, or cords are cut, worn, have any exposed wires or are damaged in any way.**
- **Using the charger with any of the above symptoms could result in a fire, property damage, personal injury, or death.**

NOTE: *When temperatures fall below 65 °F (18.3 °C), batteries charged in unheated areas should be placed on charge as soon as possible after use. Batteries are warmest immediately after use, and cold batteries require more time to fully charge.*

Insert the charger DC plug into the vehicle receptacle. The charger will turn on two to ten seconds later **(Figure 10-4)**.

When inserting the DC plug, align the raised guide on the plug with the guide slot in the receptacle and push straight in slowly.

Club Car battery chargers interact with the vehicle onboard computer. The computer records the amount of energy consumed during vehicle use. While the charger is plugged in, the vehicle's control circuit is locked out, preventing operation of the vehicle as well as the possibility of consequent damage to the charger and the vehicle.

Once the lockout is actuated, the charger turns on. The onboard computer then records the amount of energy being returned to the batteries. When the optimum amount of energy needed to replenish the batteries is returned, the charger will shut off. The control circuit lockout remains activated until the charger plug is disconnected from the vehicle.

Charging Batteries, Continued:

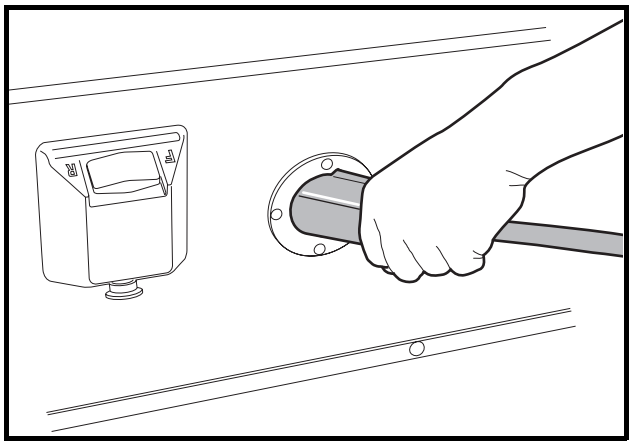


Figure 10-4 Correct Insertion of Charger DC Plug

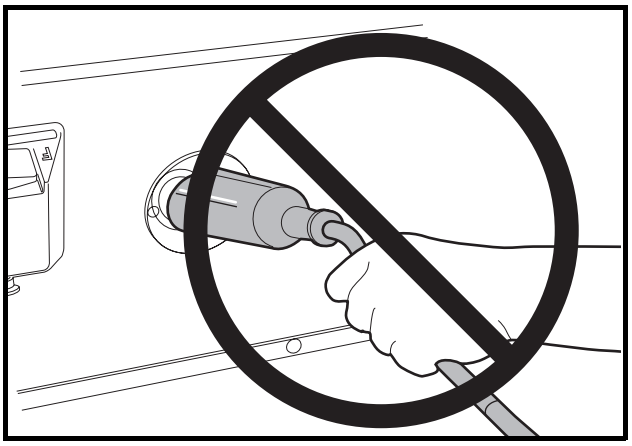


Figure 10-5 Incorrect Insertion of Charger DC Plug

Club Car electric vehicles are supplied with a PowerDrive 2 battery charger (CCI P/N 101802204). Use PowerDrive 2 chargers with this electric vehicle.

As long as the PowerDrive 2 is allowed to shut off by itself, the batteries will be fully charged. Overcharging and undercharging will normally be prevented.

Batteries should be put on charge even if they have been used for only a short period (10 minutes). The PowerDrive 2 charger is automatic and will turn off when batteries are fully charged. If the charger does not seem to be operating properly, or if the batteries seem weak, contact your local Club Car distributor/dealer.

PLUG AND RECEPTACLE

The charger cord, plug, and receptacle are wear items and should be inspected daily. Visually inspect them for cracks, loose connections, and frayed wiring; they must be replaced when worn or damaged. If charger plug or receptacle show signs of corrosion or the plug is difficult to insert or remove, the receptacle contacts and plug terminals should be cleaned with a good electrical contact cleaner or lightly sprayed with WD-40® brand spray lubricant. The plug should then be inserted and removed several times to ensure ease of insertion, ease of removal, and good electrical contact. **See following NOTE.**

NOTE: *If the warning tag has been damaged or removed from the DC cord, have it replaced immediately.*

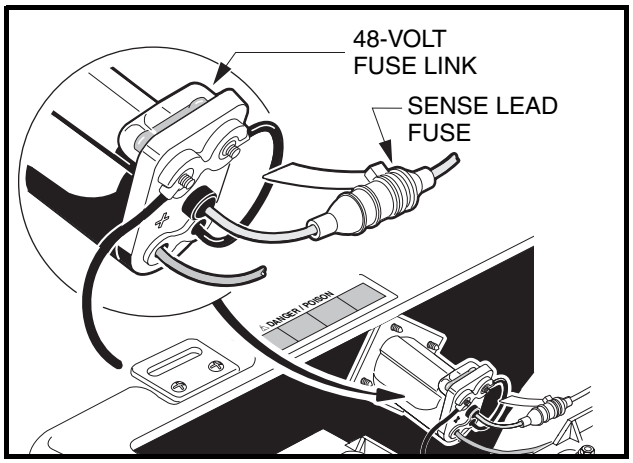


Figure 10-6 Receptacle Fuse Link

RECEPTACLE FUSE LINK

As an additional feature to protect the batteries and charging circuit from an overload, the electric vehicle is equipped with a receptacle fuse link **(Figure 10-6, Page 10-8)**. If the charger does not come on when the vehicle is placed on charge, visually inspect the fuse link. **See following WARNING.**

⚠ WARNING

- **If the receptacle fuse link is blown, determine the source of the electrical problem and correct it before replacing the fuse. Contact your nearest Club Car distributor/dealer.**

BATTERY – GASOLINE VEHICLES

See General Warning, Section 1, Page 1-1.

⚠ DANGER

- **Battery – Explosive gases! Do not smoke. Keep sparks and flames away from the vehicle and service area. Ventilate when charging or operating vehicle in an enclosed area. Wear a full face shield and rubber gloves when working on or near batteries.**
- **Tools, wires, and metal objects can cause sparks when shorted across a battery.**
- **Follow all instructions carefully when working with batteries.**
- **Charge battery in a well-ventilated area only.**
- **Battery – Poison! Contains acid! Causes severe burns. Avoid contact with skin, eyes, or clothing. Antidotes:**
  - **External: Flush with water. Call a physician immediately.**
  - **Internal: Drink large quantities of milk or water followed with milk of magnesia or vegetable oil. Call a physician immediately.**
  - **Eyes: Flush with water for 15 minutes. Call a physician immediately.**

⚠ WARNING

- **Do not jump start a dead battery using another battery and jumper cables.**

The battery in the Club Car gasoline vehicle is a 12-volt, low maintenance battery that requires infrequent watering **(Figure 10-7)**.

Any corrosion around the positive (+) or negative (–) terminals should be washed off with a solution of baking soda and water (1 cup (237 mL) per gallon (3.8 L) of water). Rinse solution off the battery. Do not allow this solution to enter battery. Be sure terminals are tight (battery terminals should be tightened to 12 ft-lb (16 N·m)). Let the terminals dry and then spray them with Battery Terminal Protector Spray (CCI P/N 1014305). **See preceding WARNING and following CAUTION.**

⚠ CAUTION

- **If battery wire terminals are damaged or corroded, they should be replaced or cleaned as necessary. Failure to do so may cause them to overheat during operation.**

Battery – Gasoline Vehicles, Continued:

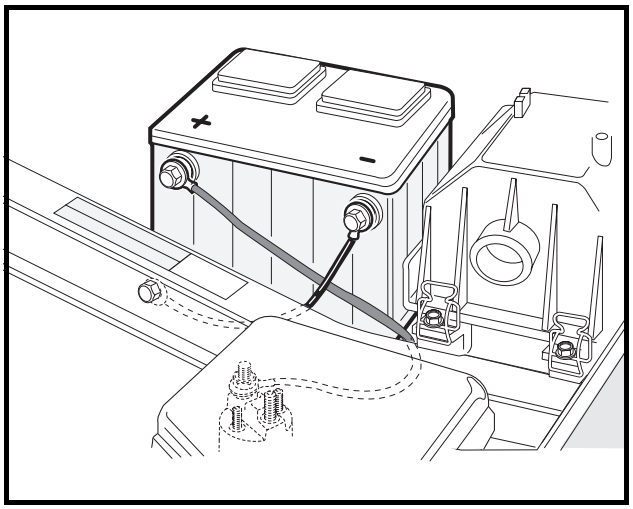


Figure 10-7 Battery – Gasoline Vehicle

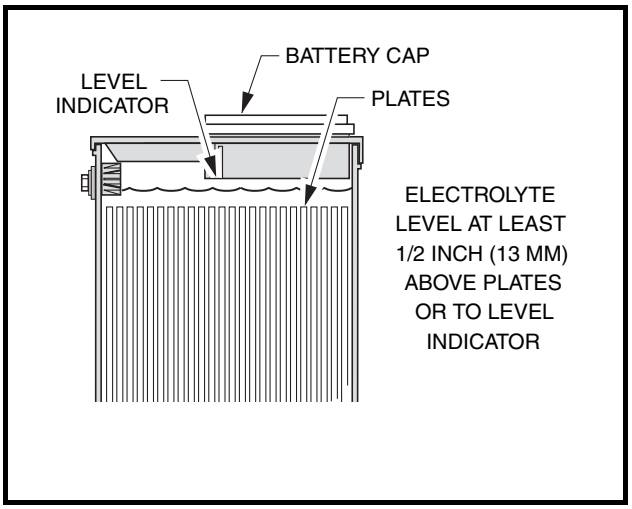


Figure 10-8 Gasoline Battery Electrolyte Level

Be sure battery clamp is properly tightened. Tighten to 12 ft-lb (16 N·m). A loose battery clamp may allow the battery to become damaged from vibration or jarring.

If battery appears weak, have it charged by a trained technician. The battery should never be left discharged any longer than absolutely necessary (do not leave discharged overnight).

ENGINE OIL – GASOLINE VEHICLES

See General Warning, Section 1, Page 1-1.

Even though the low oil warning light on the dash should illuminate if oil level becomes low, engine oil level should be checked monthly. Vehicle should be on a level surface when checking oil. Do not overfill with oil.

ENGINE OIL LEVEL CHECK

1. Remove the oil level dipstick from the oil filler tube and wipe oil from dipstick **(Figure 10-9, Page 10-11)**. **See following CAUTION.**

⚠ CAUTION

- **Do not remove dipstick while engine is running.**

2. Check oil by fully inserting the dipstick into the oil filler tube and immediately removing it.
3. If the oil level is at or below the low level mark on the dipstick gauge, add oil until the level is between low and full levels (safe level).
4. Reinsert dipstick into the oil filler tube. **See following NOTE.**

NOTE: *Properly recycle or dispose of used oil in accordance with local, state, and federal regulations.*

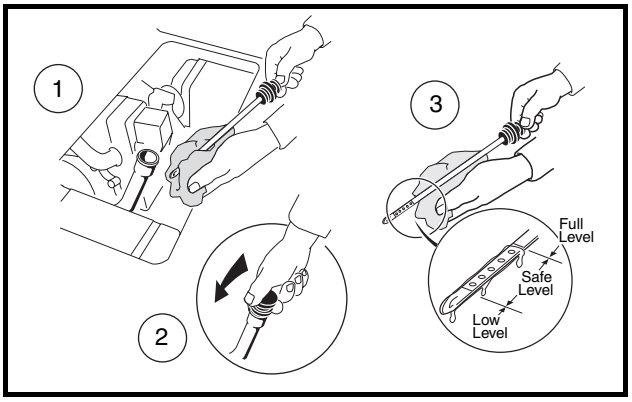


Figure 10-9 Engine Oil Level Check

ENGINE OIL AND FILTER CHANGE

Engine oil and oil filter should be changed after the first 100 hours of operation. After that, they should be changed every 200 hours of operation or annually, whichever comes first.

1. Turn the key switch to the OFF position, then remove the key. Place the Forward/Reverse handle in the neutral POSITION. Chock the front wheels.
2. Access the engine compartment. **See following WARNING.**

⚠ WARNING

- **For vehicles with cargo beds, remove all cargo before raising the bed or servicing the vehicle. If the vehicle is equipped with a prop rod, ensure that it is securely engaged while bed is raised. Do not close the bed until all persons are clear of cargo bed area. Keep hands clear of all crush areas. Do not drop cargo bed; lower gently and keep entire body clear. Failure to heed this warning could result in severe personal injury or death.**

3. Disconnect the battery cables, negative (–) cable first. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-2.**
4. Position a pan designed for oil changes under the front drain plug **(Figure 10-10, Page 10-12)**.
5. Use a 14 mm socket or box end (do not use an open end) wrench to remove the drain plug, turning it counterclockwise, and allow the engine oil to drain into the pan. **See following WARNING.**

⚠ WARNING

- **Do not attempt to change engine oil when the engine is hot or even warm. Engine oil can cause skin burns.**
- **Wear safety glasses or approved eye protection when servicing the vehicle. Wear rubber gloves when handling oil drain plug, oil filter, and oil drain pan.**

6. Clean the oil drain plug threads with solvent to remove oil and oil residue. Make sure that the compression washer remains on the drain plug.
7. Use a 14 mm socket or box end (do not use an open end) wrench and replace the front oil drain plug, turning it clockwise, and tighten to 18 ft-lb (24.4 N·m).

Engine Oil And Filter Change, Continued:

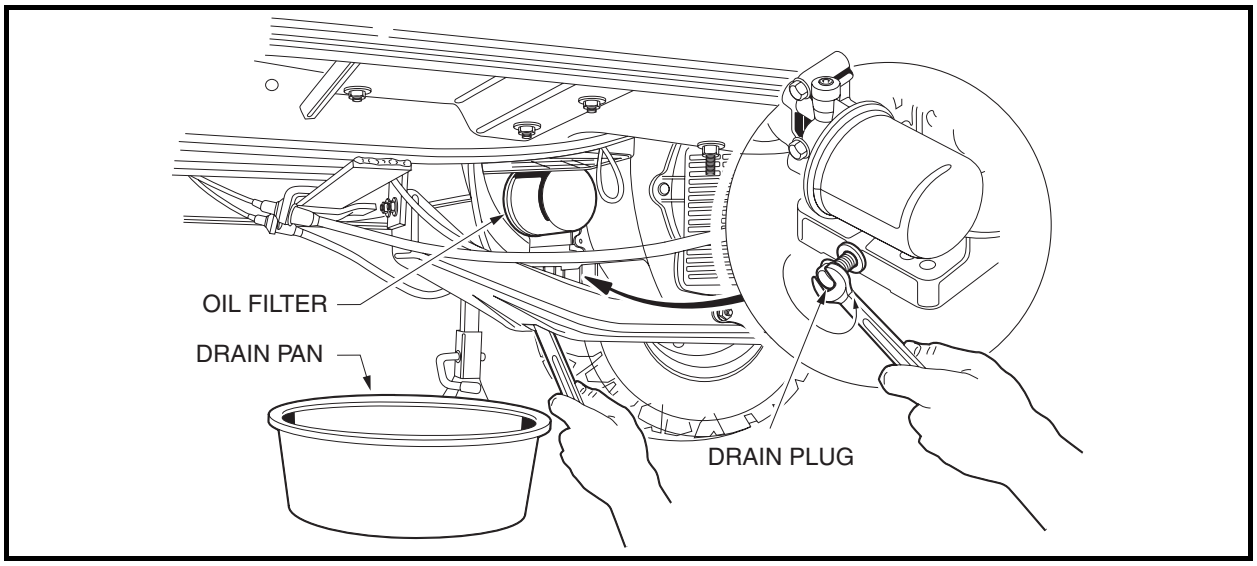


Figure 10-10 Engine Oil Drain Plug and Pan

8. Relocate the oil drain pan to a position under the engine oil filter **(Figure 10-10, Page 10-12)**.
9. Remove the engine oil filter, turning it counterclockwise, allowing the residual oil in the filter port and filter to drain into the oil drain pan **(Figure 10-11, Page 10-13)**. **See following NOTE.**

NOTE: *An oil drip guard can be used to prevent excess oil from dripping into the engine base place. Use an empty quart (one litter) container and but the bottom off at an angle, then slide the open area of the container up and under the oil filter prior to removing. Position the port of the plastic container so oil will be directed into the oil pan **(Figure 10-10, Page 10-12)**. Or, make a drip guard by folding a piece of cardboard, thin metal, or plastic under the oil filter forming a channel to direct the filter port oil into the drain pan.*

Dispose of used oil according to the environmental laws and regulations for your area.

10. Use a clean rag and wipe the oil filter mounting bracket surface clean where the oil filter gasket seats.
11. Install a new oil filter (CCI P/N 1016467) onto the engine oil filter port. Apply a light coat of white lithium NLGI Number 2 grease (Dow Corning® BR2-Plus or equivalent) or new engine oil to the rubber seal around the outside surface of the filter before attaching it to the oil filter port **(Figure 10-12, Page 10-13)**. This will help seal the filter to the oil mounting bracket.

NOTE: *Use only Club Car oil filters (CCI P/N 1016467) designed for this engine.*

12. Tighten the oil filter by hand until tight. Do not use a band wrench or channel lock pliers to tighten.
13. Remove the dipstick and add engine oil into the dipstick port. Use a funnel or pour spout to direct the oil into the dipstick port. With filter change, the engine requires 38 ounces (1.12 liters) of oil per change. Refer to oil viscosity guidelines for selection of oil grade **(Figure 10-13, Page 10-13)**. Replace the dipstick.
14. Connect the battery cables, positive (+) cable first, and tighten terminals to 12 ft-lb (16 N·m). Coat terminals with Battery Terminal Protector Spray (CCI P/N 1014305).

15. Lower the cargo bed. **See WARNING "For vehicles with cargo beds..." in General Warning, Section 1, Page 1-2.**
16. With the Forward/Reverse handle in the NEUTRAL position, start and run the engine for a few minutes. Observe both the drain plug and the oil filter from under the vehicle and watch for oil leaks. If leaks appear, begin with step 1 and repeat the appropriate step for either or both items to correct the problem.
17. Remove the dip stick and check the engine oil as a final step. Replace the dip stick.

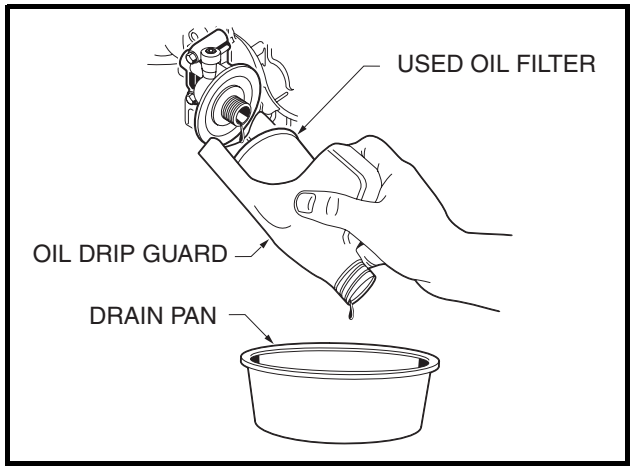


Figure 10-11 Remove Engine Oil Filter

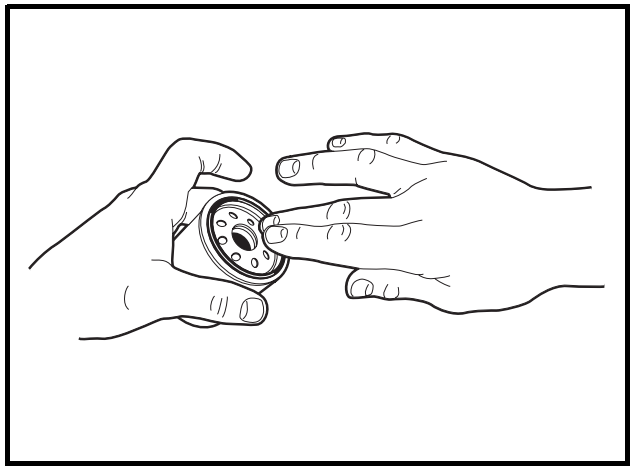


Figure 10-12 Coat Oil Filter Rubber Seal

OIL VISCOSITY

Choose the viscosity according to the temperature as indicated by the oil viscosity chart **(Figure 10-13, Page 10-13)**. **See following NOTE.**

NOTE: *Using multi-grade oils (5W-20, 10W-30, and 10W-40) will increase oil consumption. Check oil level more frequently when using them.*

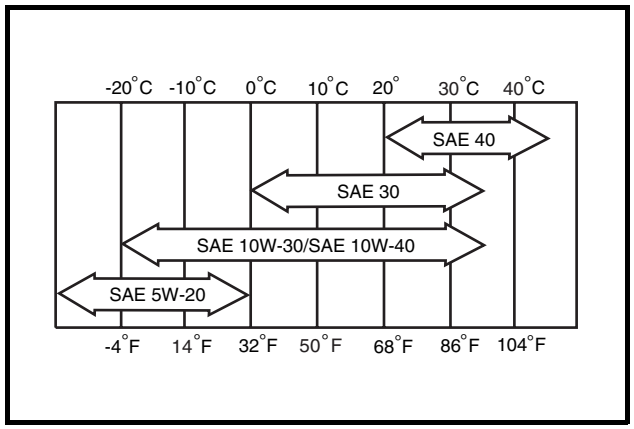


Figure 10-13 Oil Viscosity Chart

FUELING INSTRUCTIONS – GASOLINE VEHICLES

See General Warning, Section 1, Page 1-1.

⚠ DANGER

- **Turn the key switch to the OFF position before fueling.**
- **Do not pour gasoline into the fuel tank when the engine is hot or while it is running.**
- **To avoid electric arc caused by static electricity, the fuel storage/pumping device must be grounded. If the pump is not grounded, the vehicle must be grounded to the pump before and during the fueling operation.**
- **If the vehicle has an all-weather enclosure installed, be sure the fuel tank is properly vented as shown (Figure 10-14, Page 10-14).**
- **To avoid the possibility of fire, clean up any spilled gasoline before operating the vehicle.**

⚠ CAUTION

- **To allow for expansion, do not fill higher than one inch from the top of the fuel tank. Avoid fuel spillage.**

NOTE: *Whenever possible, avoid using oxygenated fuels and fuels that are blended with alcohol. Vehicles to be stored for extended periods should be prepared for storage as instructed.* ***See Preparing the Gasoline Vehicle for Extended Off-Season Storage, Section 3, Page 3-2.***

1. Turn the key switch to the OFF position.
2. Lift and remove seat bottom.
3. The fuel tank is located on passenger side of vehicle. Remove fuel cap and fill the fuel tank with fresh unleaded gasoline only. **See preceding CAUTION.**
4. Replace fuel cap on tank. Ensure cap is tightened securely.
5. Replace seat bottom.

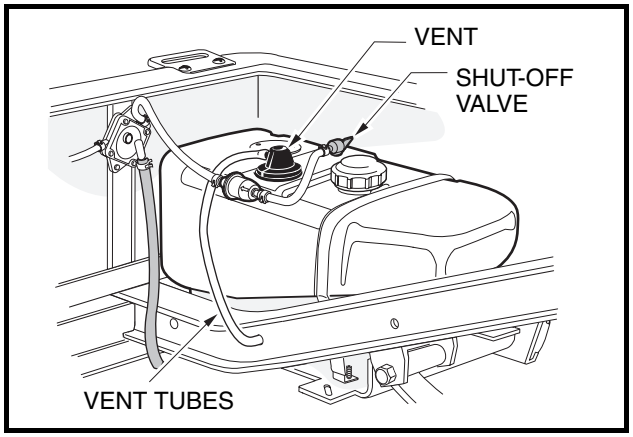


Figure 10-14 Fuel Tank

SECTION 11 – TROUBLESHOOTING AND ELECTRICAL SYSTEM: GASOLINE VEHICLE

⚠ DANGER

- **See General Warning, Section 1, Page 1-1.**

⚠ WARNING

- **See General Warning, Section 1, Page 1-1.**

TROUBLESHOOTING GUIDE

The following troubleshooting guide will be helpful in identifying operating difficulties should they occur. The guide includes the symptom, probable cause(s) and suggested checks. The procedures used in making these checks can be found in the referenced sections of this maintenance and service manual.

TROUBLESHOOTING GUIDE

SYMPTOM	POSSIBLE CAUSES	REFER TO
Engine does not start easily.	Spark plug is partially fouled or in poor condition	Section 13 – FE290 And FE350 Engines
	Spark plug wire is damaged or loose	Section 13 – FE290 And FE350 Engines
	Loose wire connection at ignition coil or RPM limiter	Section 11 – Troubleshooting and Electrical System: Gasoline Vehicle, Test Procedures 14, 15, and 16
	Intermittent ignition coil failure	Section 11 – Troubleshooting and Electrical System: Gasoline Vehicle, Test Procedures 14, 15, and 16
	Low cylinder compression	Section 13 – FE290 And FE350 Engines
	Water or dirt in the fuel system and/or carburetor; dirty or clogged fuel filter	Section 14 – Fuel System: Gasoline Vehicle
	Carburetor improperly adjusted	Section 14 – Fuel System: Gasoline Vehicle
	Starter/generator belt is slipping	Section 12 – Electrical Components: Gasoline Vehicles Belt Tension Adjustment on page 12-10
Engine starts but does not run smoothly.	Spark plug is fouled or in poor condition	Section 13 – FE290 And FE350 Engines
	Spark plug wire is damaged or loose	Section 13 – FE290 And FE350 Engines
	Intermittent ignition coil failure	Section 11 – Troubleshooting and Electrical System: Gasoline Vehicle, Test Procedures 14, 15, and 16
	Water or dirt in the fuel system and/or carburetor; dirty or clogged fuel filter	Section 14 – Fuel System: Gasoline Vehicle
	Fuel pump malfunction; fuel pressure to carburetor too low	Section 14 – Fuel System: Gasoline Vehicle

Troubleshooting Guide continued on next page...

TROUBLESHOOTING GUIDE

SYMPTOM	POSSIBLE CAUSES	REFER TO
Engine turns but fails to start.	Fuel tank is empty	Section 14 – Fuel System: Gasoline Vehicle
	Fuel line or filters clogged	Section 14 – Fuel System: Gasoline Vehicle
	Fouled spark plug	Section 13 – FE290 And FE350 Engines
	Spark plug wire damaged or loose	Section 13 – FE290 And FE350 Engines
	Loose wire connection at ignition coil or RPM limiter	Section 11 – Troubleshooting and Electrical System: Gasoline Vehicle, Test Procedures 14, 15, and 16
	Engine flooded with fuel as result of excess choking	See Owner's Manual, Controls and Indicators. See Choke.
	Fuel pump malfunction or failure	Section 14 – Fuel System: Gasoline Vehicle
	Ignition coil or RPM limiter failed	Section 11 – Troubleshooting and Electrical System: Gasoline Vehicle, Test Procedures 14, 15, and 16
	Kill circuit grounded	Section 11 – Troubleshooting and Electrical System: Gasoline Vehicle, Test Procedures 14, 15, and 16
Engine overheats.	Fan screen is partially blocked or plugged	See the Engines and Transaxles manual (CCI P/N 102396501)
	Governor is improperly adjusted	Section 14 – Fuel System: Gasoline Vehicle
	Carburetor is too lean; check main jet size	Section 14 – Fuel System: Gasoline Vehicle
Engine pre-ignites.	Excessive carbon deposits on piston head or in combustion chamber	See the Engines and Transaxles manual (CCI P/N 102396501)
	Spark plug heat range is incorrect	Section 13 – FE290 And FE350 Engines
	Unsuitable or contaminated fuel	Section 14 – Fuel System: Gasoline Vehicle
Loss of engine power.	Exhaust valve is restricted with carbon deposit	See the Engines and Transaxles manual (CCI P/N 102396501)
	Muffler or exhaust pipe restricted with carbon or other substance	Section 15 – Exhaust System: Gasoline Vehicles
	Ignition coil failed	Section 11 – Troubleshooting and Electrical System: Gasoline Vehicle, Test Procedures 14, 15, and 16
	Air filter is dirty or clogged	Section 14 – Fuel System: Gasoline Vehicle
	Governor is improperly adjusted	Section 14 – Fuel System: Gasoline Vehicle
	Throttle linkage out of adjustment	Section 14 – Fuel System: Gasoline Vehicle
	Low cylinder compression	Section 13 – FE290 And FE350 Engines
	Spark plug failed	Section 13 – FE290 And FE350 Engines
	Restricted fuel flow	Section 14 – Fuel System: Gasoline Vehicle
	Torque converter is not backshifting properly	Section 17 – Torque Converter: gasoline Vehicle

Troubleshooting Guide continued on next page...

TROUBLESHOOTING GUIDE

SYMPTOM	POSSIBLE CAUSES	REFER TO
Spark plug fouls repeatedly.	Incorrect plug	Section 13 – FE290 And FE350 Engines
	Unsuitable fuel, or incorrect (rich) fuel mixture	Section 13 – FE290 And FE350 Engines
	Spark plug wire is damaged	Section 13 – FE290 And FE350 Engines
	Dirt entering combustion chamber	Section 14 – Fuel System: Gasoline Vehicle
	Ignition coil failed	Section 11 – Troubleshooting and Electrical System: Gasoline Vehicle, Test Procedures 14, 15, and 16
	Rings are heavily worn, low cylinder pressure	See the Engines and Transaxles manual (CCI P/N 102396501)
Carburetor floods.	Inlet valve or seat is leaking, dirty, worn, or damaged	Section 14 – Fuel System: Gasoline Vehicle
	Float is damaged and filled with gasoline	Section 14 – Fuel System: Gasoline Vehicle
	Carburetor vent is clogged	Section 14 – Fuel System: Gasoline Vehicle
	Float needle valve not functioning properly	Section 14 – Fuel System: Gasoline Vehicle
Starter fails to operate.	Lockout cam is in the wrong position	Section 11 – Troubleshooting and Electrical System: Gasoline Vehicle, Lockout Cam on page 11-5
	Fuse is blown	Section 11 – Troubleshooting and Electrical System: Gasoline Vehicle, Test Procedure 2
	Battery is dead	Section 11 – Troubleshooting and Electrical System: Gasoline Vehicle, Test Procedure 1
	Starter control circuit is not operating	Section 11 – Troubleshooting and Electrical System: Gasoline Vehicle, Test Procedure 8
	Starter/generator failed	Section 11 – Troubleshooting and Electrical System: Gasoline Vehicle, Test Procedure 8
	Starter solenoid failed	Section 11 – Troubleshooting and Electrical System: Gasoline Vehicle, Test Procedure 6
	Key switch failed	Section 11 – Troubleshooting and Electrical System: Gasoline Vehicle, Test Procedure 4
	Lockout limit switch failed	Section 11 – Troubleshooting and Electrical System: Gasoline Vehicle, Test Procedure 7
	Loose or broken wire in starter/generator circuit	Starter/Generator on page 12-1
	Cylinder and/or crankcase flooded with fuel	Section 14 – Fuel System: Gasoline Vehicle

Troubleshooting Guide continued on next page...

TROUBLESHOOTING GUIDE

SYMPTOM	POSSIBLE CAUSES	REFER TO
Starter/Generator does not charge battery.	Diode failed (open condition)	Section 11 – Troubleshooting and Electrical System: Gasoline Vehicle, Test Procedure 10
	Loose or broken wire in the starter/ generator circuit	Section 11 – Troubleshooting and Electrical System: Gasoline Vehicle, Test Procedure 11
	Generator field coil is shorted	Section 11 – Troubleshooting and Electrical System: Gasoline Vehicle, Test Procedure 11
	Brushes are worn or commutator is dirty	Starter/Generator on page 12-1
	Starter/generator belt is loose or slipping	Belt Tension Adjustment on page 12-10
	Voltage regulator failed	Section 11 – Troubleshooting and Electrical System: Gasoline Vehicle, Test Procedure 12
	Battery failed	Section 11 – Troubleshooting and Electrical System: Gasoline Vehicle, Test Procedure 1
Transmission does not engage or disengage smoothly.	Transmission shifter linkage is binding or is out of adjustment	Forward/Reverse Shifter Cable Adjustment on page 16-20
	Idle RPM Setting is set too high	Section 14 – Fuel System: Gasoline Vehicle
	Insufficient (low) level of lubricant or wrong type of lubricant in transmission	Lubrication on page 16-2
	Internal gears are damaged or worn	See the Engines and Transaxles manual (CCI P/N 102396501)
	Synchronizer rings are worn, damaged or jammed	See the Engines and Transaxles manual (CCI P/N 102396501)
Excessive vehicle vibration.	Engine mounting nuts or bolts are loose	Section 13 – FE290 And FE350 Engines
	Snubber on frame is worn or damaged	Section 13 – FE290 And FE350 Engines
	Misaligned muffler mounting clamp	Section 15 – Exhaust System: Gasoline Vehicles
	Damaged drive belt or starter belt	Section 17 – Torque Converter: gasoline Vehicle
	Damaged drive clutch	Section 17 – Torque Converter: gasoline Vehicle
	Damaged driven clutch	Section 17 – Torque Converter: gasoline Vehicle
	Damaged starter/generator pulley	Starter/Generator Removal on page 12-1
	RPM setting is incorrect	Engine RPM Adjustment on page 14-11
Torque converter does not shift smoothly.	Drive belt is worn, cracked, glazed, or frayed	Drive Belt on page 17-2
	Drive clutch malfunction	Driven Clutch Inspection on page 17-13
	Driven clutch malfunction	Driven Clutch Inspection on page 17-13
	Governor is sticking	See the Engines and Transaxles manual (CCI P/N 102396501)
Troubleshooting Guide continued on next page...		

TROUBLESHOOTING GUIDE

SYMPTOM	POSSIBLE CAUSES	REFER TO
Engine won't stop running.	Kill circuit wire is disconnected from the ignition coil	Section 11 – Troubleshooting and Electrical System: Gasoline Vehicle, Test Procedure 13
	Key switch failure	Section 11 – Troubleshooting and Electrical System: Gasoline Vehicle, Test Procedures 4 and 17
	Carburetor is too lean; check main and pilot jet sizes	Section 14 – Fuel System: Gasoline Vehicle
	Carburetor throttle stop screw out of adjustment	Section 14 – Fuel System: Gasoline Vehicle

ELECTRICAL SYSTEM

The electrical system on the gasoline key-start vehicles is 12 volts DC with negative ground to frame. It consists of ten circuits that are easily identified:

- Starter Circuit
- Engine Ignition Circuit
- Reverse Buzzer Circuit
- Lockout Cam Circuit
- Hour Meter Circuit
- Generator Circuit
- Engine Kill Circuit
- Low Oil Warning Circuit
- Fuel Gauge and Sending Unit Circuit
- Lighting Circuit

A key-start vehicle uses the ignition key to activate the electrical system and start the engine. It allows the engine to run at idle or advanced RPM using the accelerator pedal when the Forward/Reverse handle is in the NEUTRAL position. **See Section 13 – FE290 And FE350 Engines.**

LOCKOUT CAM

This key-start vehicle is equipped with a lockout cam that allows the engine to be started and revved only when the Forward/Reverse handle is in the NEUTRAL position. The lockout cam (yellow) is located on the back of the Forward/Reverse handle, inside the engine compartment.

NOTE: *Be sure the cam is in the correct position. The cam should activate the limit switch only when the Forward/Reverse handle is in the NEUTRAL position* ***(Figure 11-1, Page 11-5)****.*

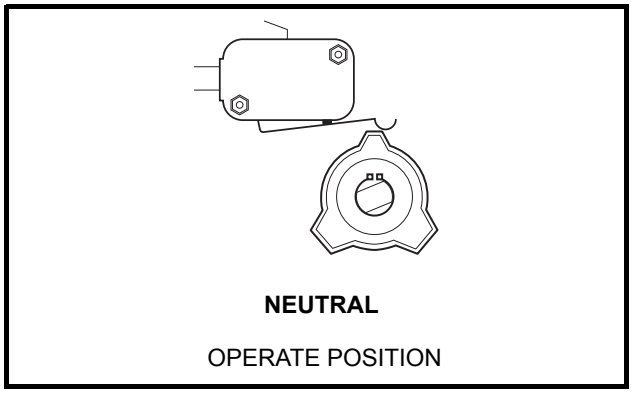


Figure 11-1 Correct Position for Lockout Cam

WIRING DIAGRAMS

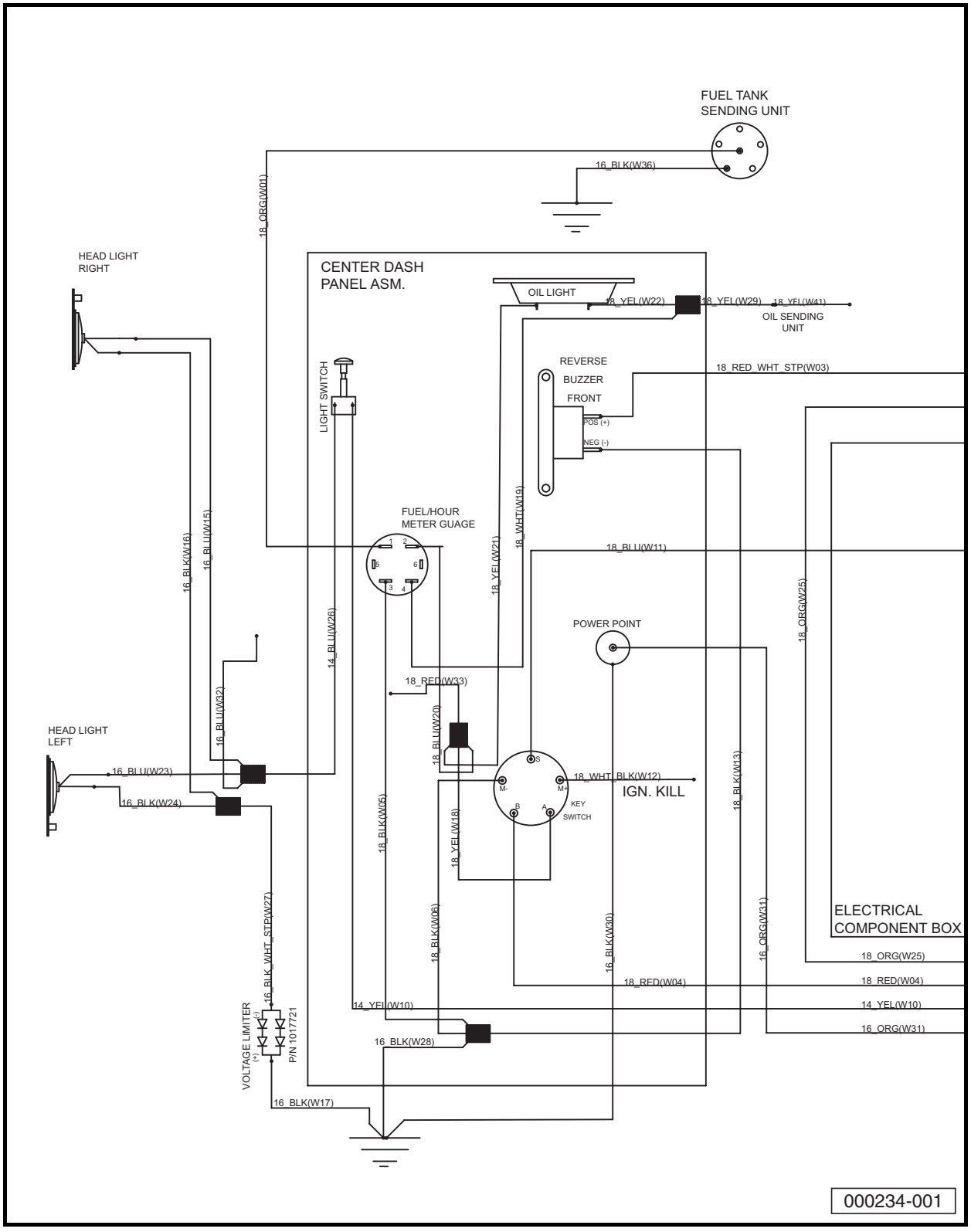


Figure 11-2 Wiring Diagram for Key-Start Gasoline Vehicles

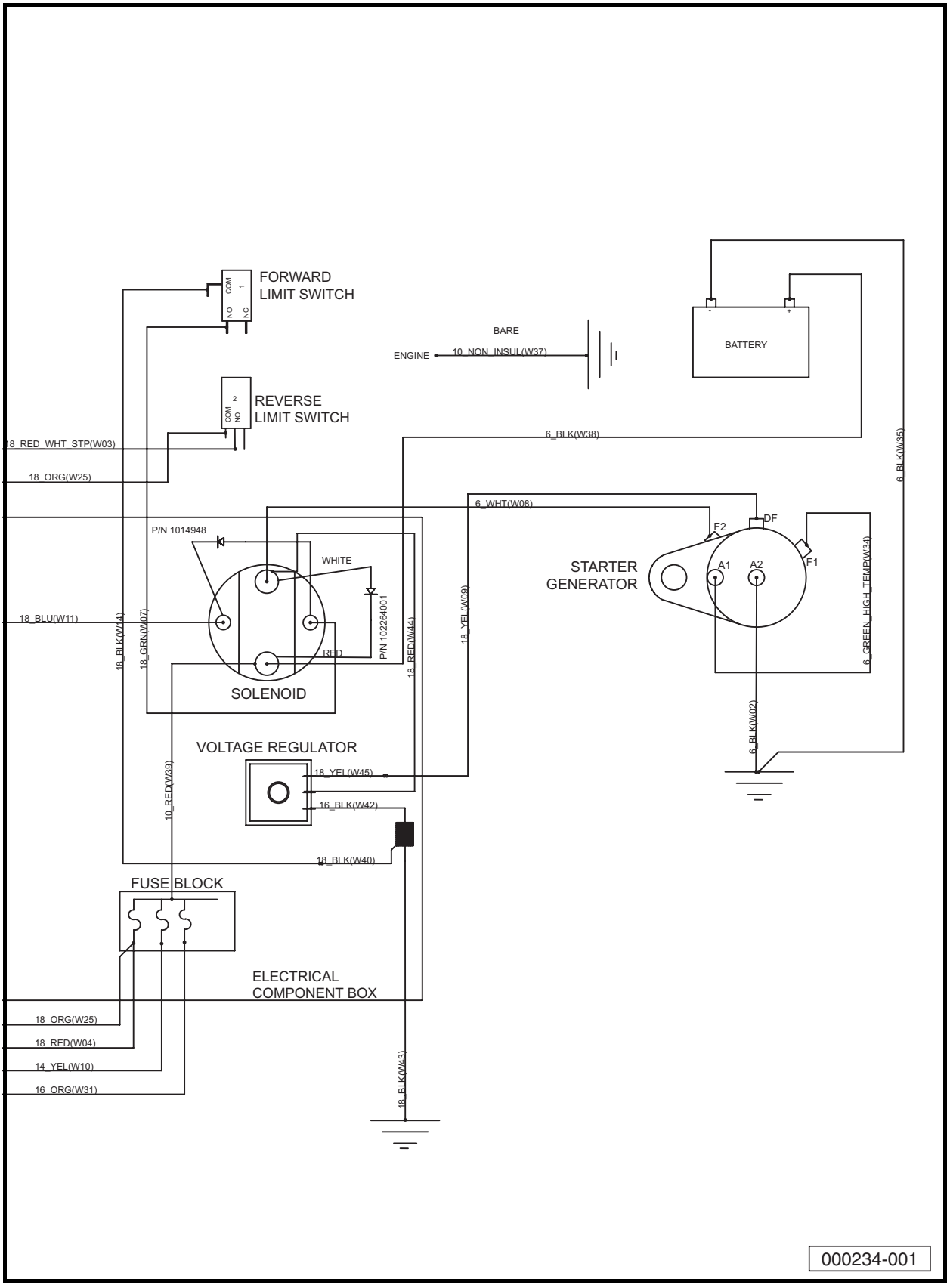


Figure 11-3 Wiring Diagram for Key-Start Gasoline Vehicles

CIRCUIT TESTING

See General Warning, Section 1, Page 1-1.

Test the vehicle battery to determine whether or not it is the source of the problem before testing the electrical circuits. A hydrometer, multimeter and 160-ampere load tester will be required. **See Test Procedure 1 – Battery on page 11-9.**

TEST PROCEDURES

INDEX OF TEST PROCEDURES

TEST PROCEDURE 1 – BATTERY

See General Warning, Section 1, Page 1-1.

⚠ DANGER

- **Due to the danger of an exploding battery, wear a full face shield and rubber gloves when working around a battery.**
- **Battery – Explosive gases! Do not smoke. Keep sparks and flames away from the vehicle and service area. Ventilate when charging or using in an enclosed space. Wear a full face shield and rubber gloves when working on or near batteries. For added protection, cover top of the battery when servicing the vehicle.**
- **Battery – Poison! Contains acid! Causes severe burns! Avoid contact with skin, eyes, or clothing.**
  - **External: Flush with water. Call a physician immediately.**
  - **Internal: Drink large quantities of milk or water. Follow with milk of magnesia or vegetable oil. Call a physician immediately.**
  - **Eyes: Flush with water for 15 minutes. Call a physician immediately.**

NOTE: *The battery must be properly maintained and fully charged in order to perform the following test procedures. Battery maintenance procedures, including watering information and allowable mineral content, can be found in Section 12 of this manual.* ***See Battery, Section 12, Page 12-29.***

1. Turn the key switch OFF and remove the key. Place the Forward/Reverse handle in the NEUTRAL position. Chock the wheels.
2. Check for loose or corroded battery terminal connections. Clean, tighten and replace connections as necessary.

Hydrometer Test

A hydrometer (CCI P/N 1011478) measures the specific gravity. The higher the specific gravity, the higher the state of charge of the battery. A fully charged battery should read between 1.250 and 1.280 at 80 °F (27 °C). Never add acid to the battery to obtain a higher specific gravity **(Figure 11-4, Page 11-10)**. **See following CAUTION.**

CAUTION

- **Do not allow battery acid from battery caps or hydrometer to drip onto the body. Battery acid will cause permanent damage. Wash off immediately.**

Performing the Hydrometer Test

1. Be sure that the battery has sufficient water to cover the plates by approximately 1/2-inch (13 mm) and is fully charged prior to beginning the test. If water must be added, recharge the battery before performing the hydrometer test **(Figure 11-5, Page 11-10)**.
2. Remove the vent cap.
3. Using a battery thermometer (CCI P/N 1011767), record the electrolyte temperature of a center cell.
4. Squeeze the rubber bulb of the hydrometer and insert into the cell. Slowly release the bulb, drawing electrolyte up into the glass tube of the hydrometer.
5. When the float rises off the bottom, adjust the electrolyte level so that the float rides free of the bottom but does not strike the bottom of the rubber bulb. Remove the hydrometer from the cell and release the pressure from the bulb.
6. Hold the hydrometer vertically, ensuring that the float is not contacting the sides of the glass tube. Hold the hydrometer at eye level and read the scale at the level of electrolyte **(Figure 11-4, Page 11-10)**.

Test Procedure 1 – Battery, Continued:

7. Record the reading.
8. Return the electrolyte to the cell from which it was taken. Replace vent cap.
9. Repeat steps 2 through 8 on all cells.

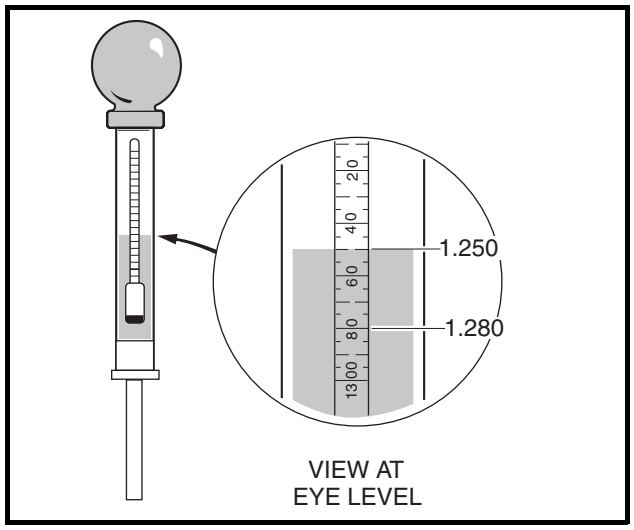


Figure 11-4 Hydrometer Test

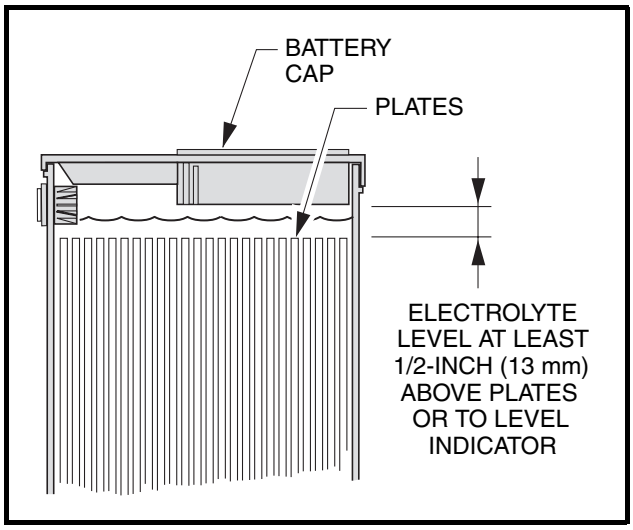


Figure 11-5 Battery Electrolyte Level

Hydrometer Calibration

Most hydrometers are calibrated to read correctly at 80 °F (27 °C). The readings obtained as described above must be corrected for temperature. For each 10 °F (5.6 °C) above 80 °F (27 °C), add 0.004 to the reading. For each 10 °F (5.6 °C) below 80 °F (27 °C), subtract 0.004 from the reading.

Interpreting the Results of the Hydrometer Test

The approximate state of charge can be determined by referring to the following table:

SPECIFIC GRAVITY (TEMPERATURE CORRECTED)	APPROXIMATE STATE OF CHARGE
1.250-1.280	100%
1.220-1.240	75%
1.190-1.210	50%
1.160-1.180	25%

If the difference between the cells is 0.020 or more, the low cell should be suspected. It may require a catch-up charge or it may be a weak cell. When the variations between cells reach 0.050 or more, the battery should be replaced.

Voltage Test

1. Place the red (+) probe of a multimeter set at Volts DC, 20 volt range, on the positive (+) cable and place the black (–) probe on the negative (–) post of the battery and take a voltage reading. If it shows less than 12.4 volts, or if the lowest specific gravity reading from the hydrometer test is less than 1.225, recharge the battery. If battery voltage is greater than 12.4 volts and specific gravity is greater than 1.225, the problem is not with the battery. If the battery does not reach 12.4 volts, or if the specific gravity of a cell is still less than 1.225 after charging, replace the battery. **See following NOTE.**

NOTE: *A fully charged battery that is in good condition should have a specific gravity of at least 1.225 in all cells, and the difference in the specific gravity of any two cells should be less than 50 points. Open circuit voltage should be at least 12.4 volts.*

Load Test

1. Connect a 160-ampere load tester to the battery posts.
2. Turn the switch on the load tester to the ON position.
3. Read the battery voltage after the load tester has been turned ON for 15 seconds. Compare the battery's voltage reading with the table below. Make sure you have the correct ambient temperature.
4. If the battery is found to be good, or if the electrical problem continues after the battery has been replaced with a good one, test the electrical circuits.

IF TEMPERATURE IS	MINIMUM CRANKING VOLTAGE
70 °F (20 °C) and above	9.6 V
60 °F (16 °C)	9.5 V
50 °F (10 °C)	9.4 V
40 °F (4 °C)	9.3 V
30 °F (-1 °C)	9.1 V
20 °F (-7 °C)	8.9 V
10 °F (-12 °C)	8.7 V
0 °F (-18 °C)	8.5 V

TEST PROCEDURE 2 – FUSE

See General Warning, Section 1, Page 1-1.

The fuse (red 10 amp) is located in the electrical component box.

1. Turn the key switch OFF and remove the key. Place the Forward/Reverse handle in the NEUTRAL position. Chock the wheels.
2. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.**
3. Remove the cover on the electrical component box.
4. Check that wires are connected correctly and are tight. If they are not, rewire or tighten as necessary.
5. Remove fuse to be tested from the fuse block. **See Fuse Removal, Section 12, Page 12-16.** The red 10 amp fuse protects the solenoid for the starter (cranking) circuit. The 20 amp fuse at the yellow wire connection protects the headlights.
6. Connect the probes of a multimeter set to 200 ohms to the fuse terminals. The reading should be continuity. If there is no continuity, determine and repair the cause of the fuse failure. Replace the fuse with a properly rated new one.

TEST PROCEDURE 3 – GROUND CABLES

See General Warning, Section 1, Page 1-1.

1. Turn the key switch OFF and remove the key. Place the Forward/Reverse handle in the NEUTRAL position. Chock the wheels.
2. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1**.
3. Check the starter/generator ground strap.
   3.1. Set the multimeter to 200 ohms. Place the red (+) probe on the (A2) terminal of the starter/generator and place the black (–) probe on the vehicle frame **(Figure 11-6, Page 11-12)**. The reading should be continuity. If the reading is incorrect, clean and tighten wire connections. If the connections are good and the reading is incorrect, repair or replace the wire.
4. Check the engine ground strap.
   4.1. Place the red (+) probe of the multimeter on the ground strap terminal end located on the oil filler bracket on the engine **(Figure 11-7, Page 11-12)**. Place the black (–) probe on the vehicle frame. The reading should be continuity. If the reading is incorrect, clean and tighten wire connections. If the connections are good and the reading is incorrect, repair or replace the wire.

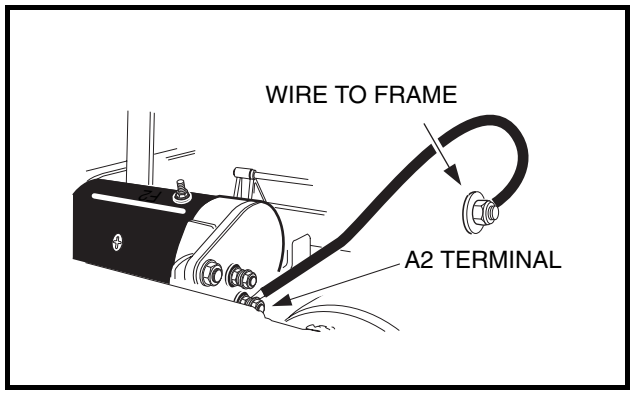


Figure 11-6 Test Starter/Generator Ground Strap

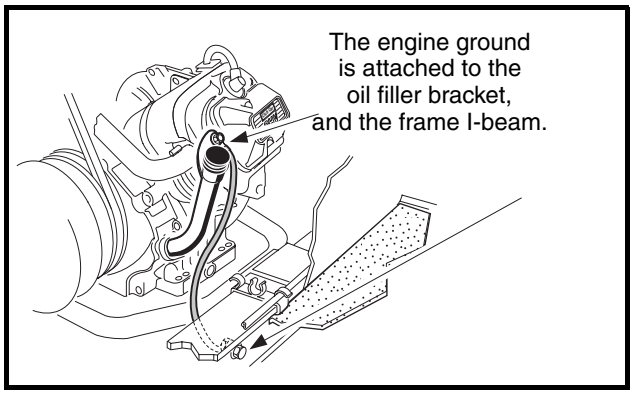


Figure 11-7 Test Engine Ground Strap

5. Check voltage regulator ground connection (at battery frame ground). Make sure it is clean and tight.
6. Check the battery ground cable.
   6.1. A 6-gauge black wire connects the negative battery post to the frame. The frame connection should be clean and tight. Visual inspection of the connection on the frame is very difficult. The best check for tightness is to pull on the black wire. If the wire moves at the connection end, disassemble the frame connection and clean the bolt, ring terminal, and nut. Install the frame connection.
   6.2. Set the multimeter to 200 ohms. Place the red (+) probe on the unconnected end of the 6-gauge black wire, and place the black (–) probe on the vehicle frame **(Figure 11-8, Page 11-13)**. The reading should be continuity. If the reading is incorrect, check that terminal connections are clean and tight. If the connections are good and the reading is incorrect, repair or replace the wire.

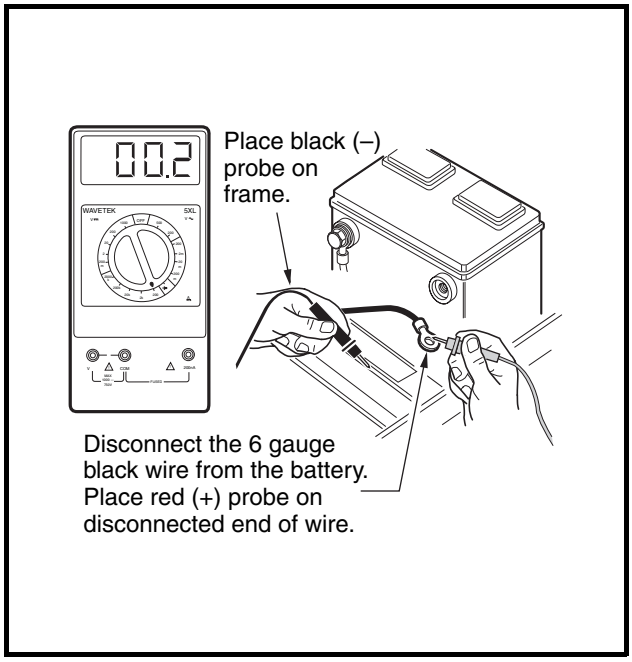


Figure 11-8 Battery Ground Cable Test

TEST PROCEDURE 4 – KEY SWITCH (STARTER CIRCUIT)

See General Warning, Section 1, Page 1-1.

1. Turn the key switch OFF and remove the key. Place the Forward/Reverse handle in the NEUTRAL position. Chock the wheels.
2. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.**
3. Remove the instrument panel. **See Key Switch Removal, Section 12, Page 12-14.**
4. Ensure that the connector is connected correctly and is tight. If it is not, repair or replace as necessary.
5. Insert the key and turn the key to ON. Place the red (+) probe of the multimeter on the (B) terminal and the black (–) probe on the (L) terminal of the key switch. The reading should be continuity. If the reading is incorrect, replace the key switch **(Figure 11-9, Page 11-14)**. **See Key Switch Removal, Section 12, Page 12-14.**
6. With the key still in the ON position, place the red (+) probe of the multimeter on the (B) terminal and the black (–) probe on the (S) terminal of the key switch. The reading should show no continuity. If the reading is incorrect, replace the key switch. **See Key Switch Removal, Section 12, Page 12-14.** If the reading is correct, leave the probes connected and proceed to the next step.
7. Insert the key and hold the key in the START position. The reading should be continuity. If the reading is incorrect, replace the key switch **(Figure 11-10, Page 11-14)**. With the red (+) probe of the multimeter on the (B) terminal and the black (–) probe on the (L) terminal of the key switch, the reading should be continuity. If either reading is incorrect, replace the key switch. **See Key Switch Removal, Section 12, Page 12-14.**

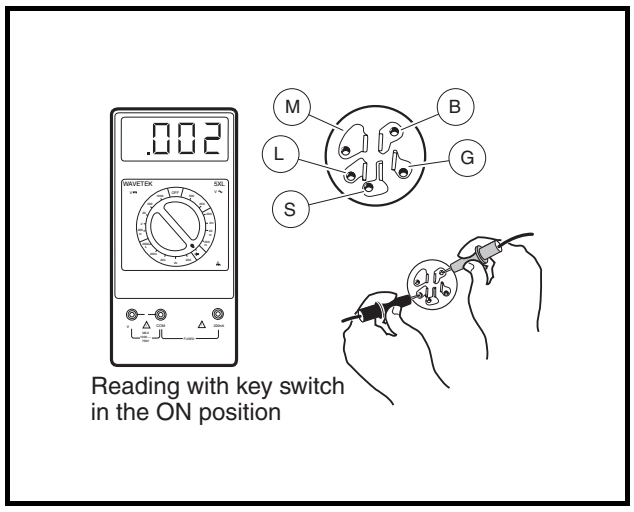


Figure 11-9 Key Switch Test – Accessory Terminal

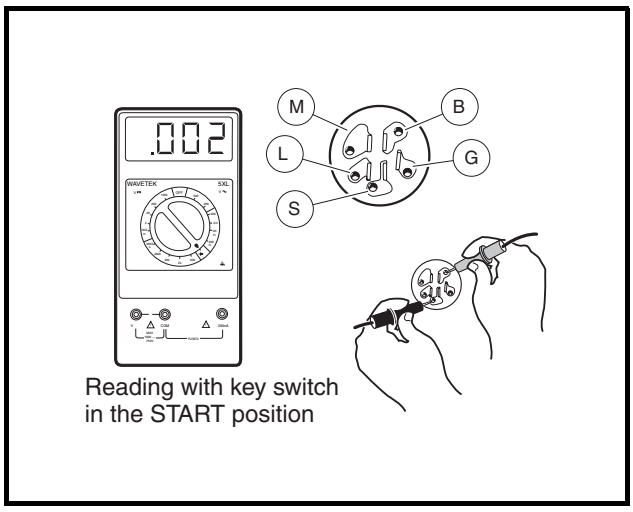


Figure 11-10 Key Switch Test – Starter Circuit

TEST PROCEDURE 5 – KEY SWITCH (ACCESSORY TERMINAL)

See General Warning, Section 1, Page 1-1.

1. Turn the key switch OFF and remove the key. Place the Forward/Reverse handle in the NEUTRAL position. Chock the wheels.
2. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1**.
3. Remove the instrument panel. **See Key Switch Removal, Section 12, Page 12-14.**
4. Ensure that the connector is connected correctly and is tight. If it is not, repair or replace as necessary.
5. Insert the key and turn the switch to the ON position. With the multimeter set to 200 ohms, place the red (+) probe of the multimeter on the (B) terminal and the black (–) probe on the (L) terminal of the key switch **(Figure 11-9, Page 11-14)**. The reading should be continuity. If the reading is incorrect, replace the key switch. **See Key Switch Removal, Section 12, Page 12-14.**

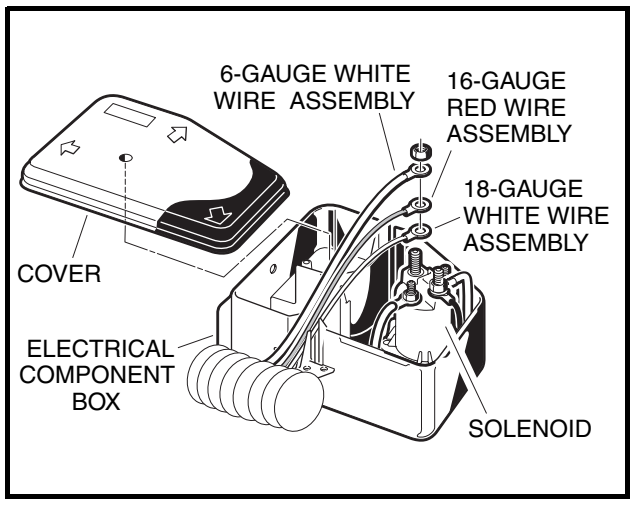


Figure 11-11 Remove Solenoid Wires

TEST PROCEDURE 6 – SOLENOID

See General Warning, Section 1, Page 1-1.

1. Turn the key switch OFF and remove the key. Place the Forward/Reverse handle in the NEUTRAL position. Chock the wheels.
2. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1**.
3. Remove the electrical component box cover.
4. Check that the wires are connected correctly and are tight. If they are not, rewire or tighten as necessary.
5. Set a multimeter to 200 ohms. Place the red (+) probe on one of the small posts of the solenoid and place the black (–) probe on the other small post. The reading should be 14 to16 ohms. If the reading is not within limits, replace the solenoid.
6. Remove the wires from the large post of the solenoid. Do not allow the wires to touch the frame or other components of the vehicle **(Figure 11-11, Page 11-14)**.
7. Set the multimeter to 200 ohms. Connect the red (+) probe to one of the large posts of the solenoid and connect the black (–) probe to the other large post **(Figure 11-12, Page 11-16)**.
8. With the key switch in the OFF position, connect the battery, positive (+) cable first.
9. Place the Forward/Reverse handle in the NEUTRAL position. With the key in the OFF position, the reading on the multimeter should be no continuity. Turn the key switch to the START position and listen for the solenoid click. While holding the key in the START position, there should be continuity. After the key is released, it should rotate to the ON position and should be no continuity. If either reading is incorrect, replace the solenoid.
10. With the Forward/Reverse handle still in the NEUTRAL position, set the multimeter to 20 volts DC and place the red (+) probe on the large post that does *not* have wires connected to it. Place the black (–) probe on the vehicle frame. Turn key switch to the START position and listen for the solenoid click. While holding the key in the START position, the meter should read full battery voltage. If the reading is incorrect, replace the solenoid **(Figure 11-13, Page 11-16)**.
11. Disconnect the 6-gauge black wire from the negative post of the battery before reconnecting the wires to the solenoid.
12. Reconnect the solenoid. **See Solenoid Installation, Section 12, Page 12-15. See also following WARNING.**

⚠ WARNING

- **Incorrect wiring could result in severe injury or death.**
- **Diode and solenoid connections must have correct polarity.**
- **Keep all persons clear of engine belts when making final connections.**

TEST PROCEDURE 7 – LOCKOUT CAM LIMIT SWITCH

See General Warning, Section 1, Page 1-1.

This limit switch is located on the Forward/Reverse switch assembly. A black wire and a green wire are connected to this limit switch.

1. Turn the key switch OFF and remove the key. Place the Forward/Reverse handle in the NEUTRAL position. Chock the wheels.
2. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.**
3. Check for proper wiring and tight connections.

Test Procedure 7 – Lockout Cam Limit Switch, Continued:

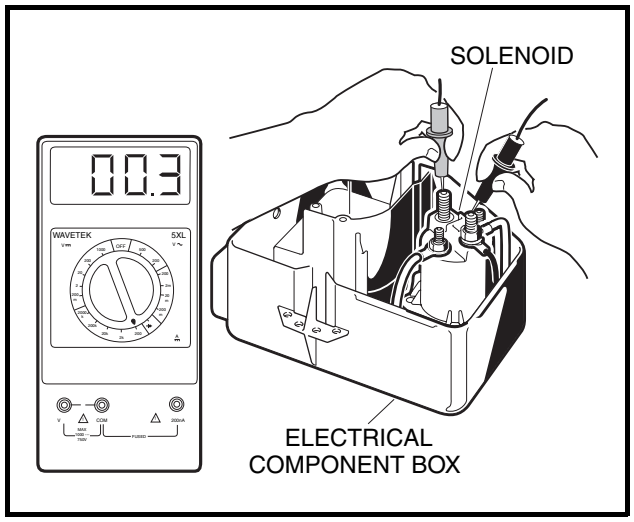


Figure 11-12 Test Solenoid Continuity

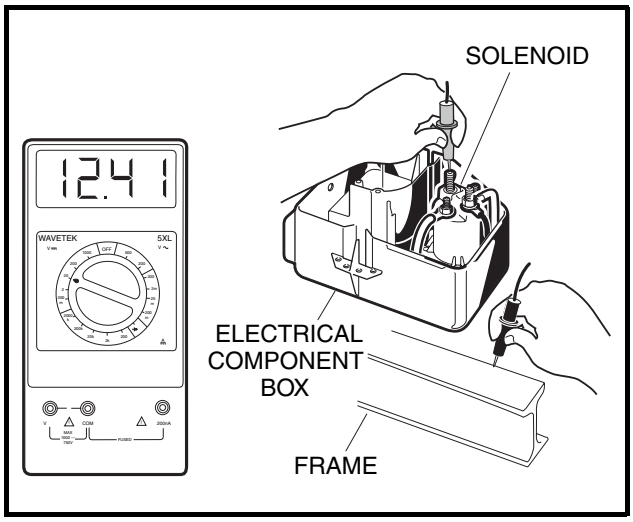


Figure 11-13 Test Solenoid Ground

4. Set the multimeter to 200 ohms. Place the red (+) probe of the multimeter on the common (COM) terminal of the limit switch. Place the black (–) probe on the normally open (NO) terminal of the switch. Without the lever pressed, the reading should be no continuity. Press the lever, and the reading should be continuity. If either reading is incorrect, replace the limit switch **(Figure 11-14, Page 11-16)**.

5. Check to be sure the lobes on the cam are pressing the lockout cam limit switch when the Forward/ Reverse shifter is in the NEUTRAL position only. The limit switch should make an audible click as it is pressed. If it does not, check for wear on the cam lobe. If the cam lobe will not activate the limit switch, replace the cam.

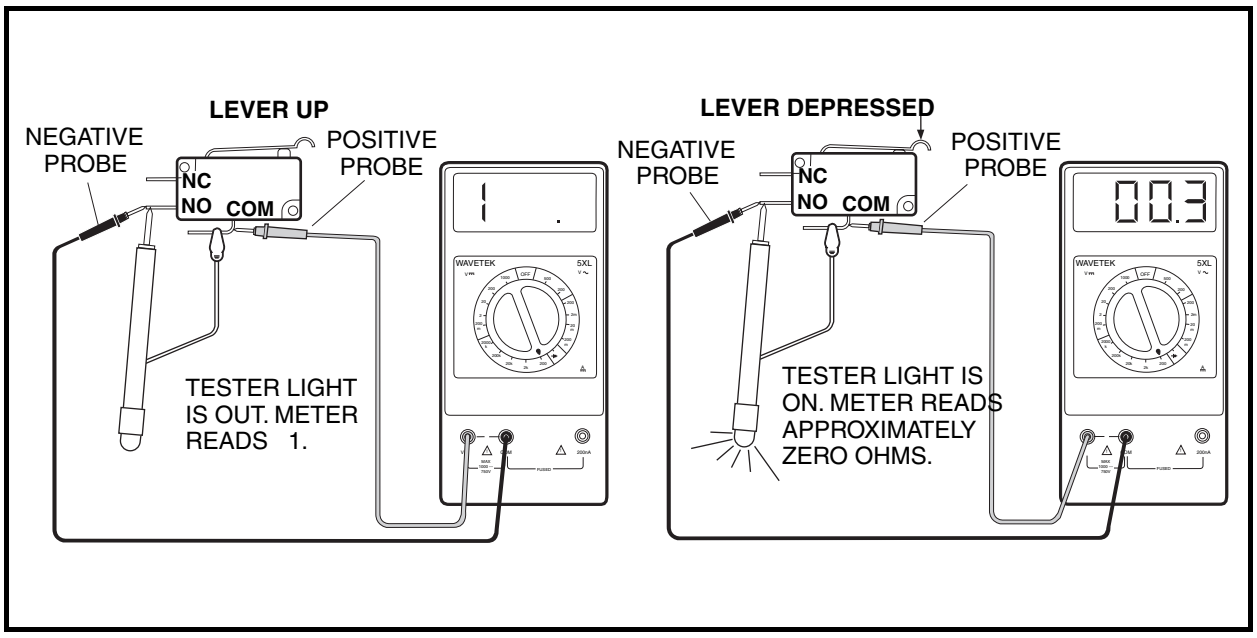


Figure 11-14 Test Lockout Cam Limit Switch

TEST PROCEDURE 8 – STARTER/GENERATOR (STARTER FUNCTION)

See General Warning, Section 1, Page 1-1.

1. Turn the key switch OFF and remove the key. Place the Forward/Reverse handle in the NEUTRAL position. Chock the wheels.
2. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1**.
3. Check that wires are connected correctly and are tight. If they are not, rewire or tighten as necessary.
4. Disconnect the wires from all the terminals on the starter/generator. Then place the black (–) probe of a multimeter, set to ohms, on the starter/generator housing (scratch through the finish to ensure a good ground). While holding the black probe against the housing, place the red (+) probe (one at a time) on the A1, A2, F1, F2 and DF terminals respectively **(Figure 11-15, Page 11-17)**. The readings should be no continuity. If the readings are incorrect, the starter/generator will need to be removed from the vehicle and disassembled by a qualified technician. **See Starter/Generator Removal, Section 12, Page 12-1.**
   - An incorrect reading from the A1 or A2 terminal indicates three possible problems: 1) a grounded A1 or A2 terminal, 2) a grounded wire in the brush area, or 3) a grounded armature/commutator.
   - If the F1 or F2 reading is incorrect, it indicates a possible grounded F1 or F2 terminal or a grounded field coil.
   - If the DF reading is incorrect, it indicates a possible grounded DF terminal or a grounded field coil.
5. Disconnect the ground wire from the A2 terminal and the green wire from the A1 terminal on the starter/generator.
6. Using a multimeter set to 200 ohms, place the red (+) probe on the A1 terminal and the black (–) probe on the A2 terminal. The reading should be continuity. If the reading is incorrect, a possible open or poor contact in a brush assembly and/or open armature windings may be the cause. The starter/generator will need to be removed from the vehicle and disassembled by a qualified technician. **See Starter/Generator Removal, Section 12, Page 12-1.**
7. With the wires still disconnected, using a multimeter set on 200 ohms, place the red (+) probe on the F1 terminal and the black (–) probe on the F2 terminal. The reading should be between approximately 0.1 and 0.3 ohms. If the reading is incorrect, a possible open field coil or bad connections at terminals may be the cause. The starter/generator will need to be removed from the vehicle and disassembled by a qualified technician. **See Starter/Generator Removal, Section 12, Page 12-1.**

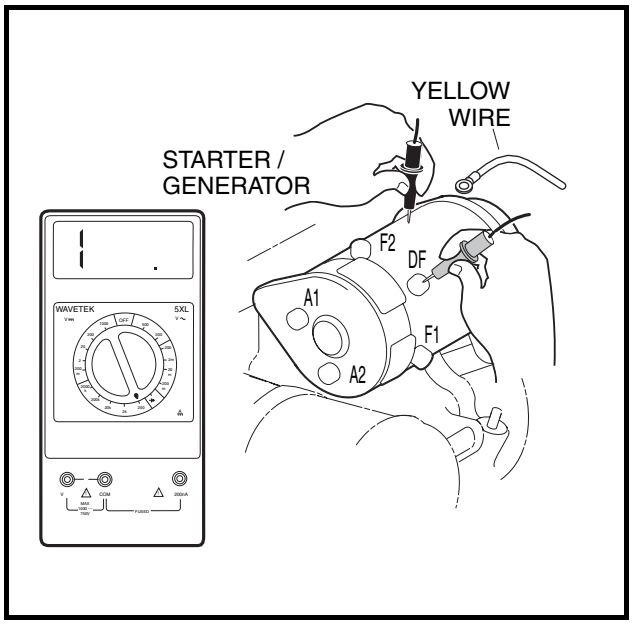


Figure 11-15 Check Starter Terminal Continuity

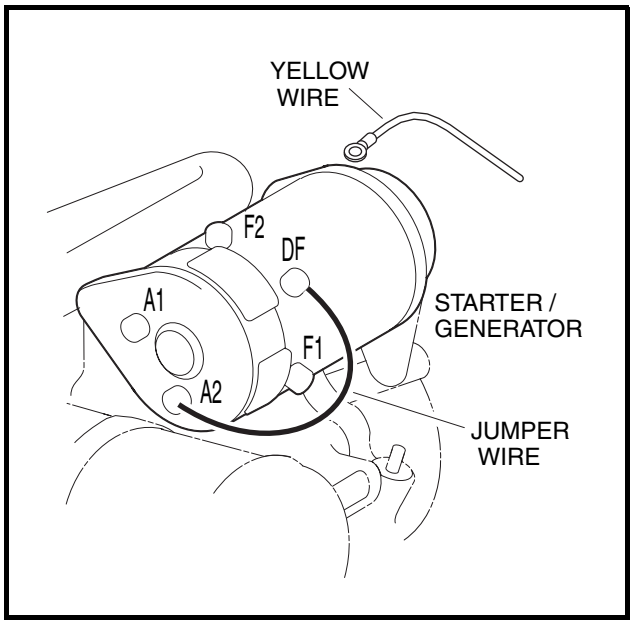


Figure 11-16 Jumper Wire Ground – DF to A2

Test Procedure 8 – Starter/Generator (Starter Function), Continued:

8. With the wires still disconnected, using a multimeter set to 200 ohms, place the red (+) probe on the DF terminal and the black (–) probe on the F1 terminal. The reading should be between 4.5 and 5.5 ohms. If the reading is incorrect, a possible grounded DF terminal and/or grounded field coil may be the cause. The starter/generator will need to be removed from the vehicle and disassembled by a qualified technician. **See Starter/Generator Removal, Section 12, Page 12-1.**

TEST PROCEDURE 9 – WIRE CONTINUITY

See General Warning, Section 1, Page 1-1.

1. Turn the key switch OFF and remove the key. Place the Forward/Reverse handle in the NEUTRAL position. Chock the wheels.
2. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.**
3. To test a wire for continuity, disconnect either end from the electrical component it is attached to.
4. Set the multimeter to 200 ohms and place the red (+) probe on the terminal at one end of the wire. Place the black (–) probe on the other terminal end of the wire. The reading should be continuity. If the reading is incorrect, repair or replace the wire.

TEST PROCEDURE 10 – DIODE (GENERATOR CIRCUIT)

See General Warning, Section 1, Page 1-1.

1. Turn the key switch OFF and remove the key. Place the Forward/Reverse handle in the NEUTRAL position. Chock the wheels.
2. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1**.
3. Disconnect the red and white wires of the diode assembly from the solenoid posts, located within the electrical component box.
   3.1. Remove the intake hose to the carburetor at the carburetor intake port and move the hose to allow easy access to the electrical component box cover.
   3.2. Remove the cover retaining screw (5) and electrical component box cover (6) **(Figure 11-17, Page 11-19)**.
   3.3. Remove the locknuts (7) from the two large solenoid posts and disconnect the diode wires from the solenoid.
4. With the multimeter set to the diode test function (→|←), connect the black (–) probe of the multimeter to the white lead of the diode and the red (+) probe of the multimeter to the red lead of the diode **(Figure 11-18, Page 11-20)**. The reading should indicate an overload (no continuity). A diode is designed to conduct current in one direction only. If a diode conducts current (shows continuity) with the meter probes as described, the diode has failed and must be replaced. **See Diode Removal, Section 12, Page 12-12.**
5. Reverse the multimeter probes and note the reading. With the black (–) probe of the multimeter to the red lead of the diode and the red (+) probe of the multimeter to the white lead, the meter should read approximately 450 mV, however, a range of 400-500 mV is acceptable **(Figure 11-19, Page 11-20)**.
6. Connect either the black (–) or red (+) lead of the multimeter to the diode body (case). Connect the other multimeter lead to both the red and white lead terminals of the diode. The multimeter should indicate an overload, (no continuity). If continuity reading does occur, it indicates that one or both of the diode leads are grounded to the diode body (case) and the diode must be replaced. **See Diode Removal, Section 12, Page 12-12.**

7. If the diode tests good, reconnect the diode leads. **See Diode Installation, Section 12, Page 12-12. See also following WARNING.**

⚠ WARNING

- **Incorrect wiring could result in severe injury or death.**
- **Diode and solenoid connections must have correct polarity.**
- **Keep all persons clear of engine belts when making final connections.**

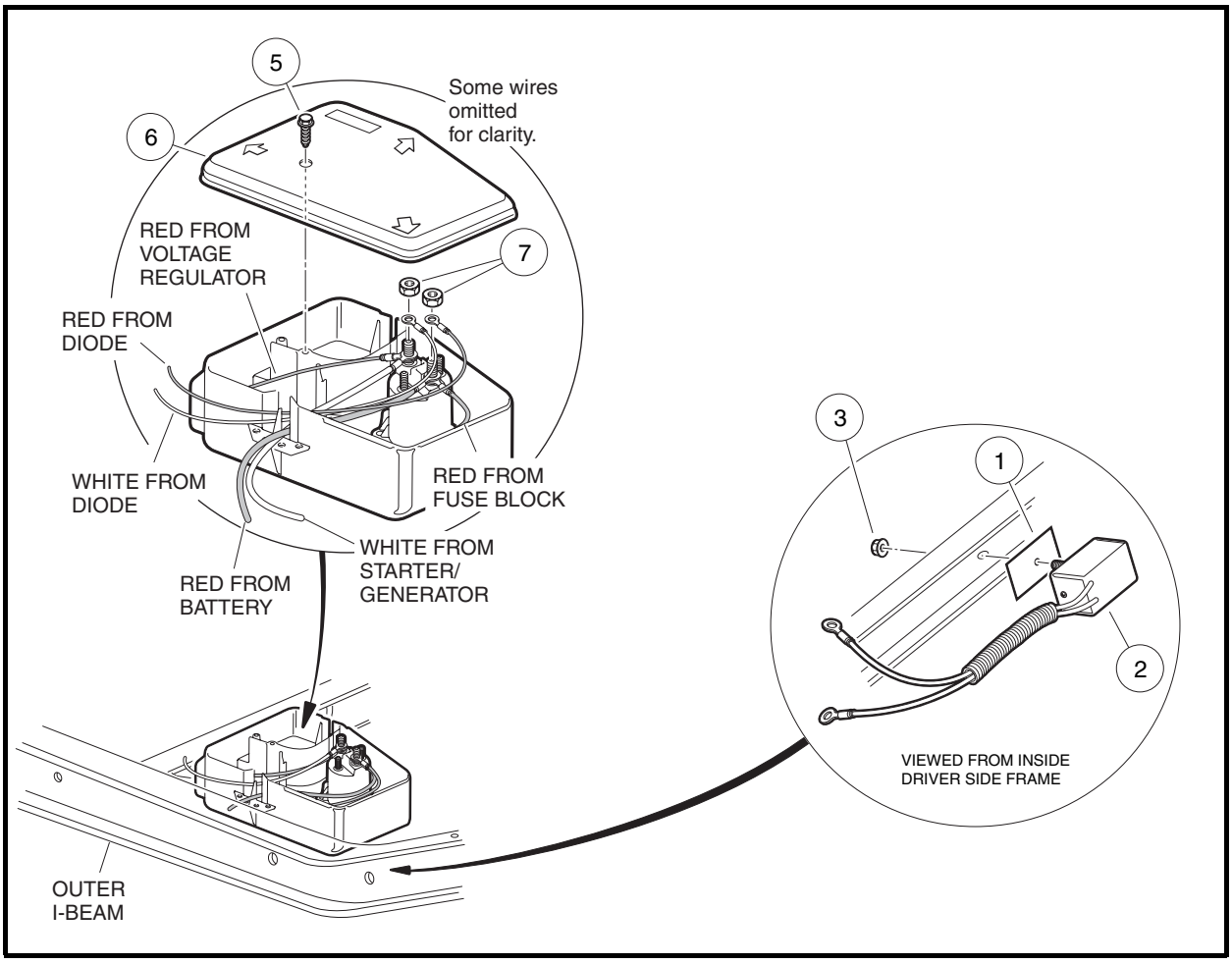


Figure 11-17 Electrical Control Box and Diode Orientation

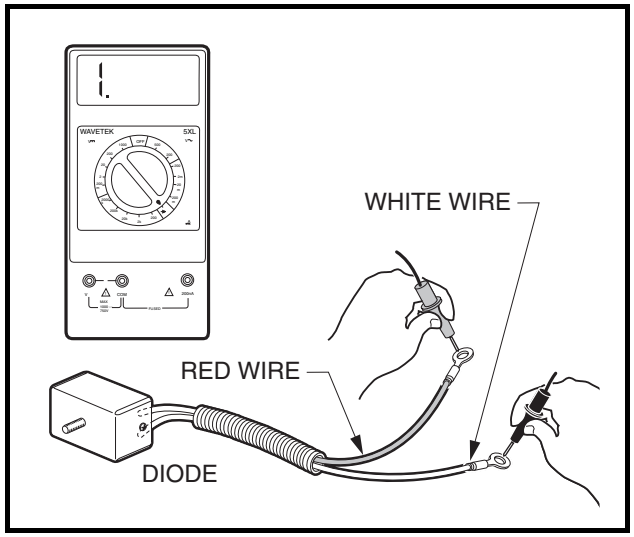


Figure 11-18 Diode Test

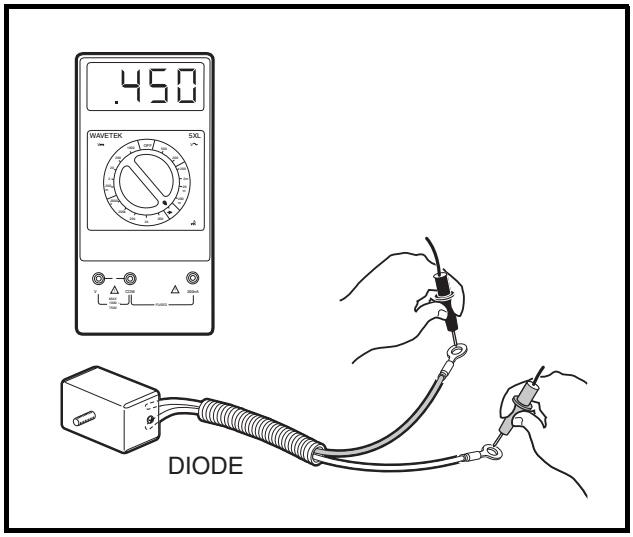


Figure 11-19 Diode Test – Probes Reversed

TEST PROCEDURE 11 – STARTER/GENERATOR (GENERATOR FUNCTION)

See General Warning, Section 1, Page 1-1.

NOTE: *Perform Test Procedure 10 before proceeding with this test procedure.*

Keep the battery connected while performing this test procedure.

1. Turn the key switch OFF and remove the key. Place the Forward/Reverse handle in the NEUTRAL position. Chock the wheels.
2. Ensure that the wires are connected correctly and are tight. If they are not, rewire or tighten as necessary.
3. Disconnect the yellow wire from the DF terminal on the starter/generator. Cover the connector on the yellow wire to make sure the yellow wire will not short to ground. Then, using a jumper wire, ground the DF terminal to the A2 terminal **(Figure 11-16, Page 11-17)**.
4. Using a multimeter set to 20 volts DC, place the red (+) probe on the positive (+) cable of the battery, and place the black (–) probe on the negative (–) post. Start the engine and run it at full governed speed. The reading should show the voltage rising on the meter. If the voltage rises, see Test Procedure 12 – Voltage Regulator on page 11-20. If the voltage does not rise, and the diode was found to be functioning properly in Test Procedure 10, a tear-down inspection of the starter/generator will be necessary. **See Starter/ Generator Removal, Section 12, Page 12-1.**
5. Reconnect the yellow wire to the DF terminal on the starter/generator.

TEST PROCEDURE 12 – VOLTAGE REGULATOR

See General Warning, Section 1, Page 1-1.

NOTE: *Perform Test Procedures 10 and 11 before proceeding with this test procedure.*

Keep the battery connected while performing this test procedure.

1. Turn the key switch OFF and remove the key. Place the Forward/Reverse handle in the NEUTRAL position. Chock the wheels.
2. Check that the wires are connected correctly and are tight. If they are not, rewire or tighten as necessary.
3. Check the engine RPM setting to ensure that it is adjusted correctly. **See Engine RPM Adjustment, Section 14, Page 14-11.**
4. With the battery in good condition and fully charged, run the engine for several minutes to bring the voltage regulator to operating temperature.

5. Turn the key switch to the OFF position, killing the engine. Using a multimeter set to 20 volts DC, place the red (+) probe on the large post of the solenoid with the red wire from the voltage regulator attached. Place the black (–) probe on the negative (–) battery post **(Figure 11-20, Page 11-21)**. With the Forward/Reverse handle in the NEUTRAL position and the wheels chocked, turn the key switch to the START position to start the engine. Press the accelerator to run the engine at full governed speed. If the reading is between 14.7 and 15.3 volts, the regulator is good. If the reading is lower than 14.7 volts but rising steadily, check battery condition. **See Hydrometer Test on page 11-9.** If the reading is lower than 14.7 volts and not rising, and the starter/generator is good; or if the reading is over 15.3 volts and continues to rise, replace voltage regulator. **See Voltage Regulator Removal, Section 12, Page 12-11.**

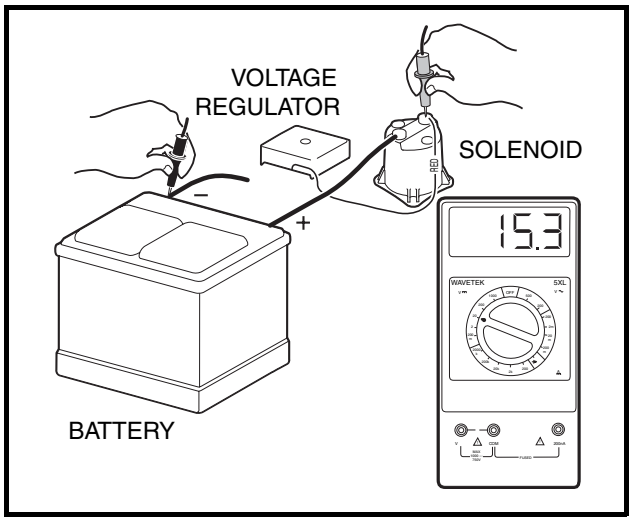


Figure 11-20 Test Voltage Regulator

TEST PROCEDURE 13 – GROUNDED KILL WIRE

See General Warning, Section 1, Page 1-1.

NOTE: *Keep the battery connected while performing this test procedure.*

1. Turn the key switch OFF and remove the key. Place the Forward/Reverse handle in the NEUTRAL position. Chock the wheels.
2. Disconnect the engine-kill white/black wire at the bullet connector located next to the RPM limiter **(Figure 11-22, Page 11-22)**.

NOTE: *Disconnecting the engine-kill wire removes it from the start/stop circuit.*

3. Turn the key switch to the START position and release after the engine starts. If the engine starts and continues to idle, check the kill-wire for grounding, the kill limit switch, and the key switch. **See Test Procedure 18 – Engine Kill Wire on page 11-29. See following WARNING.**

⚠ WARNING

- **When the white/black engine kill wire is disconnected, the engine will not stop running after the key switch is turned to the OFF position. It will be necessary to pull and hold the choke handle until the engine stops running.**

4. If the engine does not run, connect the white/black wire at the bullet connector next to the RPM limiter and proceed to Test Procedure 14 – Ignition Spark on page 11-22.

TEST PROCEDURE 14 – IGNITION SPARK

See General Warning, Section 1, Page 1-1.

NOTE: *Keep the battery connected while performing this test procedure.*

1. Turn the key switch OFF and remove the key. Place the Forward/Reverse handle in the NEUTRAL position. Chock the wheels.
2. Remove the plug wire from the spark plug. Using an ignition spark gap test tool (Thexton 404® or equivalent), check for correct spark **(Figure 11-21, Page 11-22)**.
   2.1. Adjust the tester probes to approximately to 18,000 volts (18 Kv) setting (SE – *Small Engine Setting* on the Thexton 404 tool). Connect the tester to the spark plug wire, and connect the alligator clip to a solid engine ground.
   2.2. Start the engine. There should be a strong blue spark between the probes of the spark gap tester. If there is no spark, or if the spark is a faint yellow or red color, test components of the ignition circuit.
3. If the spark gap tester tool indicates a strong blue spark, it is possible the spark plug has failed internally. Check the spark plug gap. The gap should be set at 0.027 to 0.031 of an inch (0.69 to 0.79 mm). If the gap is correct, replace the spark plug with a new part and test the engine for proper operation.

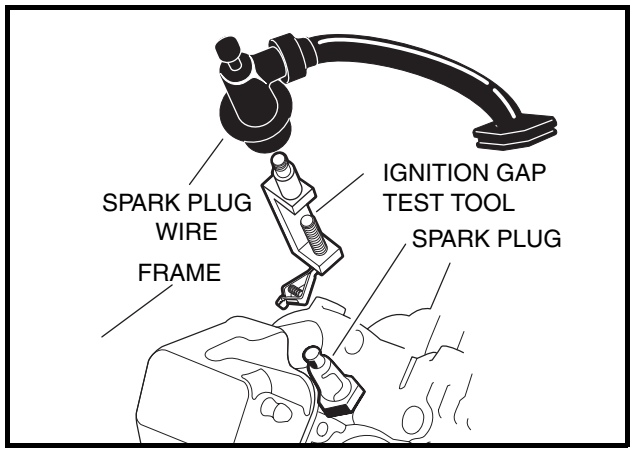


Figure 11-21 Ignition Spark Test

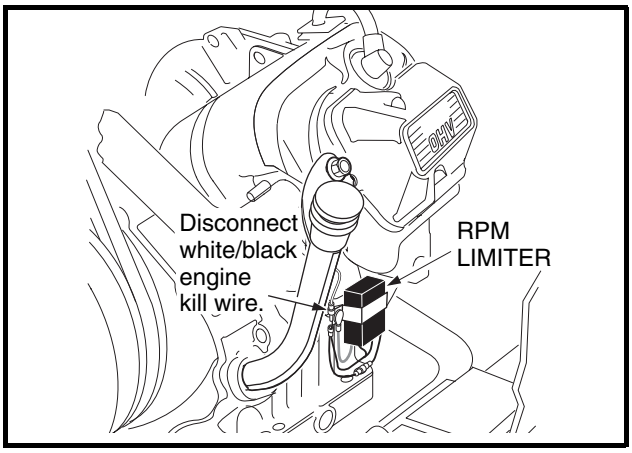


Figure 11-22 Disconnect White/Black Engine Kill Wire

TEST PROCEDURE 15 – RPM LIMITER

See General Warning, Section 1, Page 1-1.

1. Turn the key switch OFF and remove the key. Place the Forward/Reverse handle in the NEUTRAL position. Chock the wheels.
2. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.**
3. Disconnect both of the bullet terminals **(Figure 11-23, Page 11-23)**.
4. Using a multimeter set to 200 ohms, place the red (+) probe on the brown ground wire and place the black (–) probe on one of the black wire female bullet connectors. The reading should be no continuity. If the reading is not correct, replace the RPM limiter.
5. This test will find most bad RPM limiters. Some of them may bench test okay but fail under a load due to heat while operating. Another method of testing is to replace the RPM limiter and then run the engine. If the engine runs properly, keep the new RPM limiter in the circuit.

TEST PROCEDURE 16 – IGNITION COIL

See General Warning, Section 1, Page 1-1.

The following test procedures will properly detect a coil that has failed in most cases; however, in rare cases, some ignition coils can fail to operate at normal (warmer) operating temperatures. If the ignition coil has tested okay in the vehicle and on the bench, but fails to operate reliably, replace the coil with a known good coil and operate the engine for several minutes to ensure that the coil functions at normal operating temperature. If the new coil functions properly, keep the new coil in the circuit.

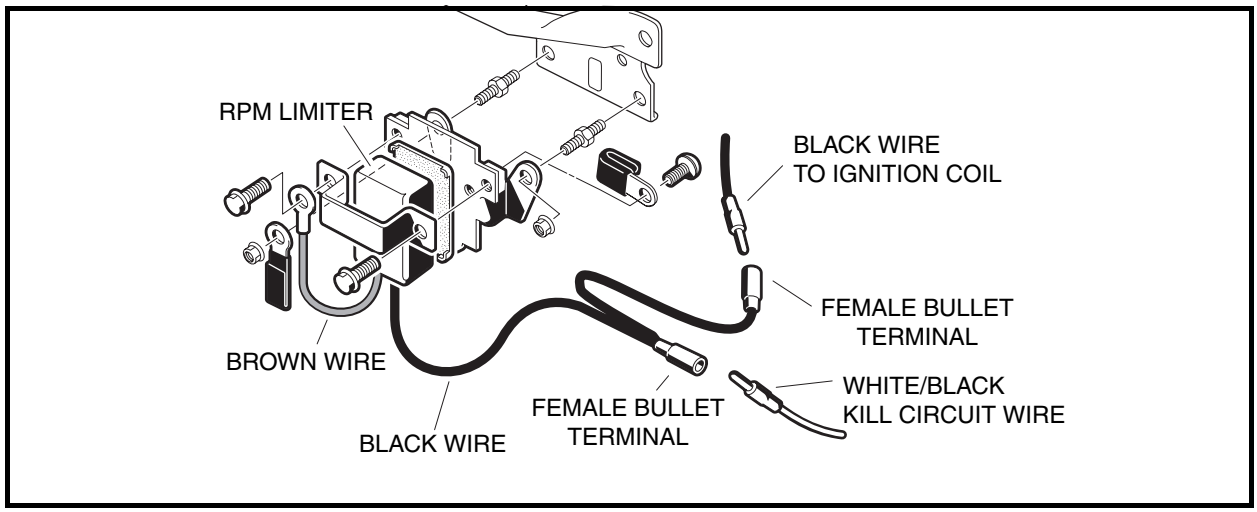


Figure 11-23 RPM Limiter

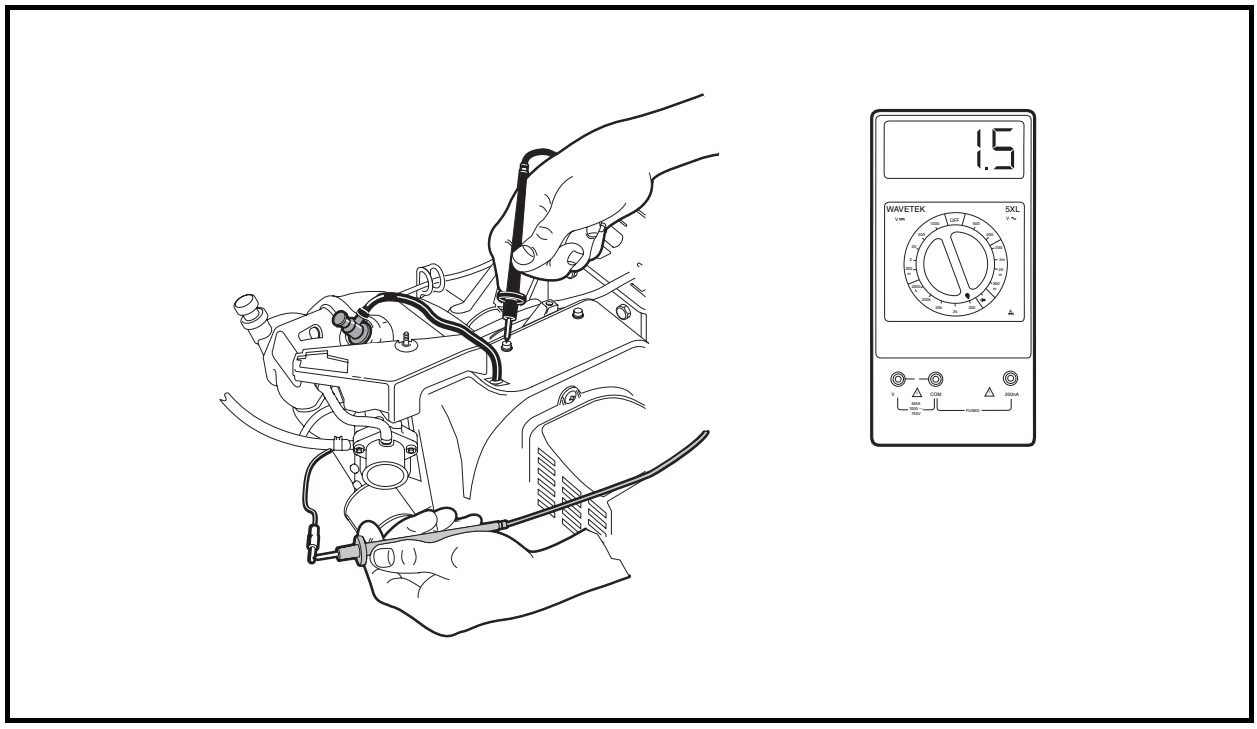


Figure 11-24 Primary Coil Resistance – In Vehicle Test

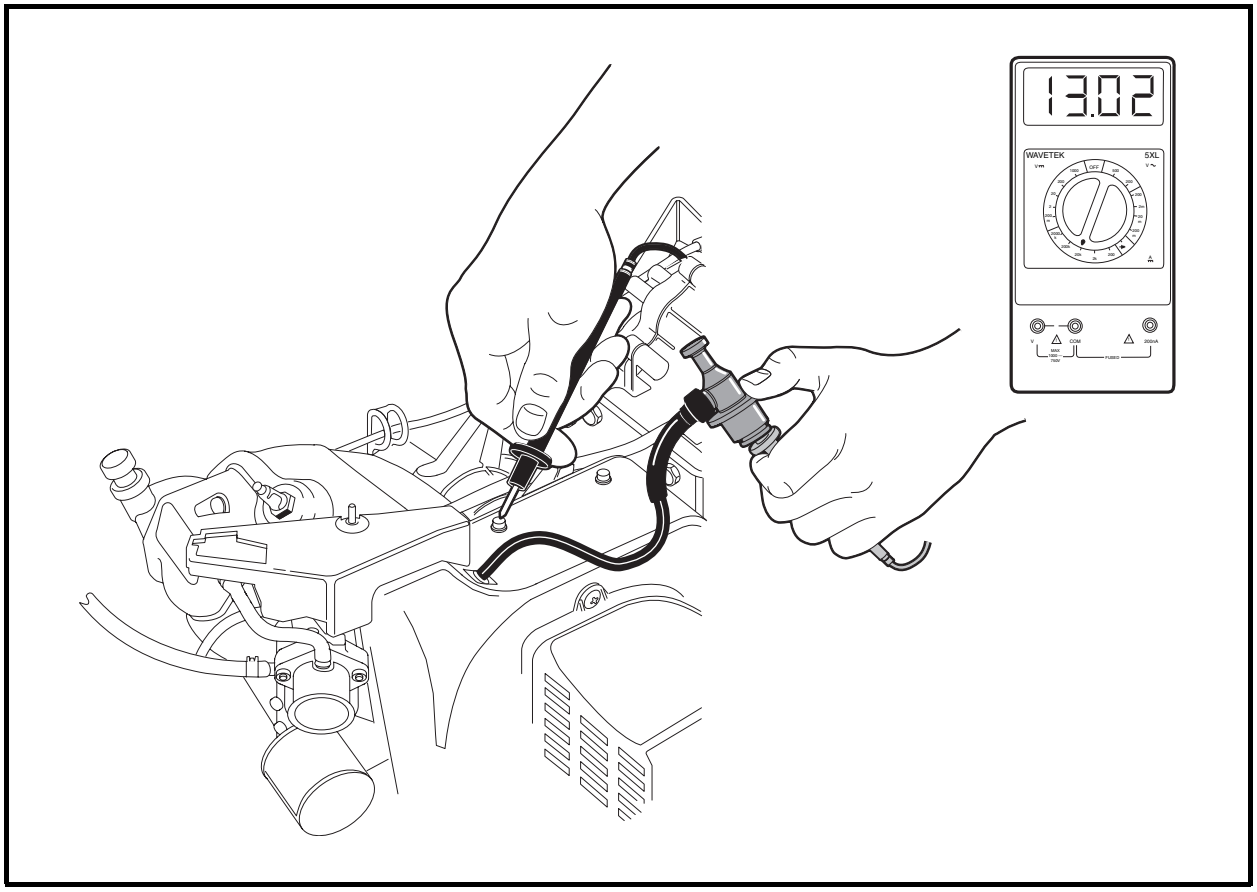


Figure 11-25 Secondary Coil Test – In Vehicle Test

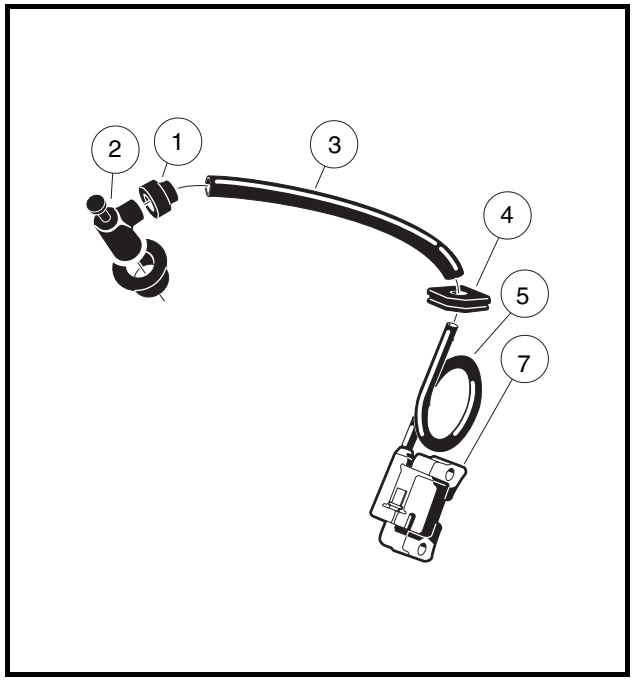


Figure 11-26 Ignition Coil and Cap

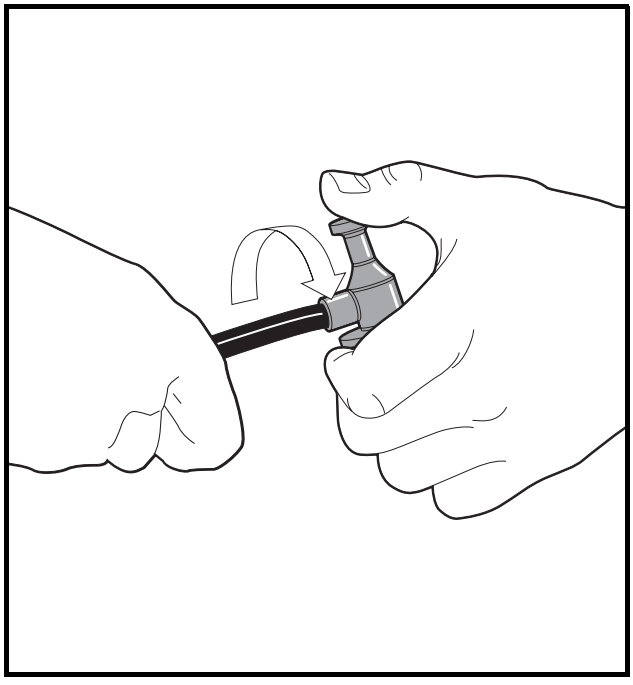


Figure 11-27 Spark Plug Cap Removal

Ignition Coil – In Vehicle Test

1. Turn the key switch OFF and remove the key. Place the Forward/Reverse handle in the NEUTRAL position. Chock the wheels.

2. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.**

3. Using a multimeter set to 200 ohms, measure the primary coil resistance.

   3.1. Disconnect both of the bullet terminals at the RPM limiter **(Figure 11-23, Page 11-23)**. Place the red (+) probe of the meter on the male bullet terminal of the wire connecting to the ignition coil under the fan housing, and place the black (–) probe on a clean unpainted surface of the engine or frame **(Figure 11-24, Page 11-23)**.

   3.2. If the resistance is not between 0.6 - 1.7 ohms, bench test the ignition coil. **See Ignition Coil – Bench Test on page 11-26.**

4. Using a multimeter set to 20k ohms, measure the resistance of the secondary coil and spark plug cap together.

   4.1. Place the red (+) probe of the meter into the end of the spark plug cap that normally connects to the spark plug and place the black (–) probe on a clean unpainted surface of the engine or frame **(Figure 11-25, Page 11-24)**.

   4.2. If the resistance is between 12.0k - 14.0k ohms, the secondary coil and spark plug cap are within acceptable limits; proceed to step 7 on page 11-25. If the resistance is not between 12.0k - 14.0k ohms, the spark plug cap and secondary coil must be tested independently from each other.

5. Test the spark plug cap separately from the secondary coil.

   5.1. Remove the rubber gasket (1) on the plug cap (2) by rolling back the gasket onto the spark plug wire (3) **(Figure 11-26, Page 11-24)**.

   5.2. Remove the cap from the wire by turning the cap counterclockwise three or four revolutions while gently pulling it off the wire **(Figure 11-27, Page 11-24)**.

   5.3. Using a multimeter set to 20k ohms, place the red (+) probe of the multimeter into the end of the spark plug cap that normally connects to the spark plug and place the black (–) probe into the end of the cap with the internal screw **(Figure 11-28, Page 11-26)**. If the resistance is not between 4.5k - 6.0k ohms, the cap has failed and must be replaced. Proceed to the next step with the spark plug cap still removed.

6. Test the secondary coil separately from the spark plug cap.

   6.1. Using a multimeter set to 20k ohms, place the red (+) probe of the meter into the end of the spark plug wire and place the black (–) probe on a clean unpainted surface of the engine or frame **(Figure 11-29, Page 11-27)**. If the resistance is between 6.0k - 11.0k ohms, the secondary coil is within acceptable limits. If the resistance is not between 6.0k - 11.0k ohms, bench test the ignition coil.

7. If the preceding procedures indicate that the ignition coil resistance readings are within acceptable ranges, but the coil fails to function properly, proceed to the following bench test procedures.

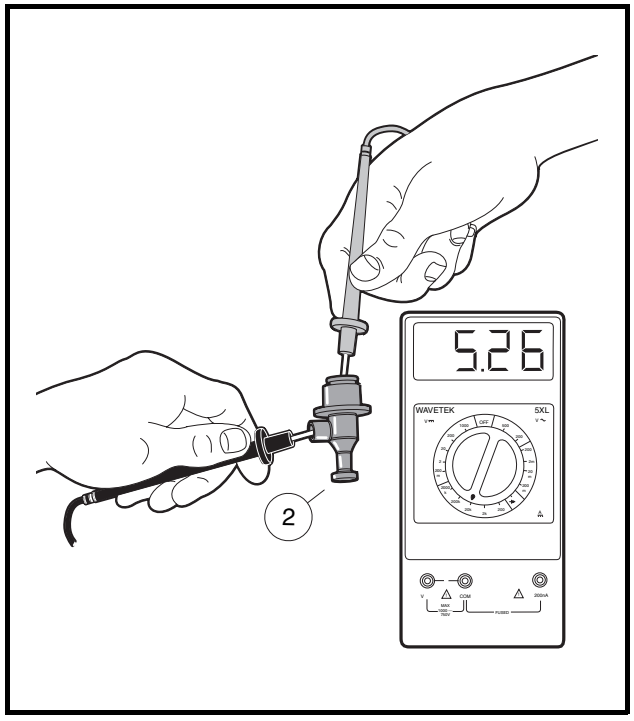


Figure 11-28 Spark Plug Cap Test

Ignition Coil – Bench Test

1. Remove the coil from the engine. **See Ignition Coil Removal, Section 12, Page 12-23.**
2. Using a multimeter set to 200 ohms, measure the primary coil resistance.
   2.1. Place the black (–) probe of the meter on the terminal on the ignition coil (1), and place the red (+) probe on the core (2) **(Figure 11-30, Page 11-27)**.
   2.2. If the resistance is not between 0.6 - 1.7 ohms, replace the ignition coil.
3. Using a multimeter set to 20k ohms, measure the resistance of the secondary coil and spark plug cap together.
   3.1. Place the red (+) probe of the meter into the end of the spark plug cap that normally connects to the spark plug (3) and place the black (–) probe on the core (2) **(Figure 11-31, Page 11-27)**.
   3.2. If the resistance is between 12.0k - 14.0k ohms, the secondary coil and spark plug cap are within acceptable limits; proceed to step 6 on page 11-28. If the resistance is not between 12.0k - 14.0k ohms, the spark plug cap and secondary coil must be tested independently from each other.

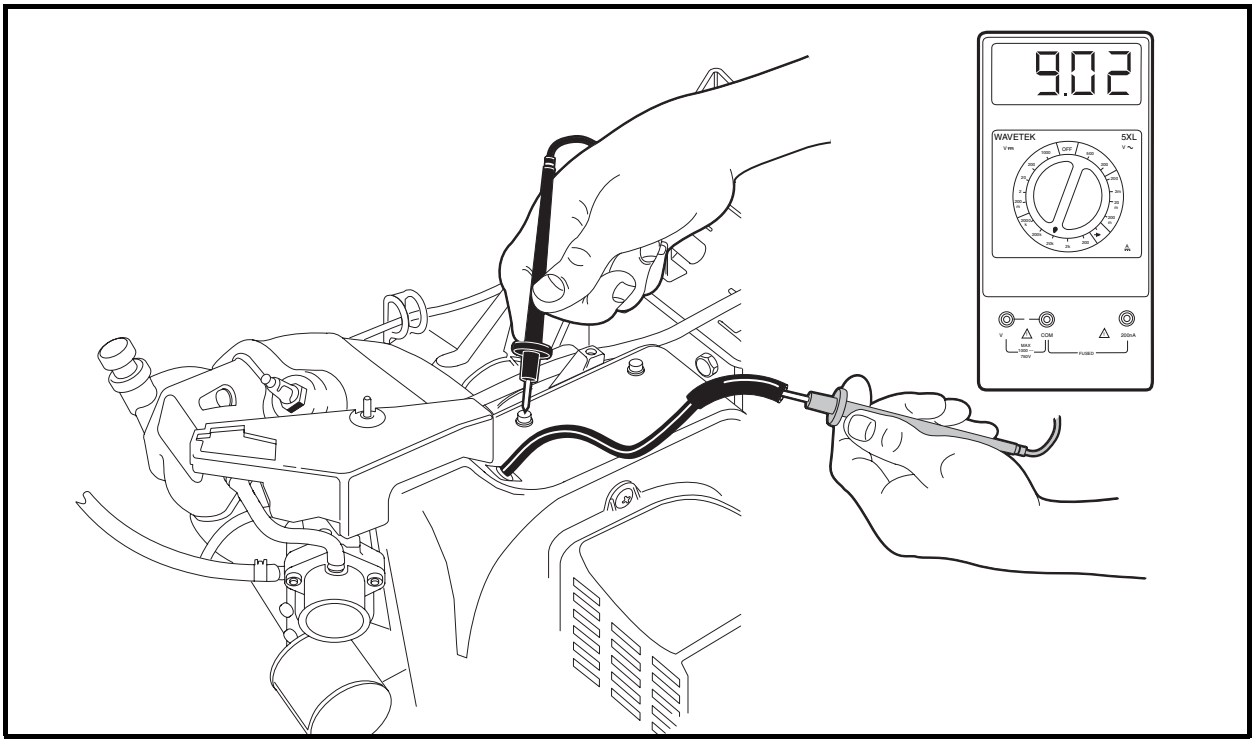


Figure 11-29 Secondary Coil Test Without Cap

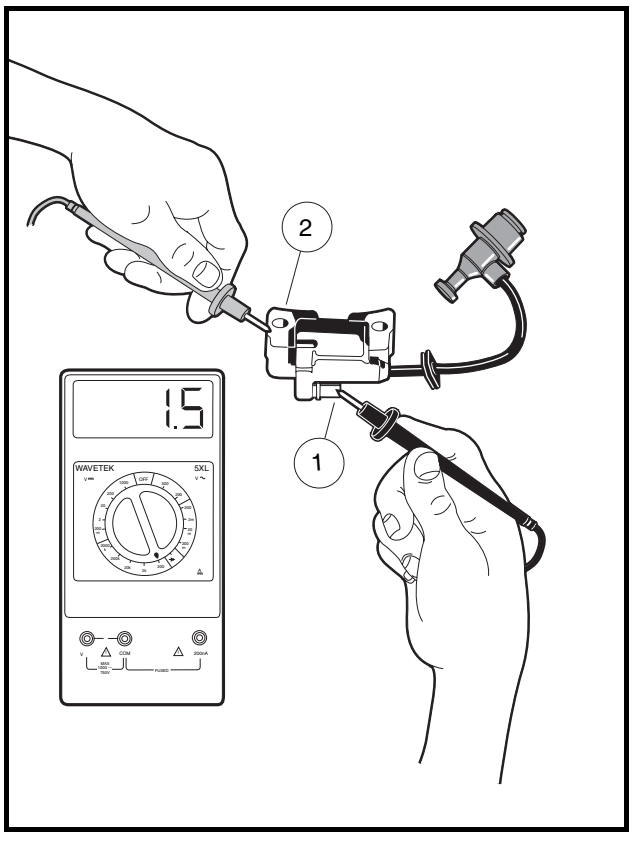


Figure 11-30 Primary Coil Resistance – Bench Test

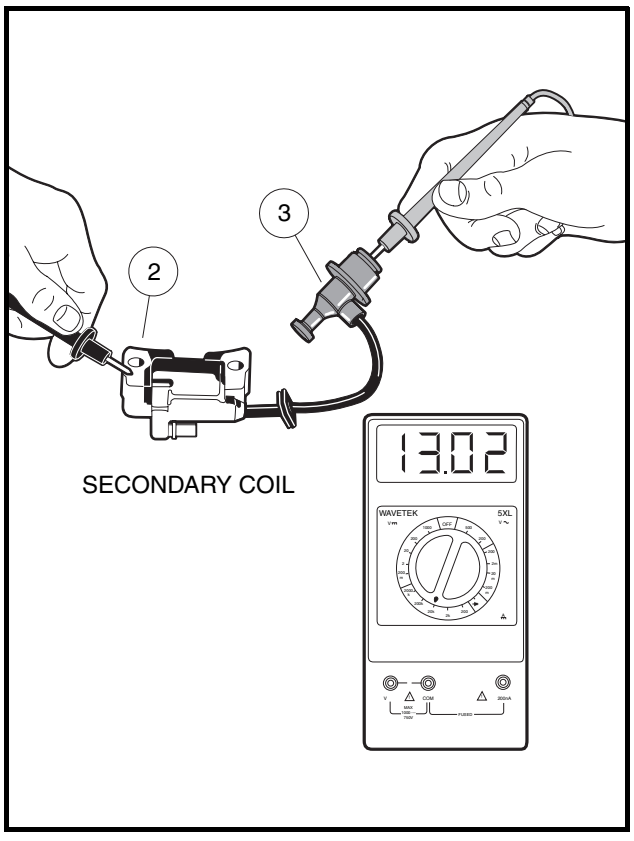


Figure 11-31 Secondary Coil and Cap Resistance – Bench Test

Test Procedure 16 – Ignition Coil, Continued:

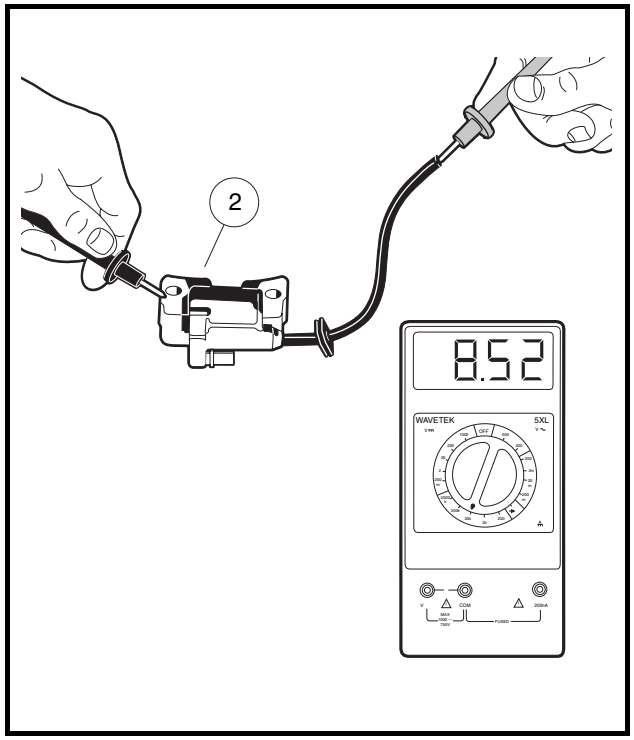


Figure 11-32 Secondary Coil Resistance – Bench Test

4. If not previously tested, test the spark plug cap separately from the secondary coil.
   4.1. Remove the rubber gasket (1) on the plug cap (2) by rolling back the gasket onto the spark plug wire (3) **(Figure 11-26, Page 11-24)**.
   4.2. Remove the cap from the wire by turning the cap counterclockwise three or four revolutions while gently pulling it off the wire **(Figure 11-27, Page 11-24)**.
   4.3. Using a multimeter set to 20k ohms, place the red (+) probe of the multimeter into the end of the spark plug cap that normally connects to the spark plug and place the black (–) probe into the end of the cap with the internal screw **(Figure 11-28, Page 11-26)**. If the resistance is not between 4.5k - 6.0k ohms, the cap has failed and must be replaced. Proceed to the next step with the spark plug cap still removed.
5. Test the secondary coil separately from the spark plug cap.
   5.1. Using a multimeter set to 20k ohms, place the red (+) probe of the meter into the end of the spark plug wire and place the black (–) probe on the core (2) **(Figure 11-32, Page 11-28)**. If the resistance is between 6.0k - 11.0k ohms, the secondary coil is within acceptable limits. If the resistance is not between 6.0k - 11.0k ohms, the ignition coil has failed and must be replaced.
6. If the preceding procedures indicate that the ignition coil resistance readings are within acceptable ranges, but the coil fails to function properly, replace the ignition coil and cap.

TEST PROCEDURE 17 – KEY SWITCH (ENGINE KILL CIRCUIT)

See General Warning, Section 1, Page 1-1.

1. Turn the key switch OFF and remove the key. Place the Forward/Reverse handle in the NEUTRAL position. Chock the wheels.
2. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.**

3. Remove the instrument panel. **See Key Switch Removal, Section 12, Page 12-14.**
4. Remove the connector from the key switch.
5. Place the red (+) probe on the (M) terminal and the black (–) probe on the (G) terminal. With the key switch OFF, the reading should be continuity. With the key switch turned ON, the reading should be no continuity. If either reading is incorrect, replace the key switch **(Figure 11-33, Page 11-29)**.
6. Reconnect the key switch to the wire harness. Ensure that the connector is connected correctly and is tight. If it is not, repair or replace as necessary.

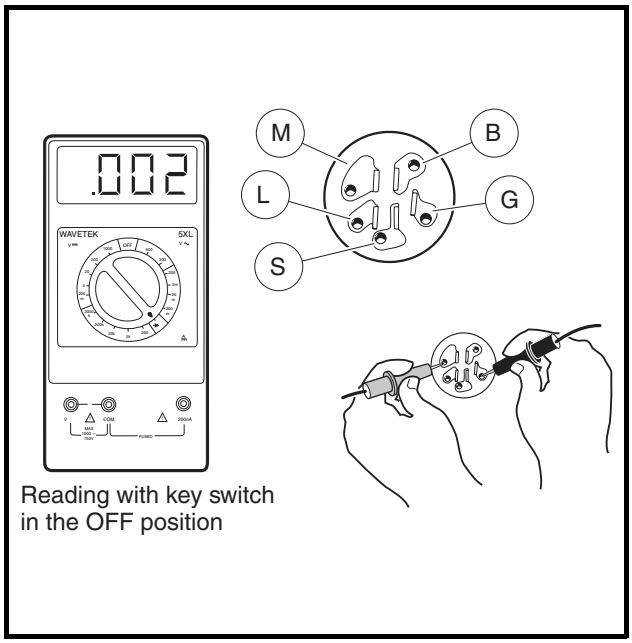


Figure 11-33 Test Key Switch – Engine Kill Circuit

TEST PROCEDURE 18 – ENGINE KILL WIRE

See General Warning, Section 1, Page 1-1.

1. Turn the key switch OFF and remove the key. Place the Forward/Reverse handle in the NEUTRAL position. Chock the wheels.
2. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.**
3. Disconnect white/black wire bullet connector located at the engine RPM limiter **(Figure 11-22, Page 11-22)**.
4. Connect red (+) probe of multimeter to the male bullet terminal on the white/black wire and connect the black (–) probe to the vehicle frame.
5. With the Forward/Reverse handle in the NEUTRAL position, turn the key switch to the ON position and note the multimeter reading. Turn the key and hold it in the START position while noting the multimeter reading. There should be no continuity when the key switch is in the ON or START position. If there is continuity, check for worn insulation on the white/black wire that is allowing the wire to ground to the frame.

TEST PROCEDURE 19 – REVERSE BUZZER LIMIT SWITCH

See General Warning, Section 1, Page 1-1.

NOTE: *Keep the battery connected while performing this test procedure.*

The reverse buzzer limit switch is located on the Forward/Reverse shifter; red/white and orange wires are connected to it.

1. Turn the key switch OFF and remove the key. Place the Forward/Reverse handle in the NEUTRAL position. Chock the wheels.
2. Move the Forward/Reverse handle to REVERSE and listen for an audible click from the limit switch. If there is no click, check the switch for proper alignment and switch arm movement.
3. If the switch is being activated but the buzzer does not function, place the red (+) probe of the multimeter on one terminal and the black (–) probe on the other terminal of the limit switch. Without the lever pressed, the reading should be no continuity. Press the lever and the reading should be continuity. If either reading is incorrect, replace limit switch.

TEST PROCEDURE 20 – REVERSE BUZZER

See General Warning, Section 1, Page 1-1.

The front reverse buzzer is mounted to the instrument panel under the front body.

1. Turn the key switch OFF and remove the key. Place the Forward/Reverse handle in the NEUTRAL position. Chock the wheels.
2. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.**
3. Remove the instrument panel. **See Key Switch Removal, Section 12, Page 12-14.**
4. Check for proper wiring and tight connections. Using a multimeter, individually check for continuity through each wire that connects to the reverse buzzer. If the buzzer will not function when properly wired, replace the buzzer. **See Reverse Warning Buzzer, Section 12, Page 12-18.**

TEST PROCEDURE 21 – OIL LEVEL SENSOR

See General Warning, Section 1, Page 1-1.

NOTE: *Keep the battery connected while performing this test procedure.*

1. Turn the key switch OFF and remove the key. Place the Forward/Reverse handle in the NEUTRAL position. Chock the wheels.
2. Disconnect the spark plug wire. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.**
3. Ensure that the low oil warning light and all connecting wires are functioning correctly. **See Test Procedure 22 – Oil Warning Light on page 11-31.**
4. Drain the engine oil into an approved container and properly dispose of used oil.
5. Turn the key switch ON, closing the circuit. The oil light should illuminate. If the low oil warning light does not illuminate, the oil level sensor may need to be replaced. Refer to Test Procedure 22 before replacing sensor. **See Oil Level Sensor Removal, Section 13, Page 13-5.**
6. Fill the engine with new oil and install a new oil filter before returning the vehicle to service. **See Engine Oil – Gasoline Vehicles, Section 10, Page 10-10.**

TEST PROCEDURE 22 – OIL WARNING LIGHT

See General Warning, Section 1, Page 1-1.

1. Turn the key switch OFF and remove the key. Place the Forward/Reverse handle in the NEUTRAL position. Chock the wheels.
2. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.**
3. Remove the instrument panel. **See Key Switch Removal, Section 12, Page 12-14.**
4. Ensure that the wires are connected correctly and are tight. If they are not, rewire or tighten as necessary.
5. Disconnect the yellow wire (to the oil level sensor) from the terminal on the oil light. Using an alligator clip jumper wire, connect the oil light terminal to the vehicle frame. Connect the red (+) battery cable to the positive (+) battery post, then attach the black (–) cable to the negative (–) battery post.
6. Turn the key switch to the ON position. The oil light should illuminate. If it does not, check continuity of the yellow wire that connects the key switch to the oil light through a sonic weld connection within the wire harness. If there is no continuity in the wire, replace the wire. Then test the key switch. **See Test Procedure 4 – Key Switch (Starter Circuit) on page 11-13.** If the yellow wire and the key switch test okay, then replace the oil light.

TEST PROCEDURE 23 – LOCKOUT CAM

See General Warning, Section 1, Page 1-1.

1. Check to be sure the lobes on the cam are pressing the lockout cam limit switch when the Forward/Reverse shifter is in the NEUTRAL position only. The limit switch should make an audible click as it is pressed. If it does not, check for wear on the cam lobe. If the cam lobe will not activate the limit switch, replace the cam.

TEST PROCEDURE 24 – BATTERY TEST (UNDER LOAD)

See General Warning, Section 1, Page 1-1.

NOTE: *Keep the battery connected while performing this test procedure.*

1. Turn the key switch OFF and remove the key. Place the Forward/Reverse handle in the NEUTRAL position. Chock the wheels.
2. Set a multimeter to 20 volts and place the red (+) probe on the F2 (white wire) terminal on the starter/generator. Place the black (–) probe on the negative battery post.
3. Turn the key switch to the START position and hold it in the START position while noting the voltage reading on the multimeter (with the key in the START position the battery is under load).
   3.1. If the voltage reading is over 9.6 volts at 70 °F (21 °C) (electrolyte temperature) check the starter/generator. **See following NOTE.**

NOTE: *The voltage reading is taken at 70 °F (21 °C). At lower electrolyte temperatures the voltage reading will be lower.*

   3.2. If the reading is below 9.6 volts at 70 °F (21 °C) (electrolyte temperature), check the battery. **See Test Procedure 1 – Battery on page 11-9.**
   3.3. If the reading is zero, there may be NO continuity across the large posts of the solenoid. **See Test Procedure 6 – Solenoid on page 11-15.**
4. If all of the test results are good and the voltage reading is zero, there may be a broken or damaged 6-gauge white wire from the solenoid to the starter/generator. **See Test Procedure 8 – Starter/Generator (Starter Function) on page 11-17.**

TEST PROCEDURE 25 – FUEL LEVEL SENDING UNIT

See General Warning, Section 1, Page 1-1.

⚠ WARNING

- **To avoid the possibility of fire or explosion, make sure the fuel tank cap is securely in place while performing this test procedure.**

1. Turn the key switch to OFF and remove the key. Place the Forward/Reverse handle in the NEUTRAL position. Chock the wheels.
2. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.**
3. Disconnect the orange wire from the center post of the fuel level sending unit.
4. With a multimeter set to 2k ohms, place the red (+) probe of the multimeter on the center post of the sending unit. Place the black (–) probe on the ground connection of the sending unit **(Figure 11-34, Page 11-33)**.
5. The following resistance readings (in ohms) should be obtained depending on the position of the float inside the fuel tank. The resistance reading will vary according to the exact position of the float. The chart below may be used as a guideline to determine if the fuel level sending unit is operating correctly. Make sure the float is at the surface of the fuel in the tank.

FLOAT POSITION	RESISTANCE READING	FUEL GAUGE READINGS
Lower position (tank empty)	240 ± 20 ohms	Empty
Center position (tank half full)	120 ± 20 ohms	Half full
Upper position (tank full)	60 ± 20 ohms	Full

6. If the readings are within the specifications listed above, the fuel level sending unit is working properly. If the readings are incorrect, the fuel level sending unit has failed and the fuel tank must be replaced. **See Fuel Tank Removal, Section 14, Page 14-20.**
7. If the readings are correct and the fuel gauge does not function correctly, check the continuity of the orange wire from the fuel level sending unit to the fuel gauge/hour meter. Leave the battery disconnected while checking continuity. Also check the continuity of the yellow wire from the fuel gauge/hour meter to the key switch, and the black ground wires at the fuel level sending unit and at the fuel gauge/hour meter. **See Fuel Gauge/Hour Meter Removal, Section 12, Page 12-21.**
8. If the readings are correct according to the position of the float, but give an incorrect reading on the fuel gauge/hour meter, test the fuel gauge/hour meter. **See Test Procedure 26 – Fuel Gauge on page 11-33.**

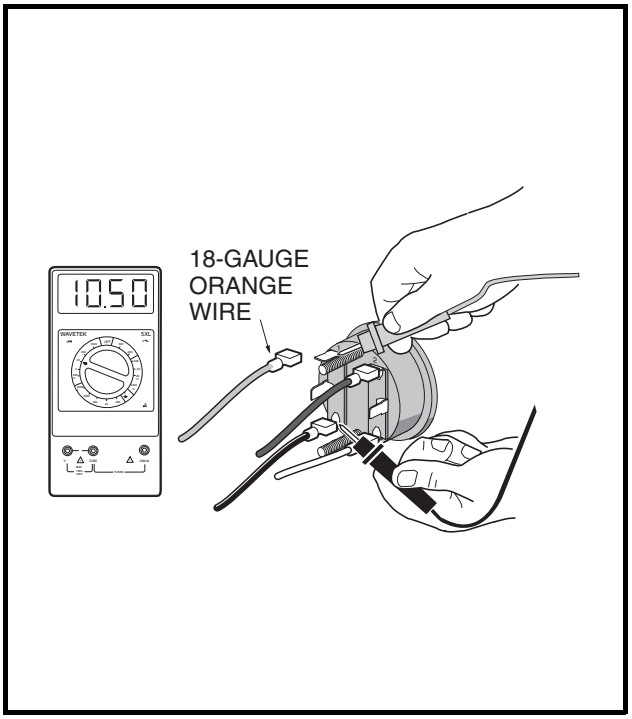


Figure 11-34 Test Fuel Level Sending Unit

TEST PROCEDURE 26 – FUEL GAUGE

See General Warning, Section 1, Page 1-1.

1. Turn the key switch OFF and remove the key. Place the Forward/Reverse handle in the NEUTRAL position. Chock the wheels.
2. Remove the instrument panel to gain access to the back of the fuel gauge/hour meter. **See Key Switch Removal, Section 12, Page 12-14.**
3. Place a sheet of insulating material between the front frame and the electrical connections on the rear of the instrument panel to prevent contact between the two.
4. Disconnect the orange wire from the fuel gauge/hour meter.
5. Set a multimeter to 20 volts DC and place the red (+) probe of the multimeter on the positive post of the battery. Place the black (–) probe on the negative post of the battery. Record the voltage reading.
6. Set a multimeter to 20 volts DC and place the red (+) probe of the multimeter on the (2) terminal of the fuel gauge/hour meter with the blue wire. Place the black (–) probe on the (3) terminal of the fuel gauge/hour meter with the black wire **(Figure 11-35, Page 11-34)**.
7. Connect the battery cables, positive (+) cable first, and tighten to 12 ft-lb (16.3 N·m).
8. Turn the key switch ON. The voltage reading should be the same as the battery voltage reading recorded earlier. If not, check the continuity of the blue and black wires **(Figure 11-35, Page 11-34)**.
9. The orange wire should remain disconnected for this step. With the black probe still on the (3) terminal of the fuel gauge/hour meter, place the red (+) probe of the multimeter on the (1) terminal of the fuel gauge/hour meter **(Figure 11-36, Page 11-34)**. The voltage reading should be the same as the full battery voltage reading obtained in step 5. If the reading is incorrect, replace fuel gauge/hour meter.

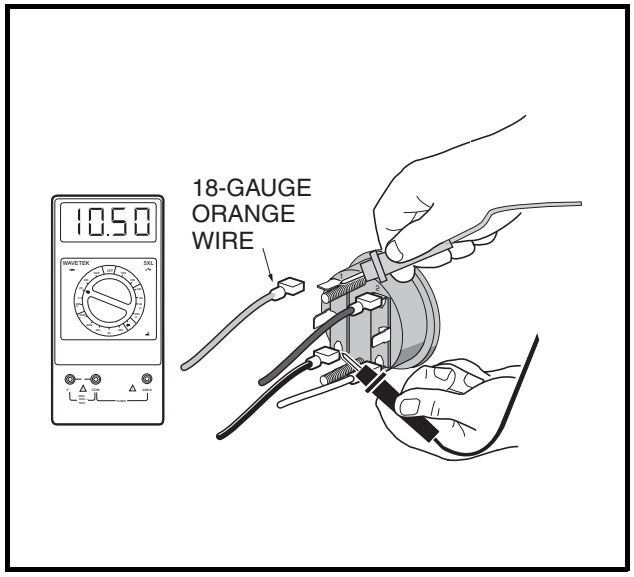


Figure 11-35 Test Fuel Gauge Continuity

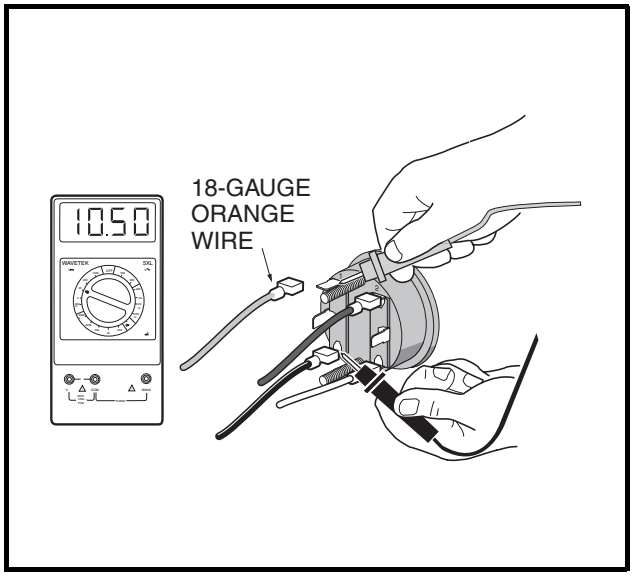


Figure 11-36 Test Fuel Gauge Voltage

TEST PROCEDURE 27 – HOUR METER

See General Warning, Section 1, Page 1-1.

NOTE: *Keep the battery connected while performing this test procedure.*

1. Place the Forward/Reverse handle in the NEUTRAL position. Chock the wheels.
2. Turn the key switch to ON and record the current hour meter reading.
3. Turn the key past the ON position to the START position and hold until the engine is running smoothly. Release the key and it will return to the ON position and the engine should idle.
4. Allow the engine to idle for at least six minutes (the meter records in six-minute increments). **See following DANGER.**

⚠ DANGER

- **Do not operate gasoline vehicle in an enclosed area without proper ventilation. The engine produces carbon monoxide, which is an odorless, deadly poison.**

5. If the reading does not change after six minutes, then replace the fuel gauge/hour meter.

TEST PROCEDURE 28 – LIGHT SWITCH

See General Warning, Section 1, Page 1-1.

1. Turn the key switch OFF and remove the key. Place the Forward/Reverse handle in the NEUTRAL position. Chock the wheels.
2. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.**
3. Remove the instrument panel. **See Key Switch Removal, Section 12, Page 12-14.**

4. Using a multimeter set on 20 volts DC, place alligator clips on the multimeter probes. Connect the red (+) probe to the light switch terminal with the blue wire connected to it **(Figure 11-37, Page 11-35)**.

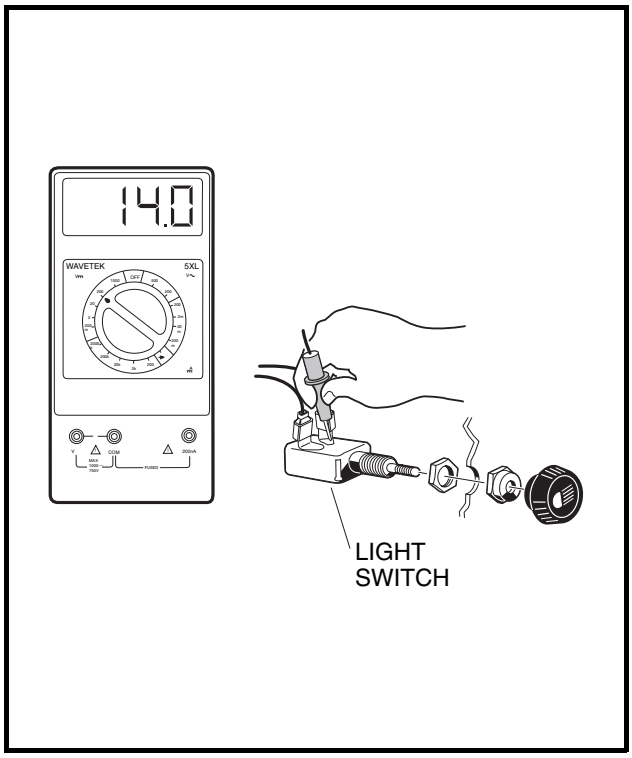


Figure 11-37 Light Switch Test

5. Connect the battery cables, positive (+) cable first.
6. Connect the black (–) probe of the multimeter to the negative (–) post of the battery.
7. With the light switch in the OFF position, the reading should be zero volts. With the light in the ON position, the reading should be between 11 and 12.5 volts. If the there is no voltage reading, check continuity of the 10-gauge red wire from the fuse block to the solenoid. Check continuity of the 14-gauge yellow wire from the light switch to the fuse block. Check the fuse. **See Test Procedure 2 – Fuse on page 11-11.** If the headlight diode is functioning correctly, the wires and fuse show continuity and the readings are still incorrect, replace the switch. **See Light Switch Removal, Section 12, Page 12-28.**

TEST PROCEDURE 29 – HEADLIGHT DIODE

See General Warning, Section 1, Page 1-1.

1. Turn the key switch OFF and remove the key. Place the Forward/Reverse handle in the NEUTRAL position. Chock the wheels.
2. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.**
3. Remove the instrument panel. **See Key Switch Removal, Section 12, Page 12-14.**
4. Using a multimeter set on 20 volts DC, connect the red (+) probe to the light switch terminal with the yellow wire **(Figure 11-38, Page 11-36)**.

Test Procedure 29 – Headlight Diode, Continued:

5. Loosen the black wire connector (on the end of the long black wire) at the headlight diode assembly just enough to maintain the connection and yet expose part of the metal terminal in the connector. Place black (–) probe on the connector **(Figure 11-38, Page 11-36)**.
6. Connect the battery, positive (+) cable first.
7. Pull the light switch to the ON position. The reading should be 11-12 volts. If the there is no voltage reading, check continuity of the 16-gauge black wire from the headlight to the headlight diode. Check continuity of the 16-gauge black wire from headlight diode to the vehicle frame. If the wires show continuity and the readings are still incorrect, replace the headlight diode. **See Headlight Diode Removal, Section 12, Page 12-28.**
8. With the Forward/Reverse handle in the NEUTRAL position and the wheels chocked, start the engine and press the accelerator pedal to the floor.
9. Push the light switch to the OFF position. The reading should be 14.7-15.3 volts.
10. Pull the light switch to the ON position. The reading should be 11-13 volts. If the reading does not drop from 14.5-15.5 volts to 11-13 volts, replace the voltage limiter.

TEST PROCEDURE 30 – VOLTAGE AT HEADLIGHT SOCKET

See General Warning, Section 1, Page 1-1.

NOTE: *Keep the battery connected while performing this test procedure.*

1. Turn the key switch OFF and remove the key. Place the Forward/Reverse handle in the NEUTRAL position. Chock the wheels.
2. Inspect wires at the light bulb socket. Make sure wires are securely fastened to the contacts inside socket.

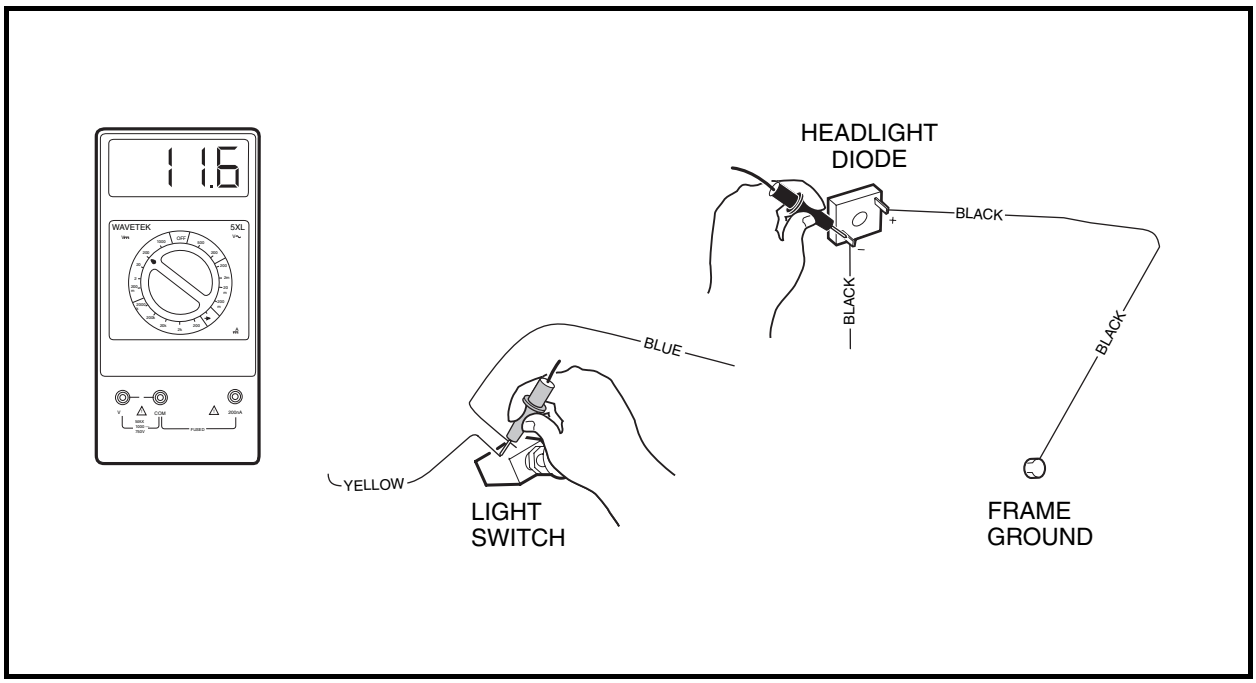


Figure 11-38 Headlight Diode Circuit Test

3. Remove the wire harness from the headlight **(Figure 11-39, Page 11-37)**.
4. Using a multimeter set to 20 volts DC, place the black (–) probe of multimeter into the black wire terminal of the wire harness. Place the red (+) probe into the blue wire terminal.
5. Pull the light switch to the ON position. If the multimeter reads approximately 12 volts, replace the headlight bulb.
6. If there is no voltage reading at the wire harness, check continuity of the 16-gauge blue wire from the headlight to the light switch. Using a multimeter set to 20 volts DC, attach using an alligator clip, the black (–) probe of multimeter onto the negative battery terminal and place the red (+) probe into the blue wire terminal of the wire harness. If the multimeter reading is approximately 12 volts, the blue wire has continuity.
7. Check continuity of the 16-gauge black wire from the headlight to the ground terminal. Using a multimeter set to 20 volts DC, place the black (–) probe of multimeter into the black wire terminal of the wire harness and attach using an alligator clip, the red (+) probe onto the positive battery terminal. If the multimeter reading is approximately 12 volts, the black wire has continuity.

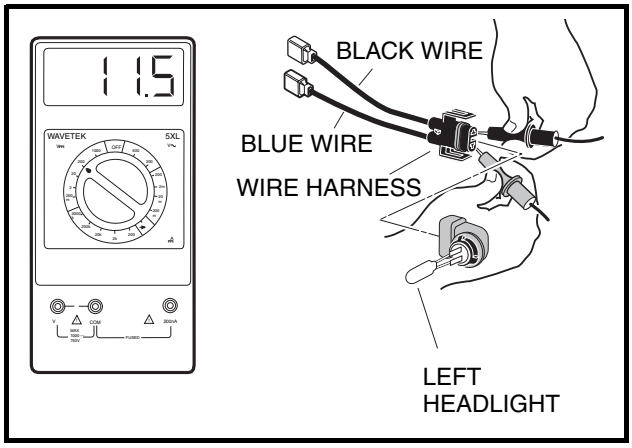


Figure 11-39 Check Voltage to Headlight Socket

SECTION 12 – ELECTRICAL COMPONENTS: GASOLINE VEHICLES

⚠ DANGER

- **See General Warning, Section 1, Page 1-1.**

⚠ WARNING

- **See General Warning, Section 1, Page 1-1.**

STARTER/GENERATOR

See General Warning, Section 1, Page 1-1.

Testing the Starter/Generator

See Test Procedure 8, Section 11, Page 11-17. Also See Test Procedure 11, Section 11, Page 11-20.

Starter/Generator Removal

1. Make sure the key switch is OFF and the Forward/Reverse handle is in the NEUTRAL position. Chock the wheels.
2. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.**
3. Disconnect the wires from the starter/generator (1). Mark wires before disconnecting. Loosen the pivot nuts (7) and bolts (5) **(Figure 12-1, Page 12-2)**.
4. Remove the mounting/adjustment nut (12), washer (9) and bolt (11). Lower the starter/generator and slip the belt (4) off the pulley (10).
5. Support the starter/generator so that when the pivot bolts are removed the starter/generator will not fall to the ground. Remove the two pivot nuts (7) and bolts (5) from the mounting bracket.
6. Remove the starter/generator.

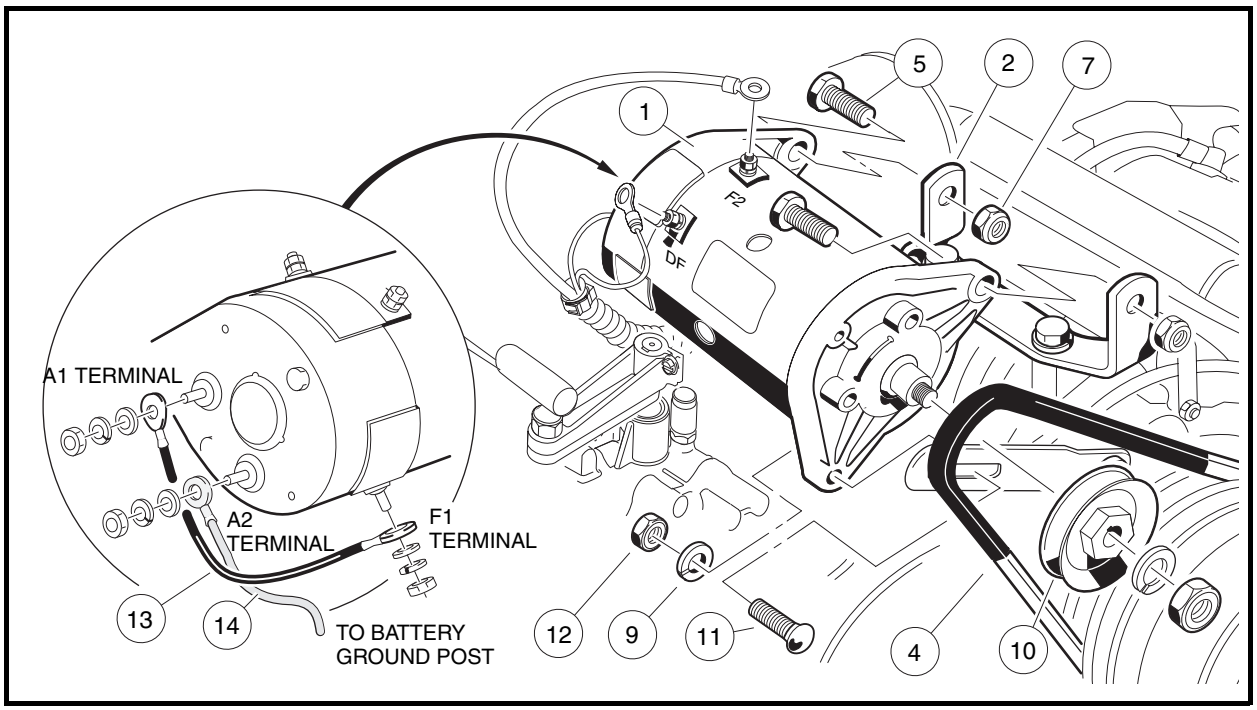


Figure 12-1 Starter/Generator Removal

Disassembly of the Starter/Generator to Service the Brushes

1. Remove the two bolts (20) and pull commutator end cover (23) free of starter/generator housing (24) **(Figure 12-2, Page 12-2)**. **See following NOTE.**

NOTE: *Brushes must be removed to avoid damage from commutator removal. Lift the brush springs out of the notches in the brushes and pull the brushes back from the center of the commutator end cover. The springs will help prevent them from sliding back towards the center* ***(Figure 12-6, Page 12-4).***

2. Remove brush covers (29 and 30), screws (25), lockwashers (26), brush springs (28) and brushes (27) **(Figure 12-3, Page 12-2)**. **See following NOTE.**

NOTE: *To clean and inspect the armature/commutator and the bearings,* ***see Disassembly of the Starter/Generator to Service the Armature/Commutator on page 12-4.***

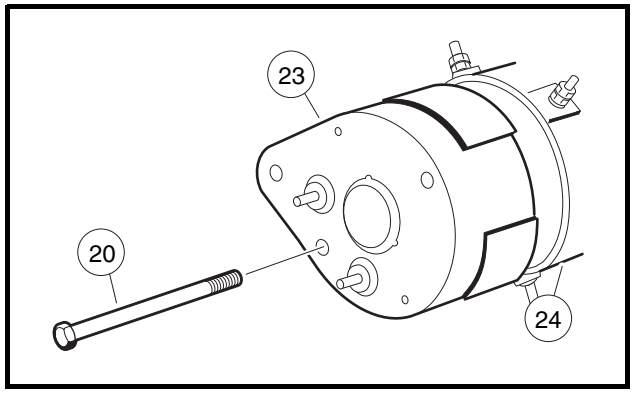


Figure 12-2 Commutator End Cover

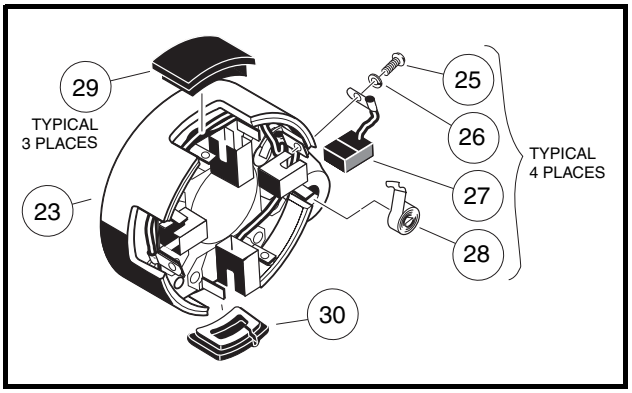


Figure 12-3 Brush Covers and Brushes

Brush Inspection and Replacement

1. Visually inspect brushes. Replace brushes that are cracked or severely chipped.
2. Check the wear line on the side of the brush. If the end of the brush is within 1/16-inch (1.6 mm) of the wear line, replace all four brushes **(Figure 12-4, Page 12-3).**

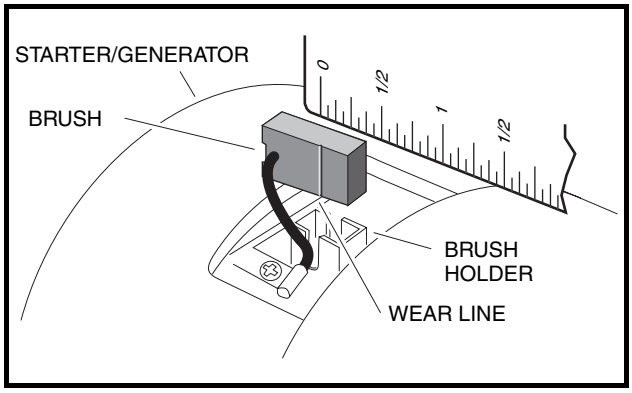


Figure 12-4 Inspect Brushes

Brush Spring Inspection and Replacement

1. Visually inspect springs. Replace all four springs if any spring is discolored from heat (straw or bluish in color).
2. Install the four brushes (27) into their holders and insert the four brush springs (28) **(Figure 12-3, Page 12-2)**. Using a spring scale, test brush spring tension. If any spring has a tension less than 24 ounces (6.67 N), replace all four springs **(Figure 12-5, Page 12-3)**. **See following CAUTION.**

CAUTION

- **When checking brush spring tension, do not push springs beyond the point they would normally be if there were new brushes installed. Exerting excessive force or pushing brush springs beyond their normal maximum extension point will damage springs.**

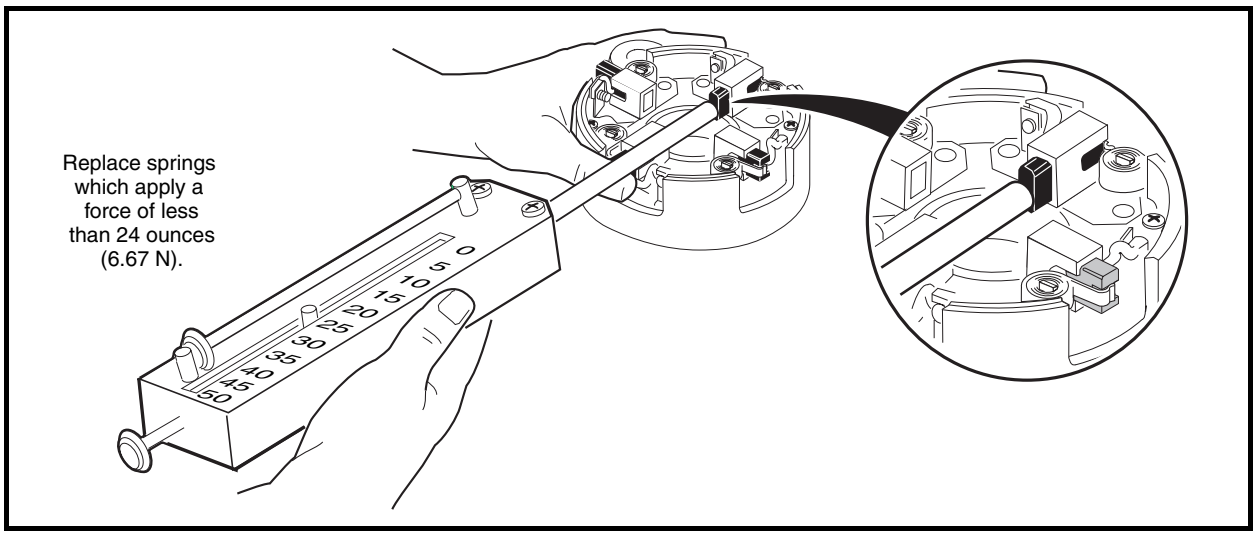


Figure 12-5 Brush Spring Tension Test

Starter/Generator Assembly

1. Connect the brush wires to the holders using four lockwashers (26) and four screws (25). Make sure the crossover leads are also connected. Tighten the screws to 31 in-lb (3.5 N·m) **(Figure 12-3, Page 12-2)**.
2. Install the commutator. Lift the brush springs out of the notches in the brushes and pull the brushes back from the center of the commutator end cover to avoid interference. The springs will rest on the sides of the brushes and help prevent them from sliding to the center **(Figure 12-6, Page 12-4)**.
3. Install the commutator end cover (23) onto the armature shaft. Align the locating pin and hole in the cover. Install two M6 x 180 mm bolts (20) and tighten to 100 in-lb (11.3 N·m) **(Figure 12-2, Page 12-2)**.
4. Push the brushes down into the holders. Place springs into the notches in the brushes. Install the brush cover (30) that has the drain hole in it next to the A2 terminal. Install the remaining three brush covers (29) onto the openings in the commutator end cover (23) **(Figure 12-3, Page 12-2)**.

Disassembly of the Starter/Generator to Service the Armature/Commutator

1. Remove the two bolts (20), and pull commutator end cover (23) free of the starter/generator housing (24) **(Figure 12-2, Page 12-2)**. **See following NOTE.**

NOTE: *Brushes must be removed to avoid damaged from commutator removal. Lift the brush springs out of the notches in the brushes and pull the brushes back from the center of the commutator and cover. The springs will help prevent them from sliding back towards the center* ***(Figure 12-6, Page 12-4)****.*

2. Remove nut (41), lockwasher (40), pulley (39), shaft key (34), spacer (37) and bearing retainer screws (43) and separate armature (33) from output end cover (36) **(Figure 12-7, Page 12-5)**.

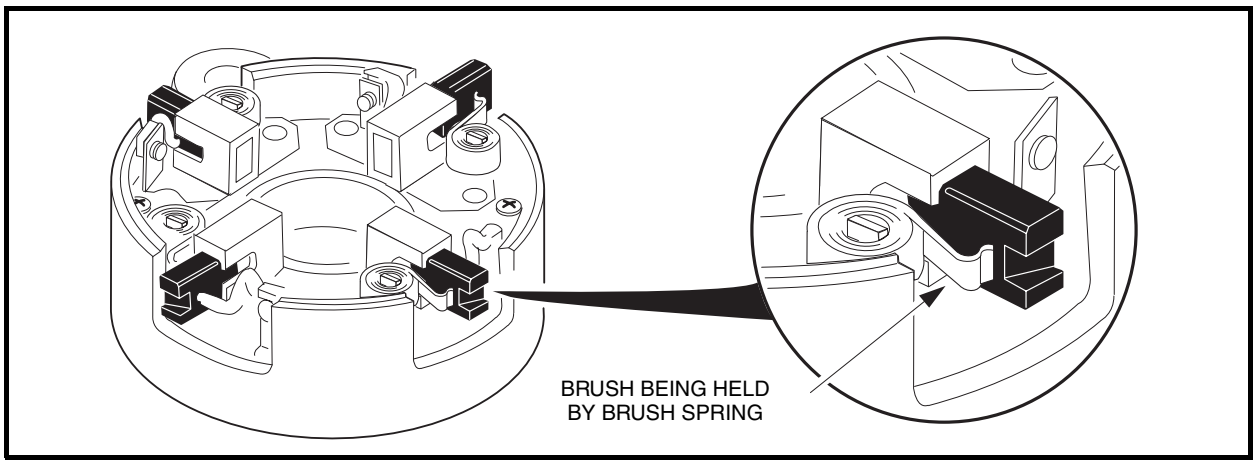


Figure 12-6 Pull Brushes Away From Center of the Commutator End Cover

Bearing Cleaning and Inspection

1. Wipe the carbon dust from the two bearings. Inspect bearings by spinning them by hand and checking for both axial (A) and radial (B) play **(Figure 12-8, Page 12-5)**.
2. Replace the bearing if it is noisy, does not spin smoothly or has excessive play. Replace if rusted, worn, cracked, or if there is an abnormal color change in the metal of the bearing. Replace if there is extensive wear or pitting on the balls or rolling surfaces. Do not remove bearings unless they are to be replaced.

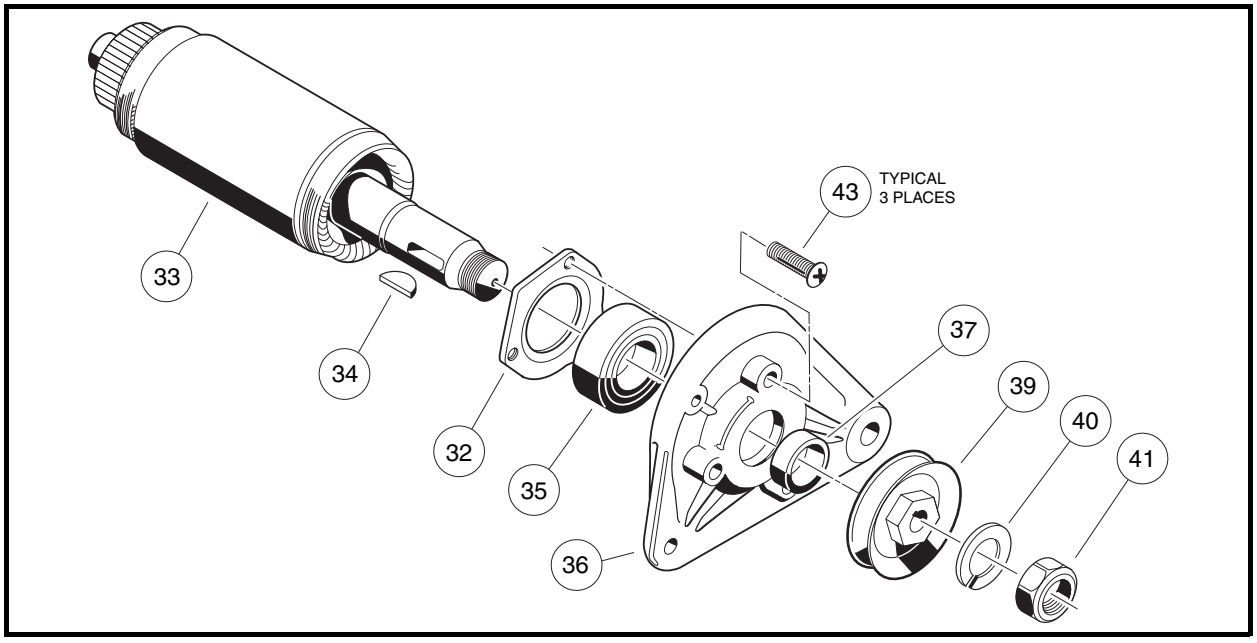


Figure 12-7 Armature and Output End Cover Assembly

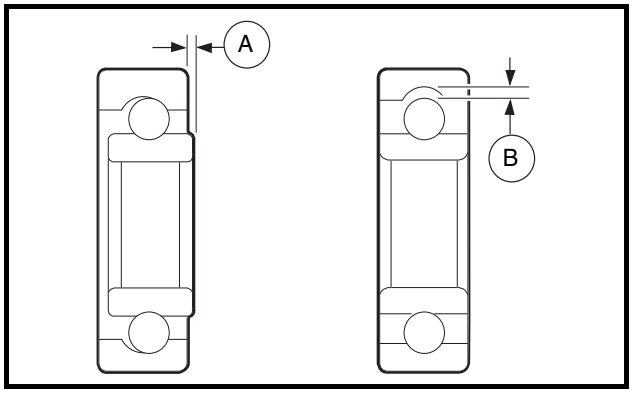


Figure 12-8 Bearing Play Inspection

Bearing Removal

1. Place the wedge attachment tool (CCI P/N 1012812) between the bearing and the armature. Make sure the wedge attachment tool is supporting the inner race of the bearing. If a press is not available, secure a bearing puller (CCI P/N 1012811) to the wedge attachment tool and pull the bearing off of the end of the armature shaft. Support the armature so that it will not drop when the bearing is removed **(Figure 12-9, Page 12-6).**
2. Discard the bearings.
3. Slide the bearing retainer (32) off of the output end of the shaft **(Figure 12-7, Page 12-5)**.

Field Coil Removal

1. Remove the retaining nut from each field coil terminal and slide the insulator out of the slots in the housing. Remove the four pole piece screws from the housing. Remove the four pole pieces from inside the housing. Remove the field coils from the inside of the housing **(Figure 12-10, Page 12-6)**. **See following NOTE.**

NOTE: *Do not remove the insulators or the field coils unless an electrical test indicates that it is necessary* ***(Figure 12-10, Page 12-6)****.* ***See Test Procedure 8, Section 11, Page 11-17.***

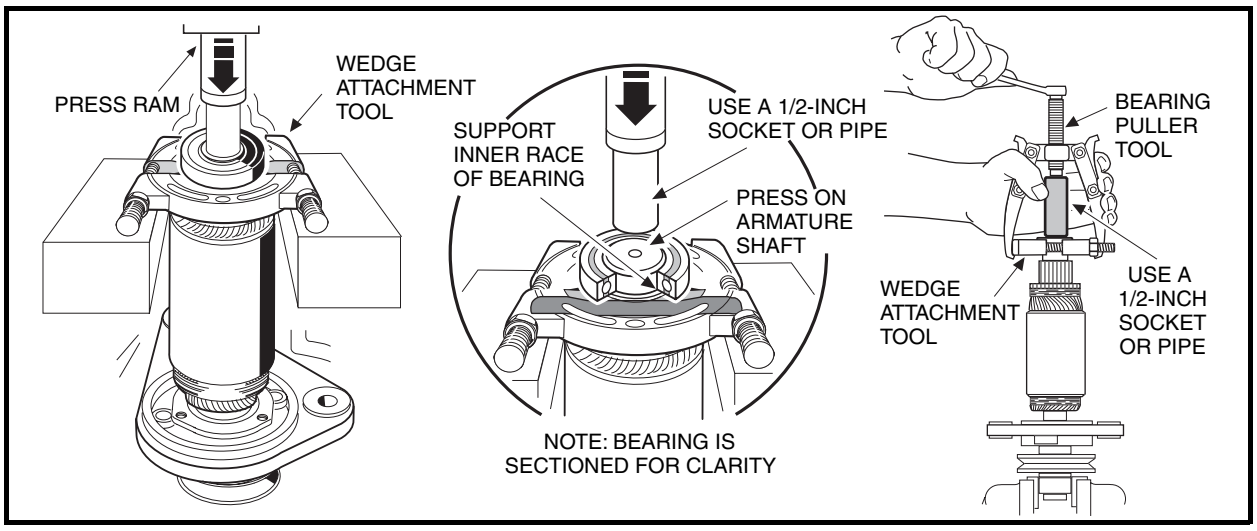


Figure 12-9 Bearing Removal

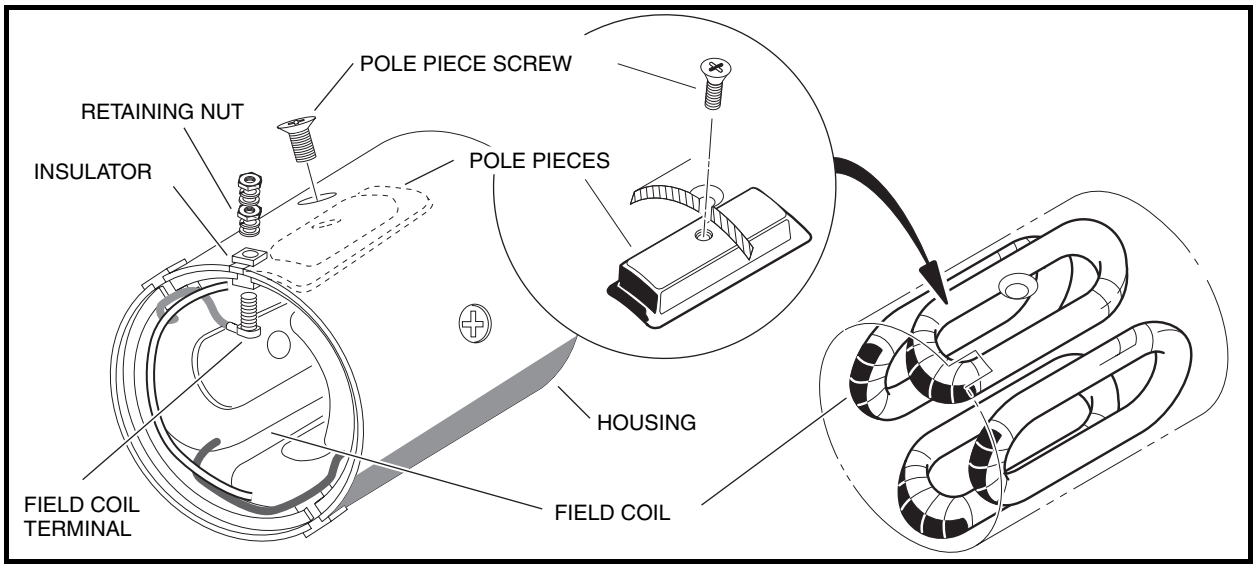


Figure 12-10 Field Coil Removal

Visual Inspection of Armature and Commutator

Some defects can be seen by examining the armature and commutator. Defects seen during the visual inspection can aid in diagnosing the original cause of the failure. Items to look for are listed below.

- Burned, charred or cracked insulation
- Improperly cured varnish
- Thrown solder
- Flared armature windings
- Worn, burned or glazed commutator
- Loose or raised commutator bars
- Bruised or damaged armature core laminations
- Worn armature bearing or shaft
- Dirty or oily commutator

Commutator Cleaning and Inspection

1. Clean the carbon dust, dirt and oil from the commutator. Slight roughness of the commutator can be polished away with 400 grit (or finer) sandpaper. **See following CAUTION**.

CAUTION

- **Never use emery cloth on the commutator. Particles of emery are conductive and may short-circuit the commutator bars. Never use oil or lubricants on the commutator or brushes.**

2. Use a micrometer and measure the outside diameter at four points: two points 90° to each other to the outside end of the commutator (A^1 and A^2), and two points 90° to each other to the inside of the commutator (B^1 and B^2). If the commutator diameter is less than 1.535 inches (39 mm) at any of the four locations, replace the armature assembly and bearings **(Figure 12-11, Page 12-7)**.

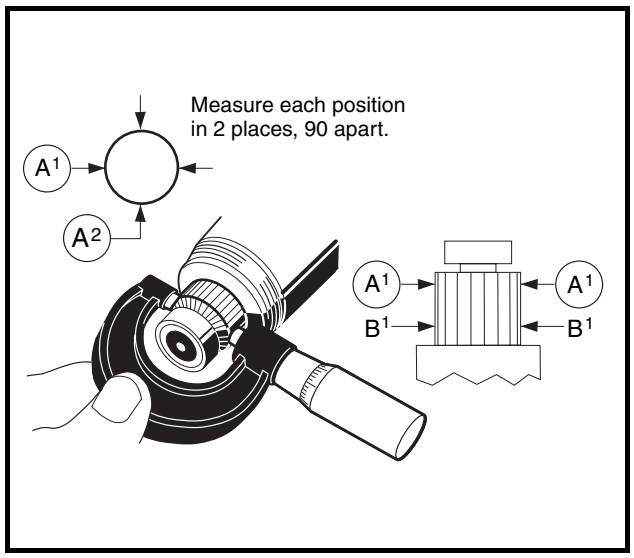


Figure 12-11 Inspect Commutator

Armature Ground Test

CAUTION

- **Do not submerge armature in solvent.**

NOTE: *Before testing, wipe the armature with a clean cloth and remove carbon dust and metal particles from between commutator bars.*

1. Use a multimeter set on 200 ohms and place the positive (+) probe on the commutator bars and the negative (–) probe on the armature core. The reading should be no continuity. If the reading is incorrect, replace the armature and the two bearings **(Figure 12-12, Page 12-8)**.

Visual Inspection of Field Coils

Burned, blackened, charred or scorched coil insulation indicates the starter/generator has overheated due to overloads, grounding or shorted coil windings and should be replaced. Be sure the insulators are tight in the housing.

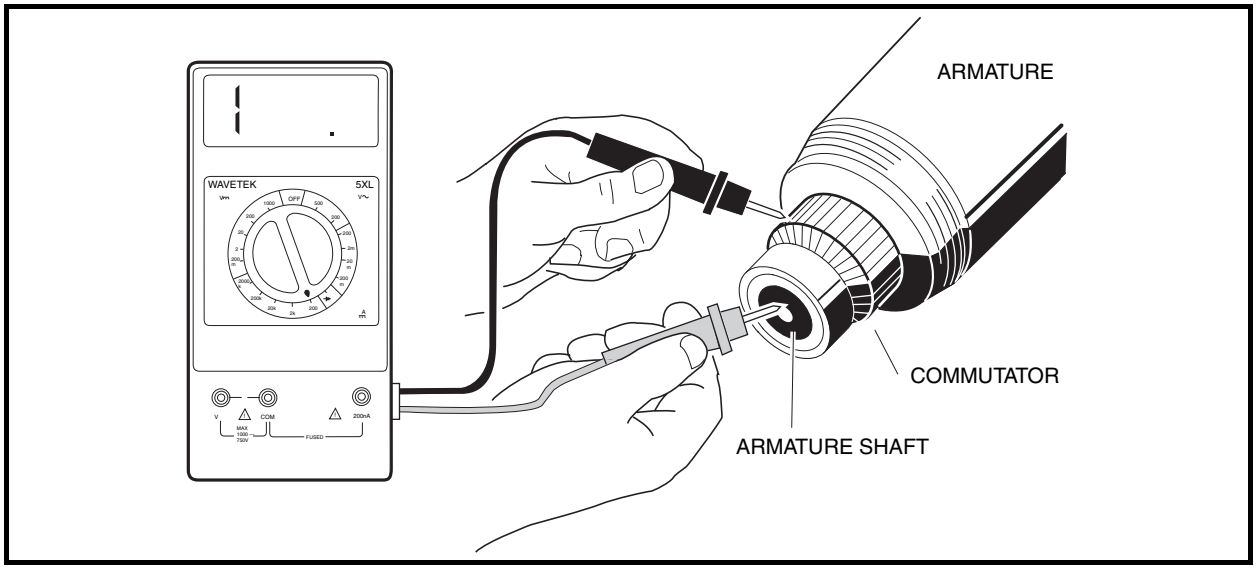


Figure 12-12 Armature Ground Test

Starter/Generator Rework

Any rework must be performed by a qualified technician. Starter/Generator service specifications are listed in the following table.

ITEM	SERVICE LIMIT
Commutator diameter (minimum)	1.535 in. (39 mm)
Concentric with armature shaft within	0.002 in. (0.051 mm)
Limit depth of cut when machining commutator	0.007 in. (0.2 mm)
If undercut of segment insulator is less than 0.016 inch (0.406 mm), then it should be undercut to	0.031 in. (0.8 mm)
Dielectric strength	500 VAC for one minute
Armature insulation resistance	0.2M ohms at 500 VDC
Starter field coil resistance	0.006-0.01 ohms
Generator field coil resistance	4.5-5.5 ohms

Starter/Generator Assembly

1. Place the field coil into the housing. The two insulators that look alike fit into the slots next to the F1 and F2 markings on the outside of the housing. The insulator that looks different slides into the slot next to the DF marking.
2. After the insulators are seated in the slots, install the threaded terminals through the wire connectors and then through the insulators. Install a flat washer, lockwasher and nut onto each threaded terminal on the outside of the housing. Tighten nuts to 47.5 in-lb (5.4 N·m) **(Figure 12-10, Page 12-6)**. **See following CAUTION.**

CAUTION

- **Route the field terminal wires so that they will not contact the armature.**

3. Install the four pole pieces into the housing. Use the four screws to secure pole pieces to the inside of the housing to retain the field wires. Tighten screws to 9 ft-lb (12.2 N·m) **(Figure 12-10, Page 12-6)**.
4. Slide the bearing retainer onto the output end of the armature shaft (33) so that it will hold the outside of the bearing (35) only **(Figure 12-7, Page 12-5)**.
5. Press a new ball bearing (35) onto the output end of the armature **(Figure 12-7, Page 12-5)**. Press a new ball bearing onto the commutator end of the armature shaft. **See following CAUTION.**

CAUTION

- **Use care while pressing new bearing onto the output end of the shaft to prevent damage to the retainer.**
- **Press against the inner race of the new bearing until it is fully seated.**

6. Install the output end cover (36) onto the armature. Secure the bearing retainer (32) to the cover and tighten the screws (43) to 39 in-lb (4.4 N·m) **(Figure 12-7, Page 12-5)**.
7. Slide the housing with field coils over the armature. Use the locating pin to align housing to the cover.

NOTE: *The terminal insulators should be on the commutator end of the housing.*

8. Install the commutator. Lift the brush springs out of the notches in the brushes and pull the brushes back from the center of the commutator end cover to avoid interference. The springs will rest on the sides of the brushes and help prevent them from sliding to the center of the cover **(Figure 12-6, Page 12-4)**.
9. Install the commutator end cover (23) onto the armature shaft. Align the locating pin and hole in the cover. Install the two M6 x 180 mm bolts (20) and tighten to 100 in-lb (11.3 N·m) **(Figure 12-2, Page 12-2)**.
10. Push the brushes down into the holders. Place springs into the notches in the brushes. Install the brush cover (30) that has the drain hole in it next to the A2 terminal. Install the remaining three brush covers (29) onto the openings in the commutator end cover (23) **(Figure 12-3, Page 12-2)**.
11. Slide the spacer (37) onto the end of the shaft. Insert the shaft key (34) into the shaft. Install the belt pulley (39) onto the shaft and install the lockwasher (40) and M14 nut (41) and tighten the nut to 28 ft-lb (38 N·m) **(Figure 12-7, Page 12-5)**.

Starter/Generator Installation

1. Install the green wire from the F1 terminal to the A1 terminal on the starter/generator **(Figure 12-1, Page 12-2)**. Install a flat washer, lockwasher, and nut onto each terminal and tighten to 48 in-lb (5.4 N·m).
2. Install two 3/8-inch hex-head pivot bolts (5) into the mounting bracket with the heads of the bolts facing towards the driver side of the vehicle. Position the starter/generator in the mounting bracket so that the bolts will go through the starter/generator before going through the bracket. Install a locknut (7) onto each bolt and tighten to finger-tight **(Figure 12-13, Page 12-10)**.
3. Install the adjustment bolt (11) through the adjusting bracket (4) and then through the starter/generator. Install a lockwasher (9) and 5/16-inch nut (12) onto the end of the adjustment bolt (11) and tighten to finger- tight **(Figure 12-13, Page 12-10)**.
4. Install the belt (3), then tighten the mounting bolts. **See Belt Tension Adjustment on page 12-10.**
5. Connect the yellow wire from the voltage regulator to the DF terminal on the starter/generator. Install a flat washer, lockwasher and nut onto the terminal and tighten the nut to 31 in-lb (3.5 N·m).

Starter/Generator Installation, Continued:

6. Install the white wire from the solenoid to the F2 terminal on the starter/generator. Install the black wire from the frame to the A2 terminal on the starter/generator. Install a flat washer, lockwasher and nut onto each terminal, and tighten the nut to 48 in-lb (5.4 N·m).
7. Connect the battery cables, positive (+) cable first, and tighten the terminals to 12 ft-lb (16.3 N·m). Coat terminals with Battery Terminal Protector Spray (CCI P/N 1014305).

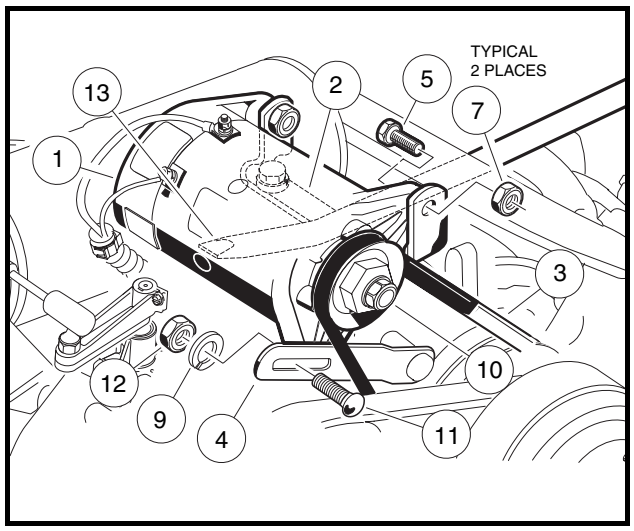


Figure 12-13 Starter/Generator Assembly

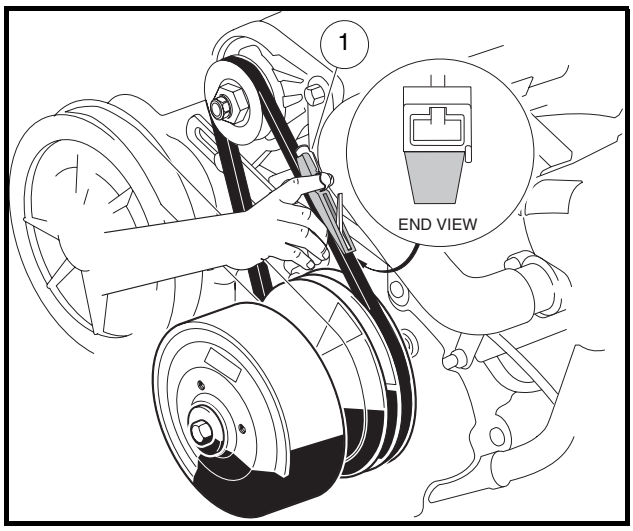


Figure 12-14 Belt Tension Gauge

Belt Tension Adjustment

Belt tension should be checked periodically. If the belt slips when starter/generator motor operates, adjust belt to correct tension.

1. Turn the key switch is OFF and remove the key. Place the Forward/Reverse handle in the NEUTRAL position. Chock the wheels.
2. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.**
3. Make sure the two pivot bolts (5) on the mounting bracket, carriage bolt (11) and hex nut (12) are finger-tight **(Figure 12-13, Page 12-10)**.
4. Push the starter/generator down to its lowest point of adjustment travel. With the starter/generator belt in place around the drive clutch pulley, install the starter/generator belt (3).
5. Place a pry bar (13) between the top of the starter/generator mounting bracket (2) and the underside of the starter/generator, by passing the pry bar under the exhaust header.
6. Hold the pry bar and measure the belt tension using a Krikit® gauge (1) (available at NAPA® Auto Parts stores), or equivalent. Proper tension for a new starter/generator belt should be 75 ft-lb (101.7 N·m), or 45 ft-lb (61 N·m) for an existing belt **(Figure 12-14, Page 12-10)**.
7. While maintaining the tension, tighten the adjustment nut (12) to 12 ft-lb (16.3 N·m). Tighten the two pivot bolts (5) and hex nuts (7) to 23 ft-lb (31.2 N·m) **(Figure 12-13, Page 12-10). See following CAUTION.**

⚠ CAUTION

- **Remove pry bar before starting engine.**

8. Connect the battery cables, positive (+) cable first, and tighten the terminals to 12 ft-lb (16.3 N·m). Coat terminals with Battery Terminal Protector Spray (CCI P/N 1014305).

VOLTAGE REGULATOR

See General Warning, Section 1, Page 1-1.

Testing the Voltage Regulator

See Test Procedure 12, Section 11, Page 11-20.

Voltage Regulator Removal

1. Turn the key switch OFF and remove the key. Place the Forward/Reverse handle in the NEUTRAL position. Chock the wheels.
2. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.**
3. Remove the air intake hose from the carburetor.
4. Remove the electrical component box cover.
5. Disconnect the voltage regulator red wire (1) at the large post on the solenoid, the yellow wire (4) at the bullet connector and the black wire (7) from the wire harness and at the battery frame ground **(Figure 12-15, Page 12-11)**.
6. Remove the voltage regulator mounting screw (8) and remove the voltage regulator (9).

Voltage Regulator Installation

1. Position the voltage regulator (9) in the electrical component box and install the mounting screw (8) and tighten screw to 23 in-lb (2.6 N·m) **(Figure 12-15, Page 12-11)**.
2. Connect the voltage regulator red wire (1) at the large post on the solenoid with the other red wires, the yellow wire (4) at the bullet connector and the black wire (7) to the wire harness and the battery frame ground **(Figure 12-15, Page 12-11)**.
3. Install electrical component box cover. Be sure to firmly press down all corners. Install screw and tighten to 18 in-lb (2 N·m).
4. Install the air intake hose onto the carburetor.
5. Connect the battery cables, positive (+) cable first, and tighten the terminals to 12 ft-lb (16.3 N·m). Coat terminals with Battery Terminal Protector Spray (CCI P/N 1014305).
6. With the Forward/Reverse handle in the NEUTRAL position, start the engine and check regulator for proper functioning as described in the voltage regulator test procedure. **See Test Procedure 12, Section 11, Page 11-20.**

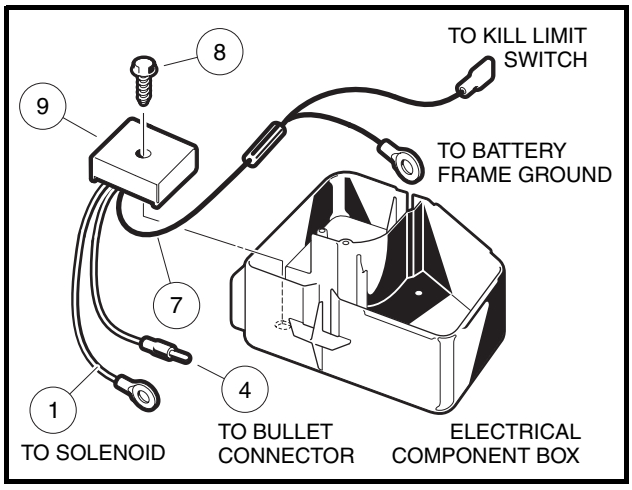


Figure 12-15 Voltage Regulator

DIODE

See General Warning, Section 1, Page 1-1.

Testing the Diode

See Test Procedure 10, Section 11, Page 11-18.

Diode Removal

1. Turn the key switch OFF and remove the key. Place the Forward/Reverse handle in the NEUTRAL position. Chock the wheels.
2. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.**
3. Remove the carburetor air intake hose to allow easy access to the electrical component box cover.
4. Remove the cover screw (5) and electrical component box cover (6) **(Figure 12-16, Page 12-13)**.
5. Remove the nuts (7) from the two large solenoid posts and disconnect the diode wires from the solenoid.
   5.1. Observe color orientation of the wires with the terminal locations on the solenoid. The 12-gauge red wire from the diode should be attached to the same terminal as the red wire from the fuse block, and the red wire from the battery. The 12-gauge white wire should be attached to the other large solenoid post, along with the red wire from the voltage regulator and the white wire from the starter/generator.
6. Remove the nut (3) and remove the diode (2) and thermal transfer pad (1) from the vehicle frame **(Figure 12-16, Page 12-13)**.

Diode Installation

1. Thoroughly clean and dry the area of the I-beam where the new diode is to be attached.
2. Peel the protective film from both sides of the new thermal pad (1) **(Figure 12-16, Page 12-13)**. **See following CAUTION.**

CAUTION

- **Be sure to remove and discard the protective film from both sides of the thermal pad before installing it. If not removed, the film will reduce the thermal heat transfer and therefore reduce the power handling capability of the diode, causing it to overheat and damage the electrical system.**

3. Mount the diode (2) using the thermal transfer pad (1) and mounting nut (3) and tighten to 25 in-lb (2.8 N·m) **(Figure 12-16, Page 12-13)**. **See following NOTE.**

NOTE: *Diodes are mounted in one of two different locations, depending on the vehicle model **(Figure 12-16, Page 12-13)**.*

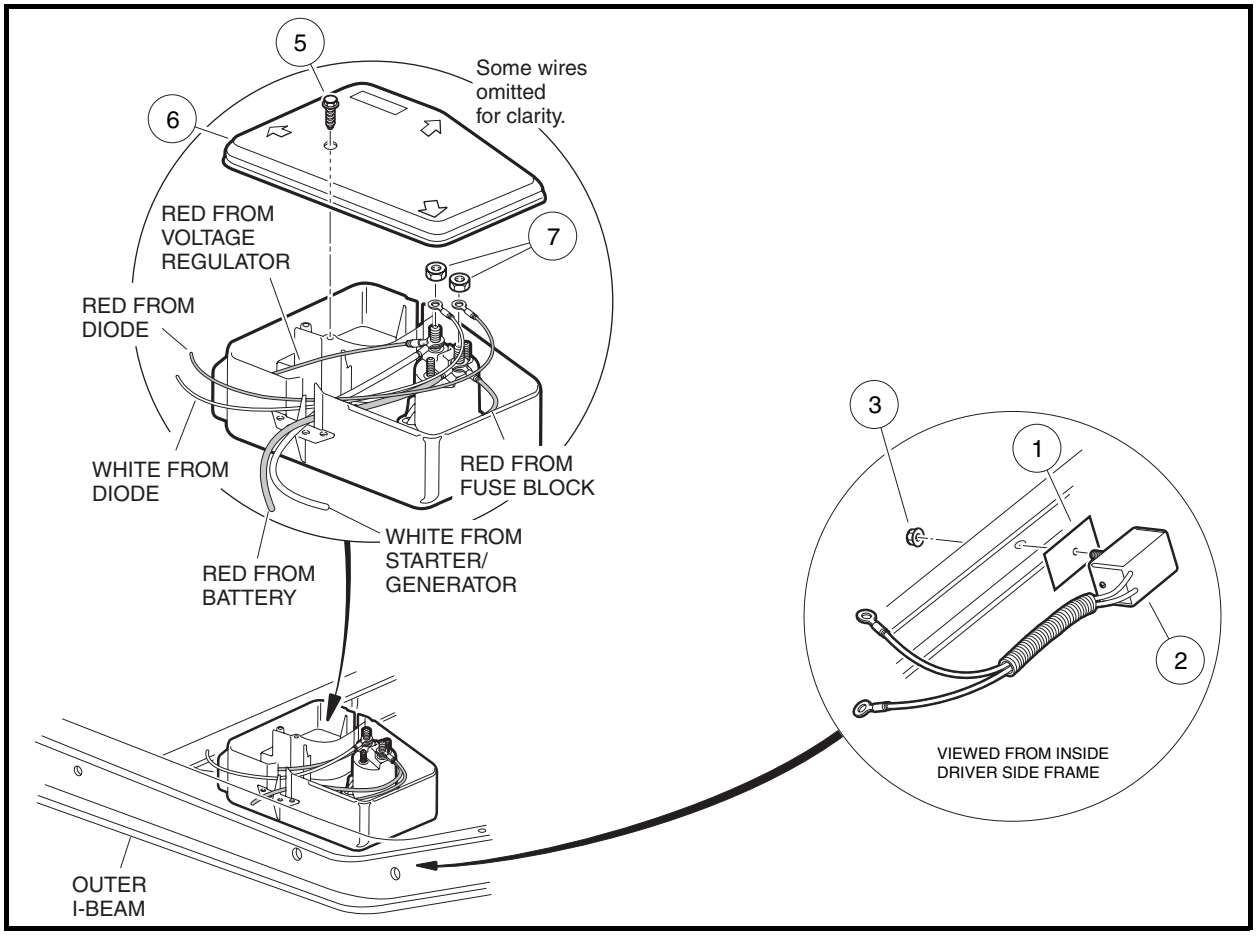


Figure 12-16 Electrical Component Box and Diode Orientation

4. Route and connect the red and white diode wires to the solenoid posts in the electrical component box. **See following WARNING.**

⚠ WARNING

- **Incorrect wiring could result in severe injury or death.**
- **Diode and solenoid connections must have correct polarity.**
- **Keep all persons clear of engine belts when making final connections.**

4.1. Connect the 12-gauge red wire from the diode to the solenoid post with the fuse block and battery red wires and tighten locknut to 90 in-lb (10.2 N·m) **(Figure 12-16, Page 12-13)**.

4.2. Connect the 12-gauge white wire to the other large solenoid post, along with the red wire from the voltage regulator and white wire from the starter/generator and tighten nut to 90 in-lb (10.2 N·m).

5. Replace the electrical component box cover (6) and screw (5) and tighten the screw to 18 in-lb (2.0 N·m).

6. Connect the intake hose to the carburetor and secure the hose with the hose clamp.

7. Connect the battery cables, positive (+) cable first, and tighten the terminals to 12 ft-lb (16.3 N·m). Coat terminals with Battery Terminal Protector Spray (CCI P/N 1014305).

KEY SWITCH

See General Warning, Section 1, Page 1-1.

Testing the Key Switch

See Test Procedure 4, Section 11, Page 11-13. Also see Test Procedure 17 – Key Switch (Engine Kill Circuit) on page 11-28.

Key Switch Removal

1. Turn the key switch OFF and remove the key. Place the Forward/Reverse handle in the NEUTRAL position. Chock the wheels.
2. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.**
3. Remove the dash panel.
   3.1. Loosen seven Tuflok screws, but do not remove screws completely, as shown in Detail A **(Figure 12-18, Page 12-15)**.
   3.2. Remove Tuflok screws from dash panel as shown in Detail B.
   3.3. Pull forward on top of dash panel to access back side of key switch.
   3.4. Disconnect the wire connector from the key switch.
4. Remove the key switch.
   4.1. Remove the key switch nut (1) **(Figure 12-17, Page 12-14)**.
   4.2. Remove key switch (2) from back side of dash panel.

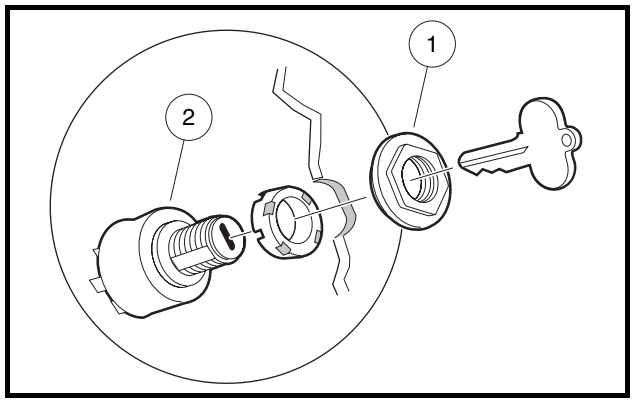


Figure 12-17 Key Switch Removal

Key Switch Installation

1. Install the key switch in the dash in reverse order of removal. Tighten the key switch nut firmly. Reconnect the wire connector to the key switch.
2. Install the dash in reverse order of removal. **See Key Switch Removal on page 12-14.**
3. Connect the battery cables, positive (+) cable first, and tighten the terminals to 12 ft-lb (16.3 N·m). Coat terminals with Battery Terminal Protector Spray (CCI P/N 1014305).

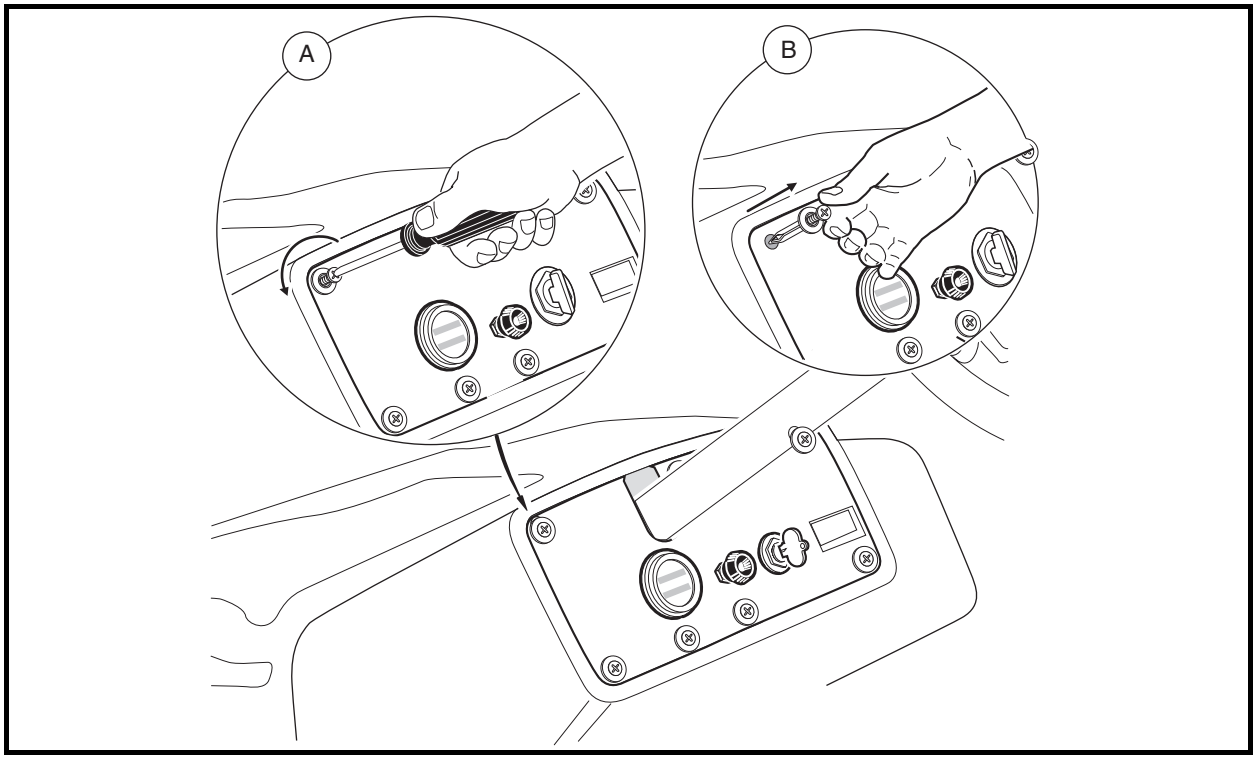


Figure 12-18 Instrument Panel Removal

SOLENOID

See General Warning, Section 1, Page 1-1.

Testing the Solenoid

See Test Procedure 6, Section 11, Page 11-15.

Solenoid Removal

1. Turn the key switch OFF and remove the key. Place the Forward/Reverse handle in the NEUTRAL position. Chock the wheels.
2. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.**
3. Remove the air intake hose from the carburetor.
4. Remove electrical component box cover.
5. Disconnect all the wires from the solenoid.
6. Remove the two screws securing the solenoid in place.

Solenoid Installation

1. Install the solenoid in the electrical component box using two screws to secure the solenoid to the box and tighten to 14 in-lb (1.6 N·m). **See following WARNING.**

⚠ WARNING

- **Incorrect wiring could result in severe injury or death.**
- **Diode and solenoid connections must have correct polarity.**
- **Keep all persons clear of engine belts when making final connections.**

Solenoid Installation, Continued:

2. Connect all wires as indicated.
   2.1. Connect the 6-gauge white wire from the starter/generator, 18-gauge red wire from the voltage regulator, and the 12-gauge white wire from the diode to the large post on the solenoid. **See Wiring Diagrams, Section 11, Page 11-6.**
   2.2. Connect the 6-gauge red wire from the battery, the 10-gauge red wire from the fuse block, and the 12-gauge red wire from the diode to the other large post on the solenoid.
   2.3. Connect the 18-gauge blue wire from the key switch to the small post on the solenoid.
   2.4. Connect the 18-gauge green wire from the Forward/Reverse limit switch to the other small post on the solenoid.
3. Tighten the hex nuts on the large solenoid posts to 60 in-lb (6.8 N·m). Tighten the nuts on the small solenoid posts to 22 in-lb (2.5 N·m).
4. Install the snap-on electrical box cover by firmly pressing down on all corners and install the screw and tighten to 18 in-lb (2 N·m).
5. Install the air intake hose onto the carburetor.
6. Connect the battery cables, positive (+) cable first, and tighten the terminals to 12 ft-lb (16.3 N·m). Coat terminals with Battery Terminal Protector Spray (CCI P/N 1014305).

FUSE

General Warning, Section 1, Page 1-1.

Testing the Fuse

See Test Procedure 2, Section 11, Page 11-11.

Fuse Removal

1. Turn the key switch OFF and remove the key. Place the Forward/Reverse handle in the NEUTRAL position. Chock the wheels.
2. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.**
3. Remove the air intake hose from the carburetor.
4. Remove electrical component box cover.
5. Remove the fuse from the fuse block.

Fuse Installation

1. Install the fuse. **See following WARNING.**

⚠ WARNING

- **If a fuse is blown, determine the cause of the failure and make necessary repairs before installing a new fuse. Use the appropriately rated fuse; if a fuse with a higher amp rating is used, damage to the vehicle electrical system may occur.**

2. Install the snap-on electrical box cover by firmly pressing down on all corners and install the screw and tighten to 18 in-lb (2 N·m).
3. Install the air intake hose onto the carburetor.
4. Connect the battery cables, positive (+) cable first, and tighten the terminals to 12 ft-lb (16.3 N·m). Coat terminals with Battery Terminal Protector Spray (CCI P/N 1014305).

LOCKOUT CAM LIMIT SWITCH

See General Warning, Section 1, Page 1-1.

Testing the Lockout Cam Limit Switch

See Test Procedure 7, Section 11, Page 11-15.

Lockout Cam Limit Switch Removal

1. Turn the key switch OFF and remove the key. Place the Forward/Reverse handle in the NEUTRAL position. Chock the wheels.
2. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.**
3. Disconnect the wires from the lockout cam limit switch (5) located on the back of the Forward/Reverse shifter assembly **(Figure 12-19, Page 12-18)**.
4. Remove two nuts (2) and washers (6) from the lockout cam limit switch (5) and slide the lockout cam limit switch off of the screws.

Lockout Cam Limit Switch Installation

1. Install the limit switch (5) with washers (6) and nuts (2) and tighten to 5 in-lb (0.6 N·m) **(Figure 12-19, Page 12-18)**. Place the Forward/Reverse handle in REVERSE to make sure that both switches actuate. **See following CAUTION.**

⚠ CAUTION

- **Do not overtighten the retaining nuts. If the nuts are overtightened, limit switches could be damaged.**

2. Connect the black wire to the common (COM) terminal and the green wire to the normally open (NO) terminal of the lockout cam limit switch. **See Wiring Diagrams, Section 11, Page 11-6.**
3. Connect battery cables, positive (+) cable first, and tighten the terminals to 12 ft-lb (16.3 N·m). Coat terminals with Battery Terminal Protector Spray (CCI P/N 1014305).
4. With the Forward/Reverse handle in the NEUTRAL position, the lockout cam should be activating the lockout cam limit switch. Make sure everyone is clear of the vehicle.
5. Turn the key switch to the START position. The engine should crank only when the Forward/Reverse handle is in the NEUTRAL position.
6. Test drive the vehicle in both forward and reverse for proper operation.

LOCKOUT CAM

See General Warning, Section 1, Page 1-1.

If the cam lobes have worn to the point where they will no longer actuate the lockout cam limit switch, the cam must be replaced.

Testing the Lockout Cam

See Test Procedure 23, Section 11, Page 11-31.

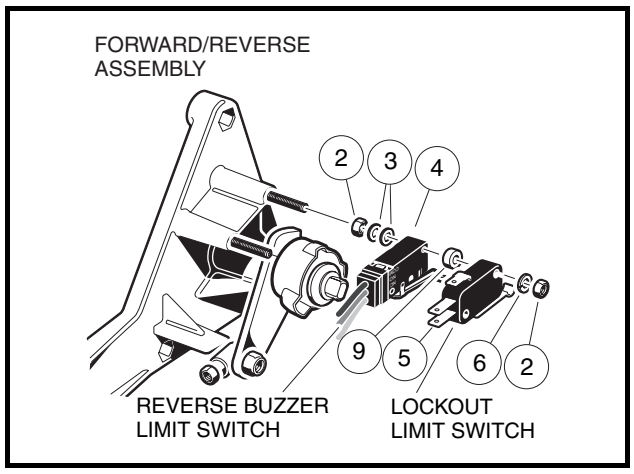


Figure 12-19 Lockout Cam and Reverse Buzzer Limit Switches

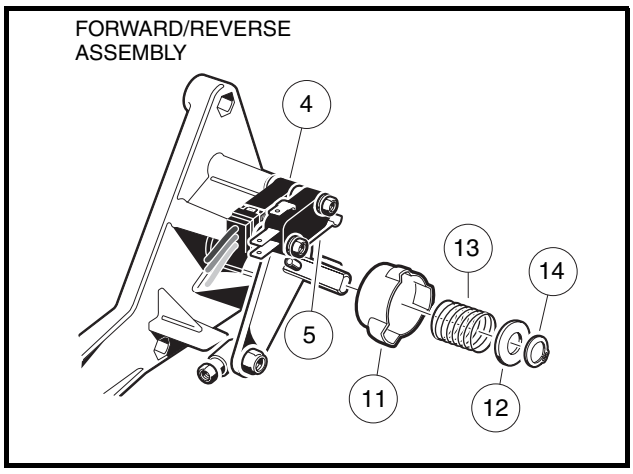


Figure 12-20 Lockout Cam

Lockout Cam Removal

1. Turn the key switch OFF and remove the key. Place the Forward/Reverse handle in the NEUTRAL position. Chock the wheels.
2. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.**
3. Remove the external snap ring (14) **(Figure 12-20, Page 12-18)**.
4. Remove the plastic washer (12) and the spring (13).
5. Remove the cam (11).

Lockout Cam Installation

1. Install the cam (11) **(Figure 12-20, Page 12-18)**.
2. Install the spring (13) and the plastic washer (12).
3. Install the external snap ring (14) into the groove on the shaft. The lockout limit switch should be activated only when the Forward/Reverse handle is in the NEUTRAL position.
4. Connect battery cables, positive (+) cable first, and tighten the terminals to 12 ft-lb (16.3 N·m). Coat terminals with Battery Terminal Protector Spray (CCI P/N 1014305).

REVERSE WARNING BUZZER

See General Warning, Section 1, Page 1-1.

Testing the Reverse Warning Buzzer

See Test Procedure 20, Section 11, Page 11-30.

Reverse Warning Buzzer Removal

1. Turn the key switch OFF and remove the key. Place the Forward/Reverse handle in the NEUTRAL position. Chock the wheels.
2. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.**
3. Remove the dash panel. **See Key Switch Removal on page 12-14.**
4. Disconnect the wires from the reverse warning buzzer (2) **(Figure 12-21, Page 12-19)**.

5. Remove the screw (3), nut (4), lockwasher (5) and flat washer (6) securing the buzzer to the vertical frame support.

Reverse Warning Buzzer Installation

1. Install the screw (3) through the buzzer (2) bracket tab and frame, secure with hardware, and tighten to 14 in-lb (1.6 N·m) **(Figure 12-21, Page 12-19)**. **See following NOTE.**

NOTE: *The reverse warning buzzer is secured at one hole only.*

2. Connect the black wire from the wire harness to the negative (–) terminal on the buzzer.
3. Connect the red/white wire from the wire harness to the positive (+) terminal on the buzzer.
4. Install the dash in reverse order of removal. **See Key Switch Removal on page 12-14.**
5. Connect battery cables, positive (+) cable first, and tighten the terminals to 12 ft-lb (16.3 N·m). Coat terminals with Battery Terminal Protector Spray (CCI P/N 1014305).

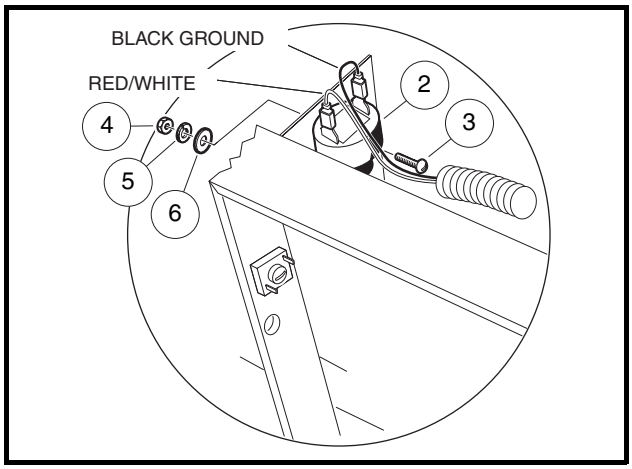


Figure 12-21 Front Reverse Warning Buzzer

REVERSE BUZZER LIMIT SWITCH

See General Warning, Section 1, Page 1-1.

Testing the Reverse Buzzer Limit Switch

See Test Procedure 19, Section 11, Page 11-30.

Reverse Buzzer Limit Switch Removal

1. Turn the key switch OFF and remove the key. Place the Forward/Reverse handle in the NEUTRAL position. Chock the wheels.
2. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.**
3. Disconnect the wires from the reverse buzzer limit switch (4) located on the back of the Forward/Reverse assembly **(Figure 12-19, Page 12-18)**.

Reverse Buzzer Limit Switch Removal, Continued:

4. Remove the nuts (2) and washers (6) from the lockout cam limit switch (5) and slide the lockout cam limit switch off of the screws. Do not disconnect the wires.
5. Remove the spacers (9) from the reverse buzzer limit switch (4) and slide the reverse buzzer limit switch off the screws.

Reverse Buzzer Limit Switch Installation

1. Install the reverse buzzer limit switch (4), and then install two spacers (9) against the limit switch.
2. Install the lockout cam limit switch (5) with two washers (6) and two nuts (2) and tighten to 5 in-lb (0.6 N·m). **See following CAUTION.**

⚠ CAUTION

- **Do not overtighten the retaining nuts. If the nuts are overtightened, limit switches could be damaged.**

3. Place the Forward/Reverse handle in REVERSE to make sure that only the reverse buzzer limit switch is actuated.
4. Connect the orange wire to the black wire (COM) terminal and the red/white wire to the blue wire, normally open (NO) terminal of the reverse buzzer limit switch (4) **(Figure 12-19, Page 12-18)**.
5. Connect the battery cables, positive (+) cable first, and tighten the terminals to 12 ft-lb (16.3 N·m). Coat terminals with Battery Terminal Protector Spray (CCI P/N 1014305).
6. Turn the key switch to the ON position. With the Forward/Reverse handle in REVERSE, the buzzer should sound.

OIL WARNING LIGHT

See General Warning, Section 1, Page 1-1.

Testing the Oil Warning Light

See Test Procedure 22, Section 11, Page 11-31.

Oil Warning Light Removal

1. Turn the key switch OFF and remove the key. Place the Forward/Reverse handle is in the NEUTRAL position. Chock the wheels.
2. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.**
3. Remove the dash panel. **See Key Switch Removal on page 12-14.**
4. Disconnect the wires from the oil warning light (1) **(Figure 12-22, Page 12-21)**. Do not allow wires to touch.
5. Press the retaining tabs and remove the light from the instrument panel.

Oil Warning Light Installation

1. Push a new unit into hole in dash until plastic tabs engage dash **(Figure 12-22, Page 12-21)**.
2. Connect the two yellow wires from the wire harness to the oil warning light.
3. Install the dash in reverse order of removal. **See Key Switch Removal on page 12-14.**
4. Connect the battery cables, positive (+) cable first, and tighten the terminals to 12 ft-lb (16.3 N·m). Coat terminals with Battery Terminal Protector Spray (CCI P/N 1014305).

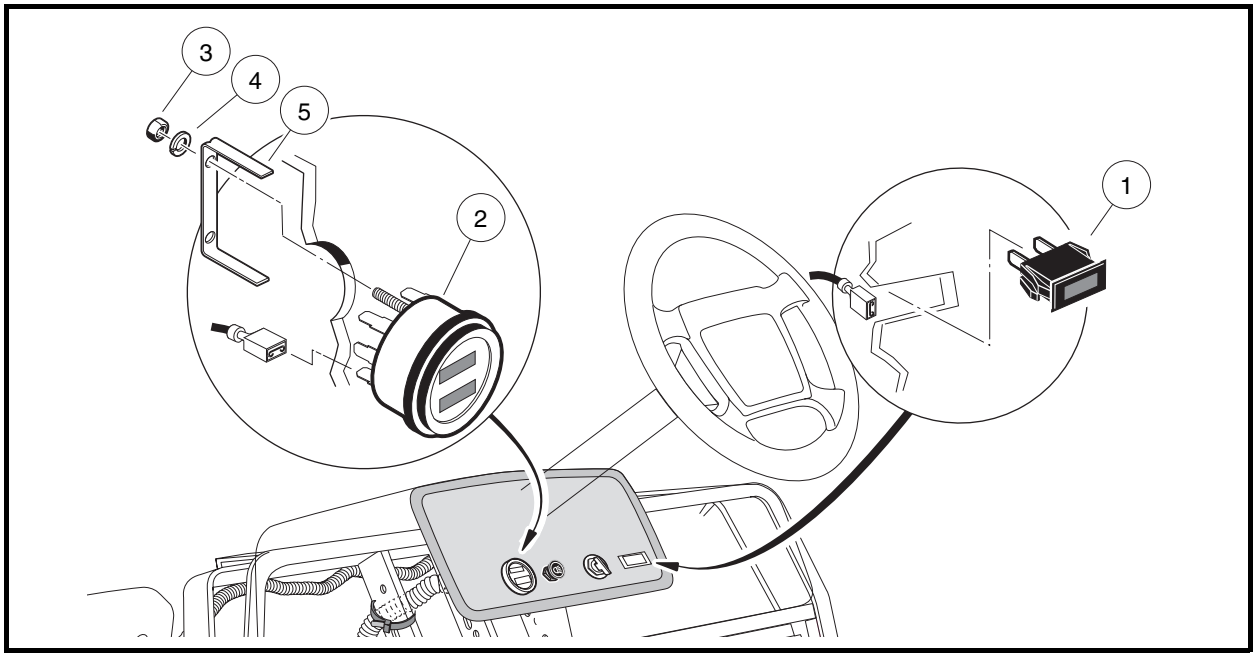


Figure 12-22 Fuel Gauge/Hour Meter and Oil Warning Light Assembly

FUEL GAUGE/HOUR METER

See General Warning, Section 1, Page 1-1.

Testing the Fuel Gauge/Hour Meter

See Test Procedure 26, Section 11, Page 11-33. Also see Test Procedure 27 – Hour Meter on page 11-34.

With the key switch in the OFF position, the fuel gauge/hour meter fields are blank. When the key switch is turned to ON, both fields activate. The fuel gauge initially registers full before indicating the actual fuel level.

The hour meter displays the number of hours of use in increments of 0.1 hour, but does not record additional time unless the key switch is in the ON position. When recording, the hourglass icon on the left blinks slowly.

Fuel Gauge/Hour Meter Removal

1. Turn the key switch OFF and remove the key. Place the Forward/Reverse handle in the NEUTRAL position. Chock the wheels.
2. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.**
3. Remove the dash panel. **See Key Switch Removal on page 12-14.**
4. Disconnect the wires from the fuel gauge/hour meter (2) **(Figure 12-22, Page 12-21)**. Do not allow wires to touch.
5. Remove the two hex nuts (3) and lockwashers (4) from the threaded studs on the back of the fuel gauge. Remove the mounting bracket (5) from the back side of the gauge/meter and remove from the dash.

Fuel Gauge/Hour Meter Installation

1. Install a new gauge/meter into hole in dash until flange seats against dash **(Figure 12-22, Page 12-21)**.
2. Slide the mounting bracket onto the two threaded studs on the gauge/meter and secure with two lockwashers and two hex nuts. Tighten to 2.5 in-lb (0.28 N·m). Place one drop of Loctite® on each hex nut. Do not allow Loctite to come into contact with the gauge/meter casing.

Fuel Gauge/Hour Meter Installation, Continued:

3. Connect the orange wire from the fuel level sending unit to the no. 1 terminal, the blue wire to the no. 2 terminal, the white wire to the No. 4 terminal and the black wire to the No. 3 terminal on the gauge/meter. **See Wiring Diagrams, Section 11, Page 11-6.**
4. Coat the terminals with Battery Terminal Protector Spray (CCI P/N 1014305).
5. Install the dash in reverse order of removal. **See Key Switch Removal on page 12-14.**
6. Connect the battery cables, positive (+) cable first, and tighten the terminals to 12 ft-lb (16.3 N·m). Coat terminals with Battery Terminal Protector Spray (CCI P/N 1014305).

FUEL LEVEL SENDING UNIT

See General Warning, Section 1, Page 1-1.

The fuel level sending unit is an integral part of the fuel tank and should never be removed. Thoroughly test the fuel level sending unit before replacing the fuel tank.

Testing the Fuel Level Sending Unit

See Test Procedure 25, Section 11, Page 11-32.

RPM LIMITER

See General Warning, Section 1, Page 1-1.

Testing the RPM Limiter

See Test Procedure 15, Section 11, Page 11-22.

RPM Limiter Removal

1. Turn the key switch OFF and remove the key. Place the Forward/Reverse handle in the NEUTRAL position. Chock the wheels.
2. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.**
3. Disconnect the white/black wire from the black wire at the bullet connector located near the RPM limiter **(Figure 12-23, Page 12-23)**.
4. Disconnect the other black wire at the other bullet connector near the RPM limiter.
5. Remove the flange head bolts from the RPM limiter band and remove the RPM limiter and damper **(Figure 12-23, Page 12-23)**.

RPM Limiter Installation

1. Place the RPM limiter on the damper squarely so that RPM limiter fits tightly against the damper.
2. Place the RPM limiter with damper on the front of the RPM limiter mounting bracket **(Figure 12-23, Page 12-23)**.
3. Place the band over the RPM limiter and align the holes. Place the brown wire ring connector onto the flange head bolt and secure the left side of the band. Use another flange head bolt to secure the other side of the band. Make sure the band holds the RPM limiter securely in place. Tighten fasteners to 7 ft-lb (9.5 N·m).
4. Connect the black wire at the two wire female bullet connector to the white/black kill circuit wire.
5. Connect other female bullet of the black coil wire to the ignition coil bullet terminal.
6. Connect the battery cables, positive (+) cable first, and tighten the terminals to 12 ft-lb (16.3 N·m). Coat terminals with Battery Terminal Protector Spray (CCI P/N 1014305).

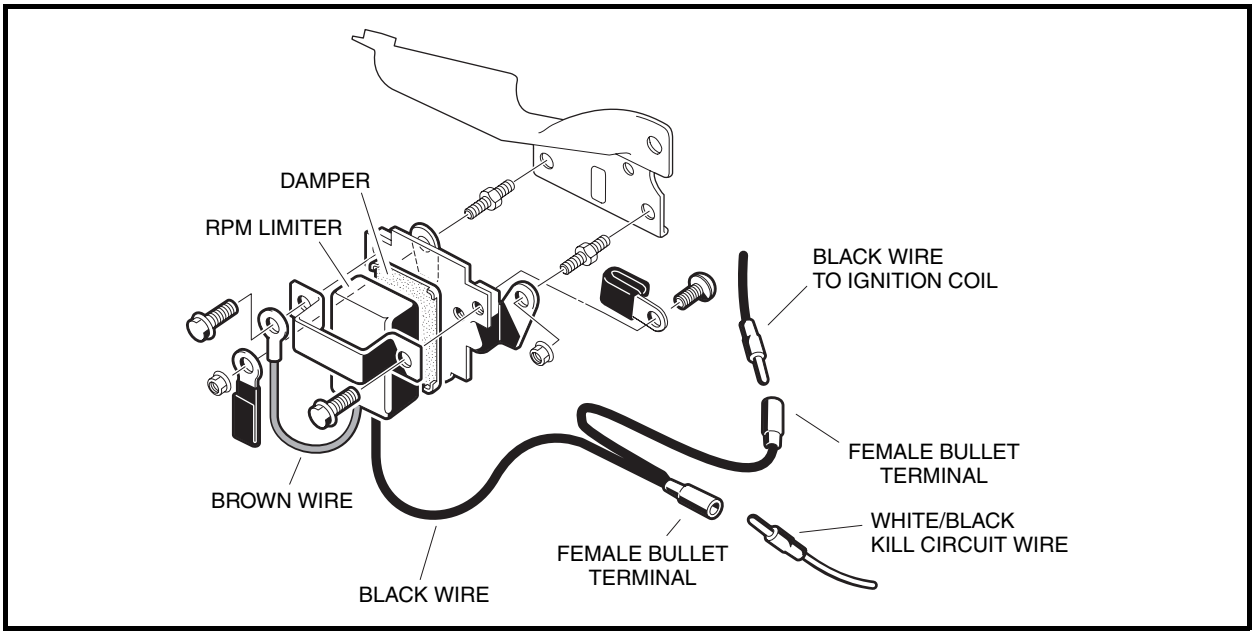


Figure 12-23 RPM Limiter Assembly

IGNITION COIL

See General Warning, Section 1, Page 1-1.

The ignition coil is located under the flywheel shroud of the engine. To replace it requires the removal and installation of the engine and transaxle. It is recommended that the ignition coil be thoroughly tested prior to replacement.

Testing the Ignition Coil

See Test Procedure 14, Section 11, Page 11-22. Also see Test Procedure 15 – RPM Limiter on page 11-22 and Test Procedure 16 – Ignition Coil on page 11-23.

Ignition Coil Removal

Removing the ignition coil requires the removal of the engine and unitized transaxle. **See Unitized Transaxle Removal, Section 16, Page 16-6. See following CAUTION.**

CAUTION

- **Before removal and disassembly, clean the engine.**

1. Remove the starter/generator. **See Starter/Generator Removal on page 12-1. See following NOTE.**

NOTE: *The crankshaft has left-hand threads at the clutch mounting hole.*

2. Remove the muffler. **See Muffler Removal, Section 15, Page 15-1.**
3. Remove the engine mounting hardware (items 1, 2, and 5). **See Figure 13-4, Section 13, Page 13-4.**
4. Remove the two nuts (6) and washers (3) from the stud bolts on the engine body.
5. Slide the engine away from the transaxle housing and lift the engine from the mounting plate.
6. Place the engine on a solid, flat surface, preferably on a sturdy work bench.

Ignition Coil Removal, Continued:

7. Remove the pan head bolts (5) securing the fan shroud (8) to the fan housing (9) **(Figure 12-24, Page 12-24)**.
8. Loosen, but do not remove, three bolts (6) attaching the fan housing as shown.
9. Remove the remaining four bolts (10) attaching the fan housing **(Figure 12-24, Page 12-24)**, then while opening the housing, detach the spark plug wire grommet (4) from the housing **(Figure 12-26, Page 12-25)**.
10. Disconnect the 18-gauge black wire (12) from the spade terminal (13) on the ignition coil (11) and remove the coil by removing two bolts (10) **(Figure 12-25, Page 12-24)**.

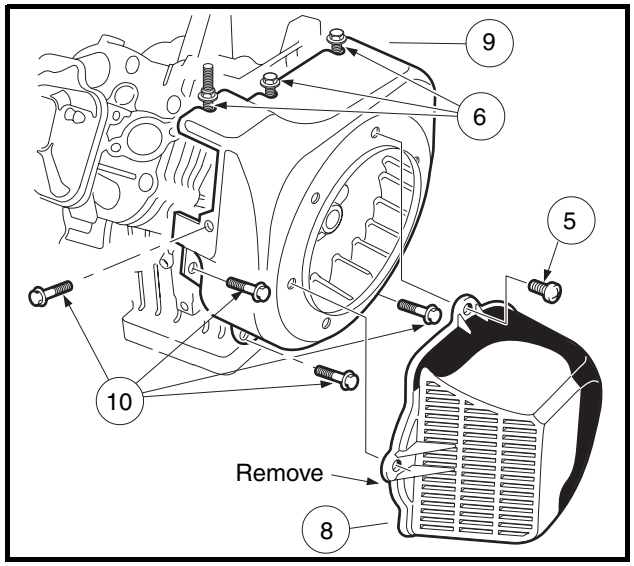


Figure 12-24 Remove Fan Housing

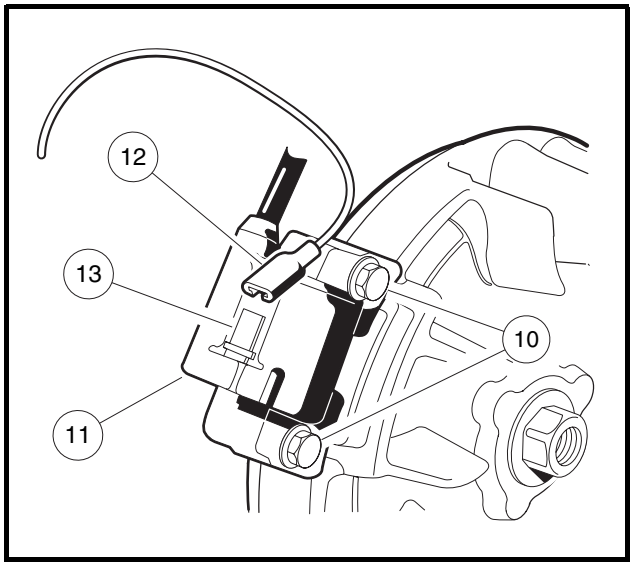


Figure 12-25 Black Wire and Ignition Coil

Ignition Coil Installation

NOTE: *If a new ignition coil is being installed, the spark plug cap, gasket, protector tube and grommet must be removed from the old coil and installed on the new coil.* ***See steps 1 through 8 for procedures to remove and install these existing parts.***

If the existing ignition coil will be remounted, proceed to step 9.

1. Remove the rubber gasket (1) on the plug cap (2) by rolling back the gasket onto the spark plug wire.
2. Remove the cap (2) from the wire by turning the cap counterclockwise three or four revolutions while gently pulling it off the wire **(Figure 12-26, Page 12-25)**.
3. Remove the gasket (1) and protector tube (3) from the old coil. **See following NOTE.**

NOTE: *Moisten the spark plug wire with water to make gasket removal and installation easier.*

4. Remove the grommet (4) from the old spark plug wire. Clean the grommet and place it on the new spark plug wire (5).
5. Install the protector tube (3) onto the new wire **(Figure 12-26, Page 12-25)**.
6. Slide the gasket (1) onto the end of the new spark plug wire.
7. Install the cap (2) on the new coil spark plug wire by rotating it clockwise three or four revolutions while applying light pressure on the cap.

8. Install the gasket (1) on the cap (2).
9. Position the ignition coil (7) onto the cast mounting bosses on the engine crankcase and tighten the two mounting bolts (6) finger-tight.
10. Rotate the flywheel (8) until the magnet is positioned directly under the ignition coil. Use a 0.012 inch (0.304 mm) bronze feeler gauge to set the air gap between the ignition coil and the flywheel magnet. Tighten the two mounting bolts (6) to 30 in-lb (3.4 N·m) **(Figure 12-27, Page 12-25)**.
11. Connect 18-gauge black (12) wire to the spade terminal (13) on the coil **(Figure 12-25, Page 12-24)**.
12. Position the fan housing close to the engine crankcase and slide the plug wire grommet into the notch on the housing.
13. When installing fan housing, make sure the top front corner of the housing is above the upper cylinder shroud. The front edge of the fan housing should be behind the lower cylinder shroud. Align the slots in the housing with the flanged bolts (6) loosened earlier **(Figure 12-24, Page 12-24)**.
14. Install the four remaining flanged bolts (10) that secure the fan housing to the engine crankcase. Tighten all seven mounting bolts (6) and (10) to 90 in-lb (10.2 N·m).
15. Install the fan shroud with four pan-head bolts (5) and tighten to 50 in-lb (5.7 N·m).
16. Place the engine onto the engine mounting plate and slide the two washers (3) onto the two engine body bolts, then slide the bolts through the mounting plate and transaxle housing. Loosely attach the two nuts (6) finger-tight. **See Figure 13-4, Section 13, Page 13-4.**
17. Attach the engine to the bottom of the engine mounting plate using the bolts (1), washers (2) and nuts (5). Tighten hardware to 21 ft-lb (28.4 N·m). **See Figure 13-4, Section 13, Page 13-4.**
18. Tighten the two engine body bolt nuts (6) to 17 ft-lb (23.1 N·m).
19. Install the engine and transaxle assembly. **See Unitized Transaxle Installation, Section 16, Page 16-14. See following CAUTION.**

CAUTION

- **Make sure wire harness is routed and secured away from the muffler.**

20. Install the muffler. **See Muffler Installation, Section 15, Page 15-1.**

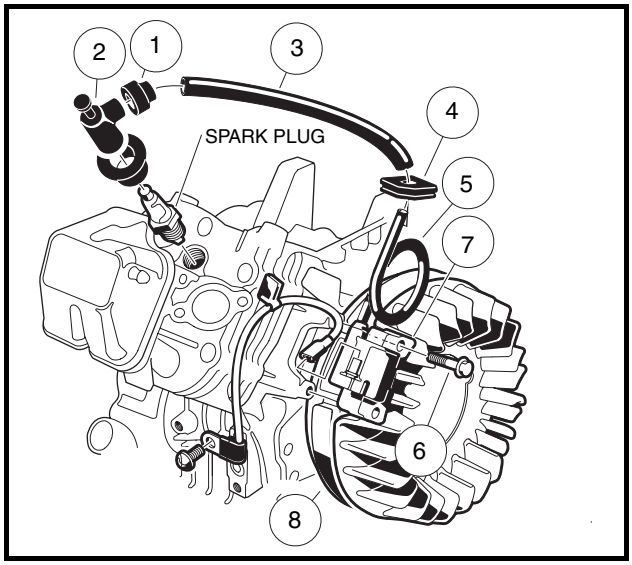


Figure 12-26 Clean Grommet

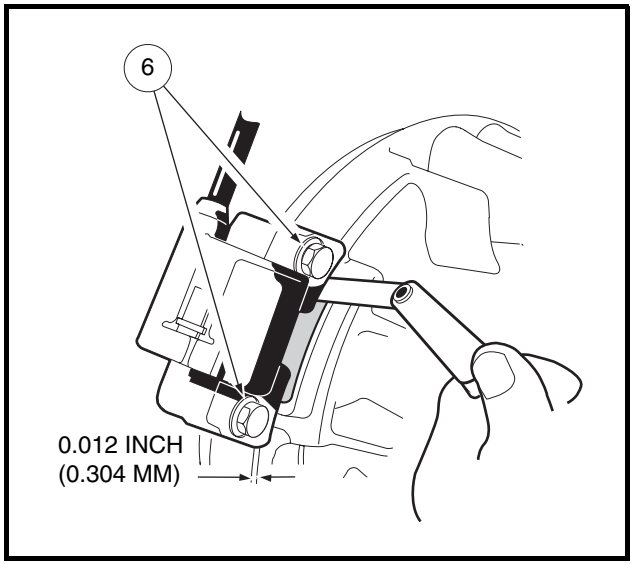


Figure 12-27 Mount Ignition Coil Using Feeler Gauge

Ignition Coil Installation, Continued:

21. Install the starter/generator and belt. **See Starter/Generator Installation on page 12-9.**
22. Connect the spark plug wire to the spark plug.
23. Connect the battery cables, positive (+) cable first, and tighten the terminals to 12 ft-lb (16.3 N·m). Coat terminals with Battery Terminal Protector Spray (CCI P/N 1014305).

OIL LEVEL SENSOR

See General Warning, Section 1, Page 1-1.

Testing the Oil Level Sensor

See Test Procedure 21, Section 11, Page 11-30.

Oil Level Sensor Removal

See Oil Level Sensor Removal, Section 13, Page 13-5.

Oil Level Sensor Installation

See Oil Level Sensor Installation, Section 13, Page 13-5.

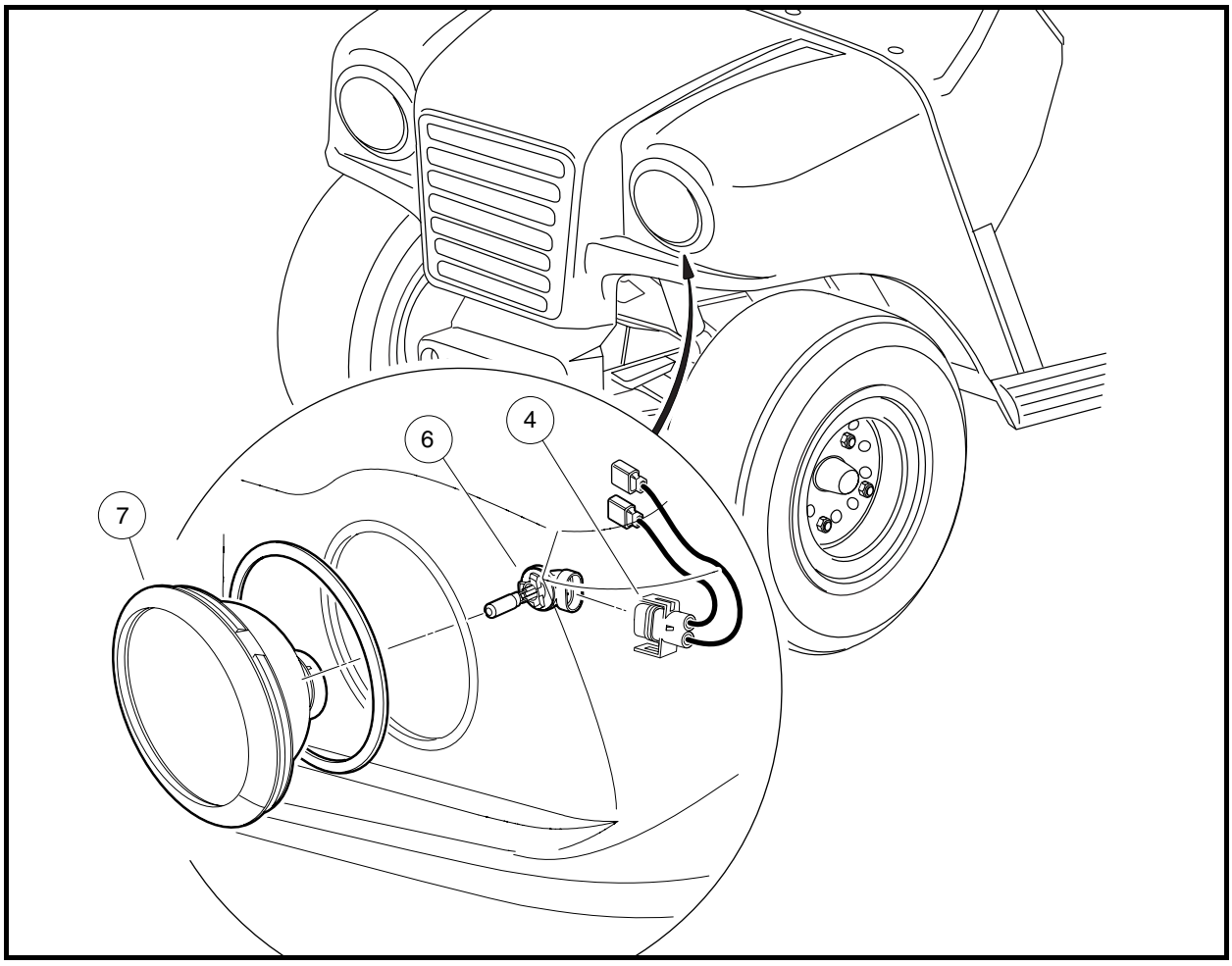


Figure 12-28 Headlight Assembly

HEADLIGHTS

See General Warning, Section 1, Page 1-1.

Testing the Headlight Socket

See Test Procedure 30, Section 11, Page 11-36.

Headlight Bulb Removal

1. Turn the key switch OFF and remove the key. Place the Forward/Reverse handle in the NEUTRAL position. Chock the wheels.
2. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.**
3. From the front of vehicle, reach under body and turn the wire harness/halogen bulb assembly (4 and 6) clockwise one-quarter turn **(Figure 12-28, Page 12-26)**.
4. Remove the wire harness/halogen bulb assembly (4 and 6) from the headlight lens (7).
5. Lift the retaining tabs on the connector (4) and remove halogen bulb assembly (6).

Headlight Bulb Installation

NOTE: *When handling halogen bulbs, do not touch glass portion of bulb. Oil from finger tips can cause premature failure of bulb.*

1. Connect wire harness (4) to the halogen bulb assembly (6). The retaining tab should lock onto the halogen bulb assembly **(Figure 12-28, Page 12-26)**.
2. From the front of vehicle, reach under body and insert wire harness/halogen bulb assembly (4 and 6) into the headlight lens (7).
3. Turn the wire harness/halogen bulb assembly (4 and 6) counterclockwise one-quarter turn.
4. Connect the battery cables, positive (+) cable first, and tighten the terminals to 12 ft-lb (16.3 N·m). Coat terminals with Battery Terminal Protector Spray (CCI P/N 1014305).

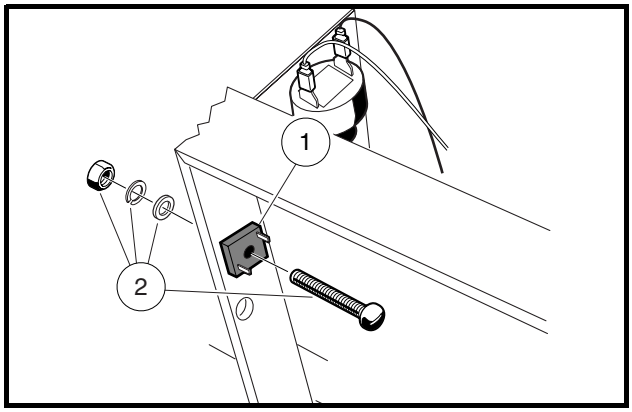


Figure 12-29 Headlight Diode

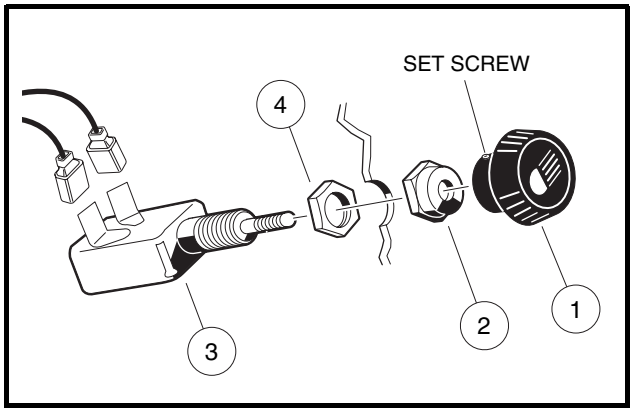


Figure 12-30 Light Switch

HEADLIGHT DIODE

See General Warning, Section 1, Page 1-1.

Testing the Headlight Diode

See Test Procedure 29, Section 11, Page 11-35.

Headlight Diode Removal

1. Turn the key switch OFF and remove the key. Place the Forward/Reverse handle in the NEUTRAL position. Chock the wheels.
2. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.**
3. Remove the instrument panel. **See Key Switch Removal on page 12-14.**
4. Disconnect wires from the headlight diode (1). Do not allow wires to touch **(Figure 12-29, Page 12-27)**.

NOTE: *Identify terminal for solid black wire and terminal for black/white wire.*

5. Remove the mounting hardware (2) from the headlight diode and remove it from the vehicle.

Headlight Diode Installation

1. Mount the headlight diode to the frame using the mounting hardware and tighten to 25 in-lb (2.8 N·m) **(Figure 12-29, Page 12-27)**.
2. Connect the black/white wire from harness to the negative (–) terminal on the diode.
3. Connect the solid black wire from the ground terminal block to the positive (+) terminal on the diode.
4. Install the dash panel in reverse order of removal. **See Key Switch Removal on page 12-14.**
5. Connect the battery cables, positive (+) cable first, and tighten the terminals to 12 ft-lb (16.3 N·m). Coat terminals with Battery Terminal Protector Spray (CCI P/N 1014305).

LIGHT SWITCH

See General Warning, Section 1, Page 1-1.

Testing the Light Switch

See Test Procedure 28, Section 11, Page 11-34.

Light Switch Removal

1. Turn the key switch OFF and remove the key. Place the Forward/Reverse handle in the NEUTRAL position. Chock the wheels.
2. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.**
3. Loosen the set screw locking the light switch knob (1) to the shaft **(Figure 12-30, Page 12-27)**.
4. Remove the dash panel. **See Key Switch Removal on page 12-14.**
5. Disconnect the wires from the light switch.
6. Remove the outer nut (2) from the light switch (3) and remove.

Light Switch installation

1. Connect the wires to the light switch. **See Wiring Diagrams, Section 11, Page 11-6.**
2. Thread the check nut (4) onto the switch until an equal number of threads show on both sides. Install to the dash panel with nut (2) on the outside of the dash and tighten the nut to 14 in-lb (1.6 N·m) **(Figure 12-30, Page 12-27)**.

3. Push the light switch shaft in. Screw the knob onto the end of the shaft until the knob touches the outer nut. Then turn the knob in the opposite direction until the headlight beams on the knob are horizontal to the ground. Tighten the set screw to lock the knob to the shaft.
4. Install the dash panel in reverse order of removal. **See Key Switch Removal on page 12-14.**
5. Connect the battery cables, positive (+) cable first, and tighten the terminals to 12 ft-lb (16.3 N·m). Coat terminals with Battery Terminal Protector Spray (CCI P/N 1014305).

BATTERY

See General Warning, Section 1, Page 1-1.

⚠ DANGER

- **Battery – Explosive gases! Do not smoke. Keep sparks and flames away from the vehicle and service area. Ventilate when charging or operating vehicle in an enclosed area. Wear a full face shield and rubber gloves when working on or near batteries.**
- **Tools, wires, and metal objects can cause sparks when shorted across a battery.**
- **Follow all instructions carefully when working with batteries.**
- **Charge battery in a well-ventilated area only.**
- **Battery – Poison! Contains acid! Causes severe burns. Avoid contact with skin, eyes, or clothing. Antidotes:**
  - **External: Flush with water. Call a physician immediately.**
  - **Internal: Drink large quantities of milk or water followed with milk of magnesia or vegetable oil. Call a physician immediately.**
  - **Eyes: Flush with water for 15 minutes. Call a physician immediately.**

⚠ WARNING

- **Do not jump start a dead battery using another battery and jumper cables.**

General Information

See preceding DANGER statements.

Gasoline vehicles are equipped with 12-volt, low-maintenance batteries. When changing a 12-volt battery in any gasoline-powered vehicle, the same size battery with adequate amperage ratings should be used as a replacement.

A group 70, side-post battery (CCI P/N 1012328), with a 650 cranking amp rating at 32 °F (0 °C) (500 CCA at 0 °F (-17.8 °C)) and a reserve capacity of at least 105 minutes is recommended. The group 70 classification indicates battery size: 8-1/4 inches W x 6-1/2 inches D x 7-1/4 inches H (21.0 cm W x 16.5 cm D x 18.4 cm H). It is important to use the proper size to ensure that the battery clamp will fit correctly.

Testing the Battery

See Test Procedure 1, Section 11, Page 11-9. Also see Test Procedure 24 – Battery Test (Under Load) on page 11-31.

Preventive Maintenance

1. To keep the battery in good operating condition, remove any corrosion immediately. Post connections should be clean and tight. Any frayed or worn wires should be replaced. After all cables have been connected and properly tightened to 12 ft-lb (16 N·m), coat terminals with Battery Terminal Protector Spray (CCI P/N 1014305) to prevent future corrosion.

Preventive Maintenance, Continued:

2. The battery should be kept clean and dry to prevent self-discharge. Any dirt, grime or acid spillage should be removed. Wash the battery with a bristle brush using water and bicarbonate of soda (1 cup (237 mL) baking soda per 1 gallon (3.8 L) of water). Rinse with water. Do not allow solution to enter battery through the vent cap holes. **See Self-Discharge on page 12-30.**
3. Maintain proper water level. **See Water Level on page 12-30.**
4. Check battery periodically to see that it is in a full state of charge. **See Charging the Battery on page 12-31.**
5. Keep battery hold-down clamp tight. **See Vibration Damage on page 12-30.**

Self-Discharge

Dirt and battery acid can provide a path for a small current draw that slowly discharges the battery. To prevent self-discharge, the battery should always be kept clean.

Hot weather also has an effect on a battery's self-discharge rate. The higher the temperature, the quicker a battery will discharge. In hotter climates, therefore, the battery should be checked more often. When storing the battery, keep in a cool place. **See Battery Storage on page 12-32.**

Water Level

The water level should be checked semi-annually to be sure water is at its proper level. Never allow the water level to fall below the tops of the plates because this will cause the exposed part of the plate to become permanently inactive. Check the water level more frequently in hot weather or when the battery becomes old. **See Figure 11-5, Section 11, Page 11-10.**

Vibration Damage

The battery hold-down clamp should always be tight enough to keep the battery from bouncing. Battery life may be severely shortened if the clamp is too loose. Excessive vibration shortens the life of the battery. It may also cause acid to leak out of the vent caps and corrosion to build up on surrounding metal parts. The acid that is lost reduces the capacity of the battery and cannot be replaced.

Mineral Content

For the longest battery life, distilled water should be used in the battery. However, if tap water is going to be used, contact your local water department to be sure mineral contents are below the levels listed in the following table. **See following NOTE.**

NOTE: *Contact your local water department for mineral content analysis.*

IMPURITY	ALLOWABLE CONTENT (PARTS PER MILLION)
Suspended matter	Trace
Total solids	100.0
Calcium and Magnesium Oxides	40.0
Iron	5.0
Ammonia	8.0
Organic matter	50.0
Nitrates	10.0
Nitrites	5.0
Chloride	5.0

Battery Removal

See General Warning, Section 1, Page 1-1 and DANGER on page 12-29.

1. Turn the key switch OFF and remove the key. Place the Forward/Reverse handle in the NEUTRAL position. Chock the wheels.
2. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.**
3. Remove the battery hold-down clamp from the battery.
4. Lift the battery from the vehicle. **See following WARNING.**

⚠ WARNING

- **Keep the battery in an upright position to prevent electrolyte leakage. Tipping the battery beyond a 45° angle in any direction can allow a small amount of electrolyte to leak out of the vent hole. Do not exceed this 45° angle when lifting, carrying or installing battery. The battery acid could cause severe personal injury when accidentally coming in contact with the skin or eyes, and could damage clothing.**

Charging the Battery

See General Warning, Section 1, Page 1-1 and DANGER on page 12-29.

1. Charge the battery using an automotive type 12-volt battery charger. Follow all warnings and procedures supplied by the battery charger manufacturer.
2. Attach the charger, positive (+) cable to the positive (+), and negative (–) cable to the negative (–) battery post.
3. The battery may be charged with a slow charge (3-10 amps) or a fast charge (20-30 amps). Charge until the specific gravity reaches 1.250. **See following WARNING.**

⚠ WARNING

- **If the battery case feels hot (approximately 125 °F (52 °C) or more), emits gases, or fluid boils from vents, stop charging immediately. Failure to stop charging battery when any of these conditions are present could result in an explosion, personal injury and/or damage to the battery.**
- **Do not disconnect the charger DC leads from the battery when the charger is on. The resulting arcing between the DC leads and battery post could cause an explosion.**
- **If the charger must be stopped, disconnect the AC supply cord from the wall outlet before disconnecting the DC leads from the battery. Allow the battery to cool to room temperature and resume charging battery at a lower amp rate.**

Battery Installation

See General Warning, Section 1, Page 1-1 and DANGER on page 12-29.

1. Place the battery into the vehicle with the battery posts facing the engine.
2. Secure the battery to the vehicle with the clamp and install bolt, washer and locknut and tighten to 12 ft-lb (16.3 N·m).
3. Connect the battery cables, positive (+) cable first, and tighten the terminals to 12 ft-lb (16.3 N·m). **See Figure 1-1, Section 1, Page 1-3.** Coat terminals with Battery Terminal Protector Spray (CCI P/N 1014305).

Battery Storage

See General Warning, Section 1, Page 1-1 and DANGER on page 12-29.

1. Keep the battery clean and free of corrosion. **See Preventive Maintenance on page 12-29.**
2. The battery cables should be disconnected from the vehicle so it can be connected to the charger. The battery can be left in the vehicle. Disconnect the negative (–) cable first. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.**
3. Fully charge the battery prior to storage.
4. Store in a cool, dry area. The colder the area in which the battery is stored, the less the battery will self-discharge. A battery stored at 0 °F (-17.8 °C) will discharge very little over a four-month period. A battery stored at 80 °F (27 °C) will have to be recharged every few weeks.
5. Check the state of charge periodically. A battery that is discharged and left in a cold environment can freeze and crack. If the specific gravity drops below 1.220, the battery should be recharged. **See following WARNING.**

⚠ WARNING

- **If the battery is frozen or the container is bulged, discard battery. A frozen battery can explode.**

6. The frequency of recharging required depends on the temperature of the storage area, but it is recommended that the battery be monitored for state of charge every month. Also, if the storage area is unheated in a cold climate and recharging is required, it is recommended that the area be heated to at least 60 °F (16 °C) prior to charging. The battery will not charge effectively in cold temperatures for the same reasons that it does not discharge as rapidly in cold temperatures.

Charging a Dead Battery

See General Warning, Section 1, Page 1-1 and DANGER on page 12-29.

The vehicle is equipped with a starter/generator. The generator is not designed to charge a dead battery. If the vehicle battery has become discharged, it must be charged using a properly rated automotive type charger. **See following WARNING.**

⚠ WARNING

- **Do not jump-start a dead battery using another battery and jumper cables.**

GROUND CABLES

Testing the Ground Cables

See Test Procedure 3, Section 11, Page 11-12.

SECTION 13 – FE290 AND FE350 ENGINES

⚠ DANGER

- **See General Warning, Section 1, Page 1-1.**

⚠ WARNING

- **See General Warning, Section 1, Page 1-1.**

GENERAL INFORMATION

See General Warning, Section 1, Page 1-1.

This gasoline vehicle is powered by a 4-cycle, overhead valve, single cylinder, air-cooled engine. The 4-cycle engine has an oil reservoir (crankcase) similar to automobiles, trucks, aircraft, heavy equipment, machinery and other applications designed for reliable heavy-duty service. The engine has two major component assemblies: the cylinder assembly and the crankcase assembly. **See following NOTE.**

NOTE: *Engine rotation is clockwise as viewed from the clutch side of the engine.*

This section contains information for removing and replacing FE290 and FE350 engines. For complete instruction on engine disassembly, repair, rebuilding, and reassembly, see your authorized dealer.

BEFORE SERVICING

Carefully read the applicable information and instructions before beginning engine service. Diagrams, DANGER, WARNING, CAUTION and NOTE statements and detailed descriptions have been included wherever necessary. Anyone attempting engine service should have knowledge and experience in small engine service and repair.

ENGINE ROTATION

When turning the crankshaft by hand, always turn it clockwise as viewed from the clutch side of the engine. This will ensure proper adjustments.

SPARK PLUG

Spark plugs are selected to suit specific engine design and vehicle operating conditions. The spark plug (CCI P/N 101881101) is designed to give maximum life and efficient combustion of fuel. The spark gap should be set to 0.027-0.031 inches (0.69-0.79 mm).

Spark Plug Removal

See General Warning, Section 1, Page 1-1.

⚠ CAUTION

- **Before removal and disassembly, clean the engine.**

Remove all dirt from plug base in the cylinder head before removing plug. Use a 13/16-inch deep well socket wrench or 13/16-inch spark plug wrench to loosen the plug.

Spark Plug Cleaning, Inspection and Repair

Examine the plug **(Figure 13-1, Page 13-2)**. The deposits on the plug base and electrode are an indication of the correct heat range and efficiency as well as a guide to the general condition of the engine, fuel and air mixture and ignition system. If all of the above conditions are proper, the spark plug should be a light brown color. There should be no bridging between the electrode and base. The electrode should not be eroded. Black color, excessive carbon, and/or a wet plug indicates that the fuel is too rich. White, burned or melted electrodes indicate the fuel is too lean or pre-igniting. Oily deposits on the plug electrode are an indication of worn rings, valve guides, cylinder wall, etc. Also examine the spark plug wire. Remove rubber boot and inspect internal spring for damage. Inspect spark plug wire for damage and be sure spring coil is securely attached to spark plug. **See following WARNING**.

⚠ WARNING

- **Remove spark plug wire to avoid accidental start up of the engine when servicing vehicle. To avoid ignition of fuel and serious personal injury or death, never try to start the engine with plug removed from engine.**

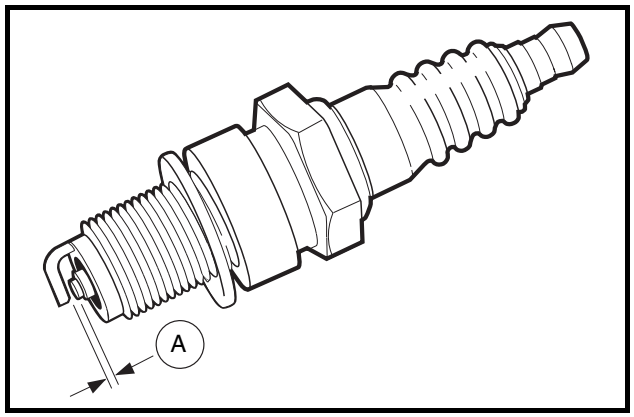


Figure 13-1 Spark Plug

Testing the Spark Plug

Check the sparking ability of a cleaned and properly gapped plug on a sparking comparator if possible. Spark should be blue and strong and able to jump a 5/16-inch (8 mm) gap.

Setting the Spark Gap

1. Pass a contact point file between the electrodes to produce flat, parallel surfaces to facilitate accurate gauging.
2. Use a wire type gauge. Bend the outside or ground electrode so only a slight drag on the gauge is felt when passing it between the electrode. Never make an adjustment by bending the center electrode. Set gap (A) to 0.027-0.031 inches (0.69-0.79 mm) **(Figure 13-1, Page 13-2)**.

Spark Plug Installation

NOTE: *Before installing the plug, check the condition of the threads in the cylinder head. Soften deposits in cylinder head threads with penetrating oil and clean the threads with a tap if necessary.*

Use a high temperature, anti-seize lubricant on the threads of the spark plug to reduce friction when installing a new plug, and reduce "gauling" and thread seizing for future replacements.

1. Install the spark plug by threading it in until finger tight, then tighten the spark plug to 20 ft-lb (27 N·m).

CYLINDER HEAD

See General Warning, Section 1, Page 1-1.

GENERAL INFORMATION

Test cylinder compression using a standard compression tester. Low compression would normally indicate a problem in the cylinder assembly such as defective rings, gaskets, etc. At a cranking speed of 550-600 RPM, the compression should be 156-185 psi. **See Engines and Transaxles Manual for inspection and repair.**

BREATHER VALVE (REED VALVE)

General Information

The function of the breather is to create a vacuum in the crankcase which prevents oil from being forced out of the engine through the piston rings, oil seals or gaskets. The breather has a reed valve which limits the direction of air flow caused by the piston moving up and down. Air can flow out of the crankcase, but the one-way reed valve blocks return flow and therefore maintains a vacuum in the crankcase.

Oil laden air in the crankcase passes through the reed valve and expands into the rocker chamber. In the rocker chamber most oil separates from the air and drains back to the crankcase. The air passes through a tube and vents to the intake manifold. **See Engines and Transaxles Manual for inspection and repair.**

CRANKCASE

See General Warning, Section 1, Page 1-1.

ENGINE REMOVAL

To perform repairs on crankcase components, remove engine from the vehicle. **See following CAUTION.**

⚠ CAUTION

- **Before removal and disassembly, clean the engine.**

1. Remove the powertrain. **See Unitized Transaxle Removal, Section 16, Page 16-6. See following NOTE.**

NOTE: *The crankshaft has left-hand threads at the clutch mounting hole.*

2. Remove starter/generator. **See Starter/Generator Removal, Section 12, Page 12-1.**
3. Remove drive clutch. **See Drive Clutch Removal, Section 17, Page 17-4 and following NOTE.**
4. Remove muffler. **See Muffler Removal, Section 15, Page 15-1.**
5. Remove engine mounting hardware (items 1, 2, 5 and 6) **(Figure 13-4, Page 13-4)**.
6. Lift engine from the mounting plate.
7. Remove crankcase oil drain plug and filler tube. Tip the engine slightly to allow all of the oil to drain from the crankcase. Dispose of engine oil properly.

CRANKCASE COVER REMOVAL

1. Remove yellow jumper wire (11) from cord connector (12) **(Figure 13-2, Page 13-4)**.
2. Remove nuts and clamps at two-ended bolts (1 and 2) **(Figure 13-3, Page 13-4)**.

Crankcase Cover Removal, Continued:

3. Remove eight bolts (3) and remove the crankcase cover (4). **See following NOTE**.

NOTE: *If the crankcase cover sticks, tap lightly with a plastic mallet on alternate sides near the dowel pins (5)* ***(Figure 13-3, Page 13-4)****.*

4. Remove the crankcase cover gasket completely. It may stick to the flanged surface of the crankcase.

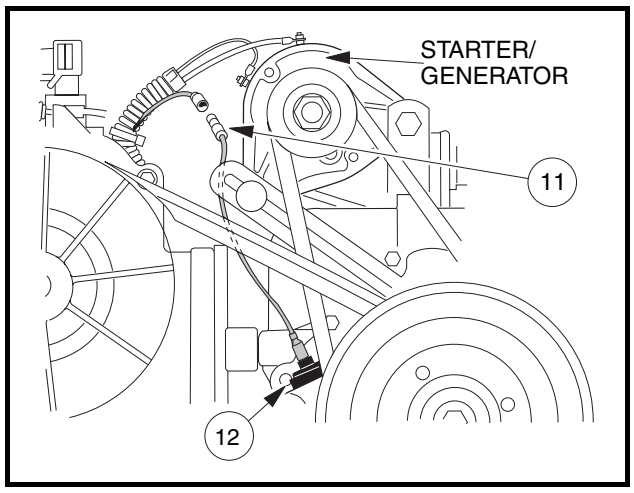


Figure 13-2 Oil Level Sensor Wire

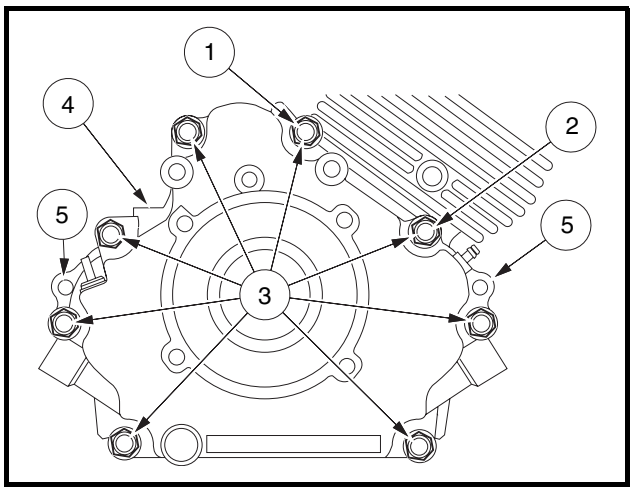


Figure 13-3 Crankcase Cover

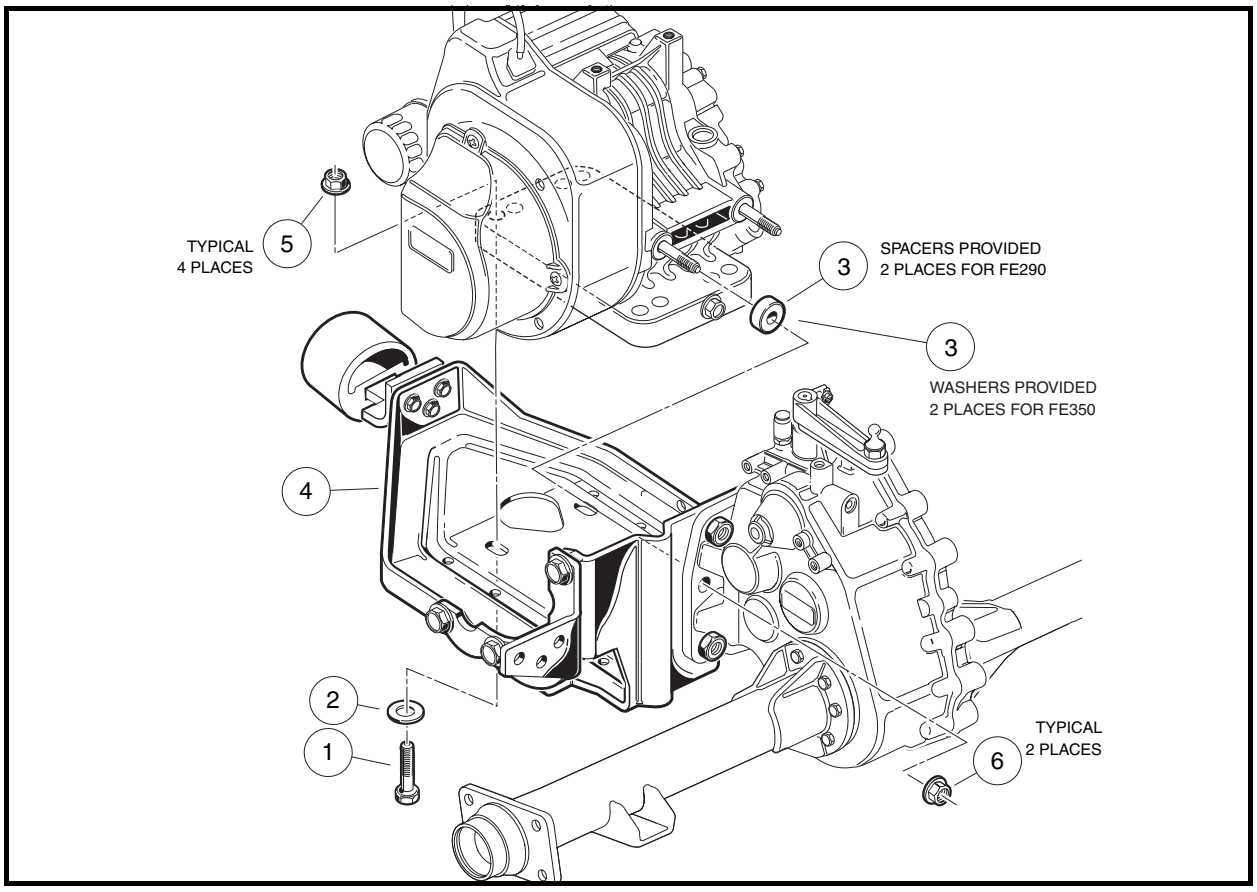


Figure 13-4 Engine Mounting Plate

OIL LEVEL SENSOR

Testing the Oil Level Sensor

See Test Procedure 21, Section 11, Page 11-30.

Oil Level Sensor Removal

1. If not already removed, remove crankcase cover. **See Crankcase Cover Removal on page 13-3.**
2. Disconnect the oil level sensor wire (2) from the cord connection (1) **(Figure 13-2, Page 13-4)**.
3. Remove the screw (3) from the wire clamp (4).
4. Remove the two mounting screws from the inside of the crankcase cover and remove the oil level sensor and bracket.
5. If necessary, remove the three screws (7) that hold the sensor to the bracket (5).

Oil Level Sensor Installation

1. If the oil level sensor was removed from the bracket, install sensor (6) into bracket (5) and secure with three screws (7) **(Figure 13-5, Page 13-5)**. Tighten to 17 in-lb (1.9 N·m).
2. Position the sensor and bracket on inside of crankcase and install two mounting screws.
3. Connect sensor wire (2) to cord connector (1) **(Figure 13-5, Page 13-5)**.
4. Install screw (3) through wire clamp and into crankcase cover. Tighten to 30 in-lb (3.4 N·m).

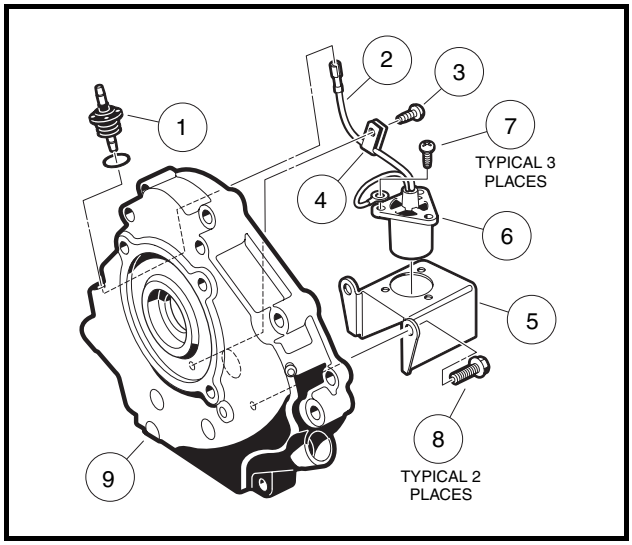


Figure 13-5 Oil Level Sensor

CRANKCASE COVER INSTALLATION

⚠ CAUTION

- **Before assembly, make sure parts are clean.**
- **Do not reuse the gasket. Install a new one.**
- **Install and tighten crankcase cover bolts as instructed. Failure to do so could cause the cover to become warped.**

Crankcase Cover Installation, Continued:

1. Clean the gasket surfaces on the crankcase cover to fit a new gasket during installation and inspect the oil seal for wear and damage.
2. Install crankcase cover. Using HANDS ONLY, seat cover completely against the crankcase. If the cover will not seat, the camshaft is not installed correctly.
3. Install and finger tighten evenly the eight cover mounting bolts **(Figure 13-6, Page 13-6)**.
4. Tighten the cover mounting bolts in two steps. First, in the sequence shown, tighten all eight bolts to approximately 130 in-lb (14 N·m). Then, repeating the sequence, tighten them to 250 in-lb (28.2 N·m) **(Figure 13-6, Page 13-6)**.
5. Connect the yellow jumper wire (11) to the cord connector (12) **(Figure 13-2, Page 13-4)**.

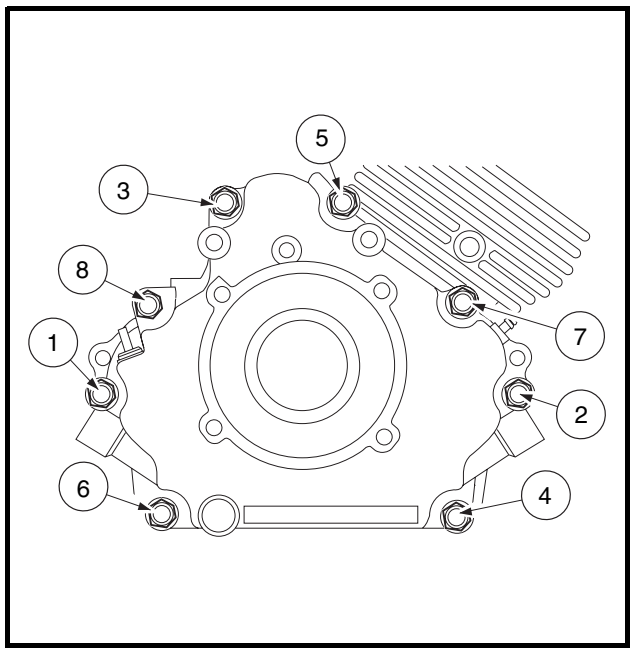


Figure 13-6 Crankcase Cover Installation

IGNITION COIL AND FLYWHEEL

See General Warning, Section 1, Page 1-1.

Ignition Coil and Flywheel Removal

1. Loosen three screws and remove the remaining four screws attaching the flywheel housing as shown, then remove the housing **(Figure 13-7, Page 13-7).**
2. Disconnect the ignition coil (1) from its primary lead wire at the connector (2). Remove the two bolts (3) and take out the ignition coil **(Figure 13-8, Page 13-7)**.

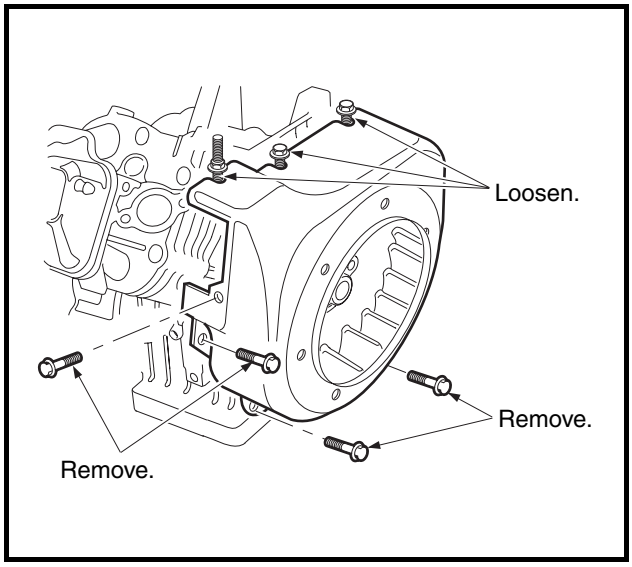


Figure 13-7 Flywheel Housing

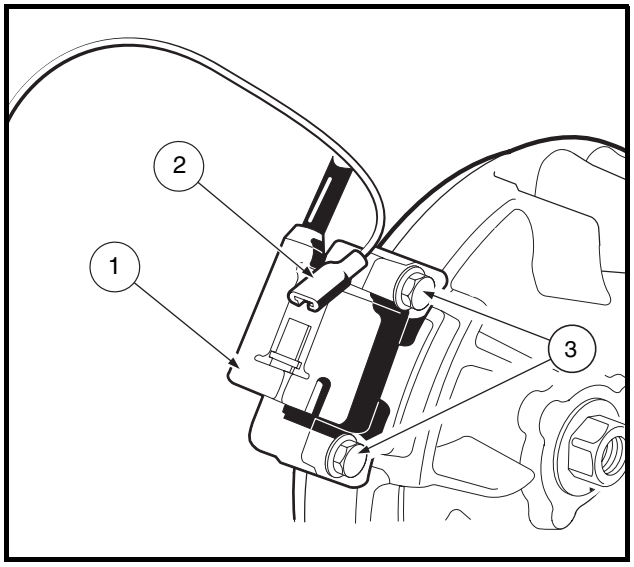


Figure 13-8 Ignition Coil

3. Hold the flywheel (4), not the fan (7), with a strap wrench (5) and, using a 25 mm socket, remove the flywheel nut (and flat washer) by turning it counterclockwise **(Figure 13-9, Page 13-7)**. **See following CAUTION.**

⚠ CAUTION

- **The flywheel nut has right-hand threads. Turn it clockwise to tighten, or counterclockwise to loosen.**
- **Do not damage the fan blades with the strap wrench. Do not place screwdriver or pry bar in the fan blades.**

4. Remove the flywheel with a puller (CCI P/N 1016627).
5. Remove the flywheel key from its groove.

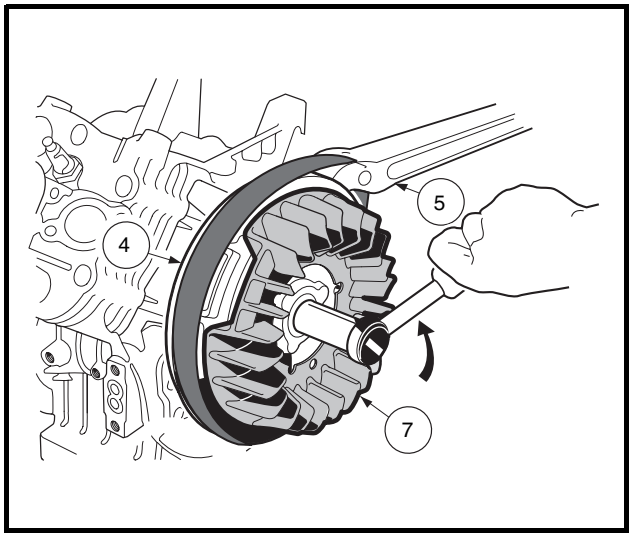


Figure 13-9 Flywheel Nut

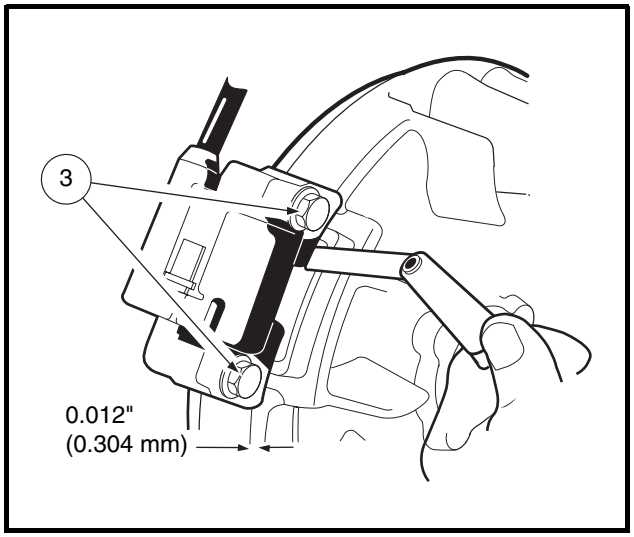


Figure 13-10 Adjust Ignition Coil Air Gap

Flywheel Installation

See Flywheel Installation on page 13-8.

Ignition Coil Inspection and Repair

See Test Procedure 16, Section 11, Page 11-23.

Ignition Coil Installation

1. Installation is the reverse of removal.
2. While tightening the two bolts (3), use a bronze feeler gauge to adjust the ignition coil air gap to 0.012 inch (0.304 mm) **(Figure 13-10, Page 13-7)**.
3. Tighten the two ignition coil bolts to 30 in-lb (3.4 N·m).

Crankcase Cover Installation

See Crankcase Cover Installation on page 13-5.

FLYWHEEL INSTALLATION

1. Insert the flywheel key into the keyway in the crankshaft. Then align the keyway in the flywheel to the key and push the flywheel and fan assembly onto the crankshaft until it seats. Install flat washer and nut finger tight.
2. Use a strap wrench (3) to keep the flywheel and fan assembly (1) from turning while tightening the flywheel nut to 63 ft-lb (85.4 N·m) **(Figure 13-11, Page 13-8). See following CAUTION**.

⚠ CAUTION

- **The flywheel nut has right-hand threads. Turn it clockwise to tighten, or counterclockwise to loosen.**
- **Be careful not to damage the fan blades. Use a strap wrench to hold flywheel. Do not place screwdriver or pry bar between fan blades.**

3. Install the fan housing and tighten the screws to 90 in-lbs (10 N·m).

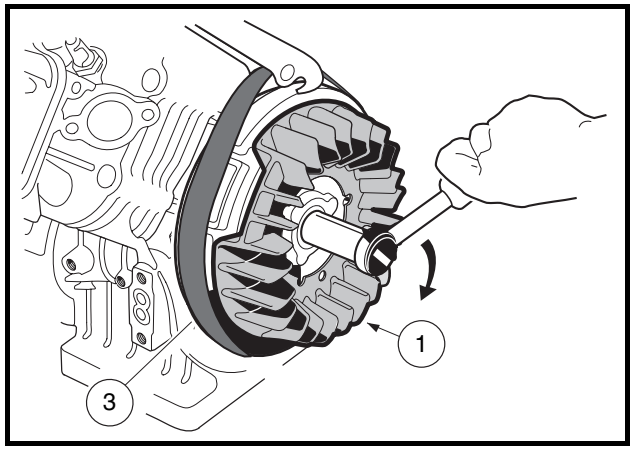


Figure 13-11 Fan and Flywheel Installation

ENGINE INSTALLATION

See General Warning, Section 1, Page 1-1.

1. Place engine onto engine mounting plate and tighten the mounting hardware (1, 2 and 5) to 13 ft-lb (17.7 N·m). Tighten nuts (6) to 17 ft-lb (23.1 N·m) **(Figure 13-4, Page 13-4)**.
2. Install drive clutch. **See Drive Clutch Installation, Section 17, Page 17-12.**
3. Install drive belt. **See Drive Belt Installation, Section 17, Page 17-3.**
4. Install muffler. **See Muffler Installation, Section 15, Page 15-1.**
5. Install starter/generator and belt. **See Starter/Generator Installation, Section 12, Page 12-9.**
6. Install the powertrain. **See Unitized Transaxle Installation, Section 16, Page 16-14.**
7. Install oil drain plug in the crankcase and tighten to 20 ft-lb (27.1 N·m). Apply a light film of oil on the seal of a new oil filter and install the filter on the crankcase. Fill the crankcase to the proper level with the correct type of oil. This engine should be regarded as a new engine for next scheduled oil change. **See Section 10 – Periodic Maintenance.**
8. Check all hardware for proper torque/tightness.
9. Check engine oil level **(Figure 13-12, Page 13-9)**.
   9.1. With vehicle on level surface, remove dip stick and clean with cloth **(Figure 13-12, Page 13-9)**.
   9.2. Reinsert dip stick until fully seated.
   9.3. Oil must be in the SAFE LEVEL range.

⚠ CAUTION

- **Do not overfill with oil.**

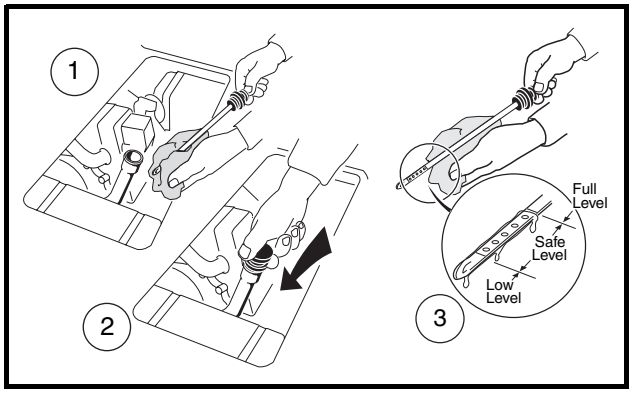


Figure 13-12 Check Engine Oil Level

10. Install a new or cleaned spark plug, gapped to 0.027-0.031 inch (0.686-0.787 mm), and connect plug wire to plug.
11. Connect battery cables, positive (+) cable first, and tighten hardware to 12 ft-lb (16 N·m). **See Figure 10-1, Section 10, Page 10-1.** Coat terminals with Battery Terminal Protector Spray (CCI P/N 1014305) to minimize corrosion.
12. Adjust the engine RPM setting. **See Engine RPM Adjustment, Section 14, Page 14-11.**
13. If initial checks indicate the engine is functional, place the neutral lockout cam in OPERATE position.
14. Test-drive vehicle to ensure all systems are functional and correctly adjusted.

TORQUE SPECIFICATIONS

ITEM	SIZE	LIMITS
Flywheel retaining nut	M16	63 ft-lb (86 N·m)
Crankcase cover to block bolts	M8	250 in-lb (28.3 N·m)
Starter/Generator bracket to block bolts	M8	200 in-lb (23 N·m)
Oil drain plug	M14	20 ft-lb (27.1 N·m)
Fan housing screws	M6	90 in-lb (10 N·m)
Fan shroud screws	M6	25 in-lb (2.8 N·m)
Bolts marked with “4” (when used with nuts)	M8 M6 M5	130 in-lb (15 N·m) 50 in-lb (5.9 N·m) 30 in-lb (3.4 N·m)

ADJUSTMENTS AND SETTINGS

ITEM	LIMITS
Spark plug gap (standard)	0.027 to 0.031 in. (0.69 to 0.79 mm)
Ignition coil air gap (standard)	0.012 in. (0.304 mm)
Compression pressure (min.)	156 psi (1076 kPa)
Engine RPM	2700 (±30) RPM

SECTION 14 – FUEL SYSTEM: GASOLINE VEHICLE

⚠ DANGER

- **See General Warning, Section 1, Page 1-1.**

⚠ WARNING

- **See General Warning, Section 1, Page 1-1.**

GENERAL INFORMATION

The engine is equipped with a float bowl type carburetor with fixed jets that require no adjustment. The carburetor atomizes the fuel, mixes it with air, and feeds the combustible mixture into the cylinder.

CARBURETOR

See General Warning, Section 1, Page 1-1.

Before suspecting the carburetor as the cause of poor engine performance, make sure the fuel and ignition systems are in proper operating condition. Check the following items:

- Spark plug and gap condition. **See Spark Plug Cleaning, Inspection and Repair, Section 13, Page 13-2.**
- Air filter element. **See Air Filter on page 14-15.**
- Fuel filters. **See Fuel Filters on page 14-15.**
- Choke and air intake system (for restriction of air flow). **See Choke and Air Intake System on page 14-12.**
- Fuel pump. **See Fuel Pump on page 14-17.**
- Fuel lines (from fuel tank to filter to pump to filter to carburetor). **See Fuel Lines on page 14-23.**
- Exhaust system (for restrictions). **See Section 15 – Exhaust System: Gasoline Vehicles.**

If the carburetor floods or leaks fuel at the float bowl gasket or carburetor vent tube, the fuel inlet valve could be worn or dirty. Another cause of this condition may be a damaged float that has filled with fuel and sinks.

For elevations above 3000 feet, main jets other than standard operate more effectively. The following chart lists the elevation ratings for various jet sizes. No adjustment is required for the pilot jet. If the vehicle idles roughly, turn the pilot air screw out until the vehicle idles smoothly.

MAIN JET ELEVATION/SIZE CHART

ALTITUDE	FE290 ENGINE MAIN JET SIZE
0-3000 ft. (0-914.4 m)	82
3000-5000 ft. (914.4-1524 m)	80
5000-8000 ft. (1524-2438.4 m)	78
8000-10,000 ft. (2438.4-3048 m)	75
10,000 ft. and over (3048 m and over)	72

CHANGING THE MAIN JET

1. Remove the carburetor.
   1.1. Turn fuel shut-off valve on fuel tank to the closed (OFF) position **(Figure 14-15, Page 14-24)**.
   1.2. Loosen the intake air hose clamp (22) and disconnect the intake air hose (23) at the carburetor end only **(Figure 14-1, Page 14-3).**
   1.3. Remove the governor guard (5).
   1.4. Disconnect the governor cable (30) from the carburetor.
   1.5. Disconnect the carburetor vent line (14).
   1.6. Disconnect the fuel supply line (26) at the carburetor end only. Temporarily plug the end of the fuel line to prevent fuel leakage.
   1.7. Remove the carburetor retaining nuts (19), intake pipe (17), and carburetor (12). **See following NOTE**.

NOTE: *Note the orientation of the gasket (16), between the carburetor intake pipe (17) and the carburetor body (12) so that it can be replaced in the same orientation **(Figure 14-1, Page 14-3)**.*

When removing the carburetor body, the throttle return spring (11) must be disconnected. Note its proper orientation so that it can be replaced in the same orientation.

The carburetor must be kept upright during removal.

2. Position the carburetor with the drain screw (11) over a catch basin **(Figure 14-2, Page 14-4)**.
3. Turn the carburetor bowl drain screw counterclockwise two or three turns and drain all the fuel from the bowl into the catch basin **(Figure 14-2, Page 14-4)**. Tighten the drain screw to 10 in-lb (1.1 N·m). Return fuel to the fuel tank or dispose of properly.
4. Mark the body of the carburetor and the carburetor fuel bowl with an indelible ink marker so that, after removal, the bowl can be installed again in the same position **(Figure 14-2, Page 14-4)**.
5. Remove the carburetor fuel bowl retaining screw and washer (12), then remove the fuel bowl (10) and clean it with a nonflammable solvent **(Figure 14-2, Page 14-4). See following NOTE**.

NOTE: *Make sure the fuel bowl gasket (9) remains properly seated in the carburetor body when the fuel bowl is removed* ***(Figure 14-2, Page 14-4)****.*

During normal operation, the fuel bowl retains the float pivot pin (6). Make sure that the float pivot pin does not fall out of the carburetor body after the fuel bowl is removed.

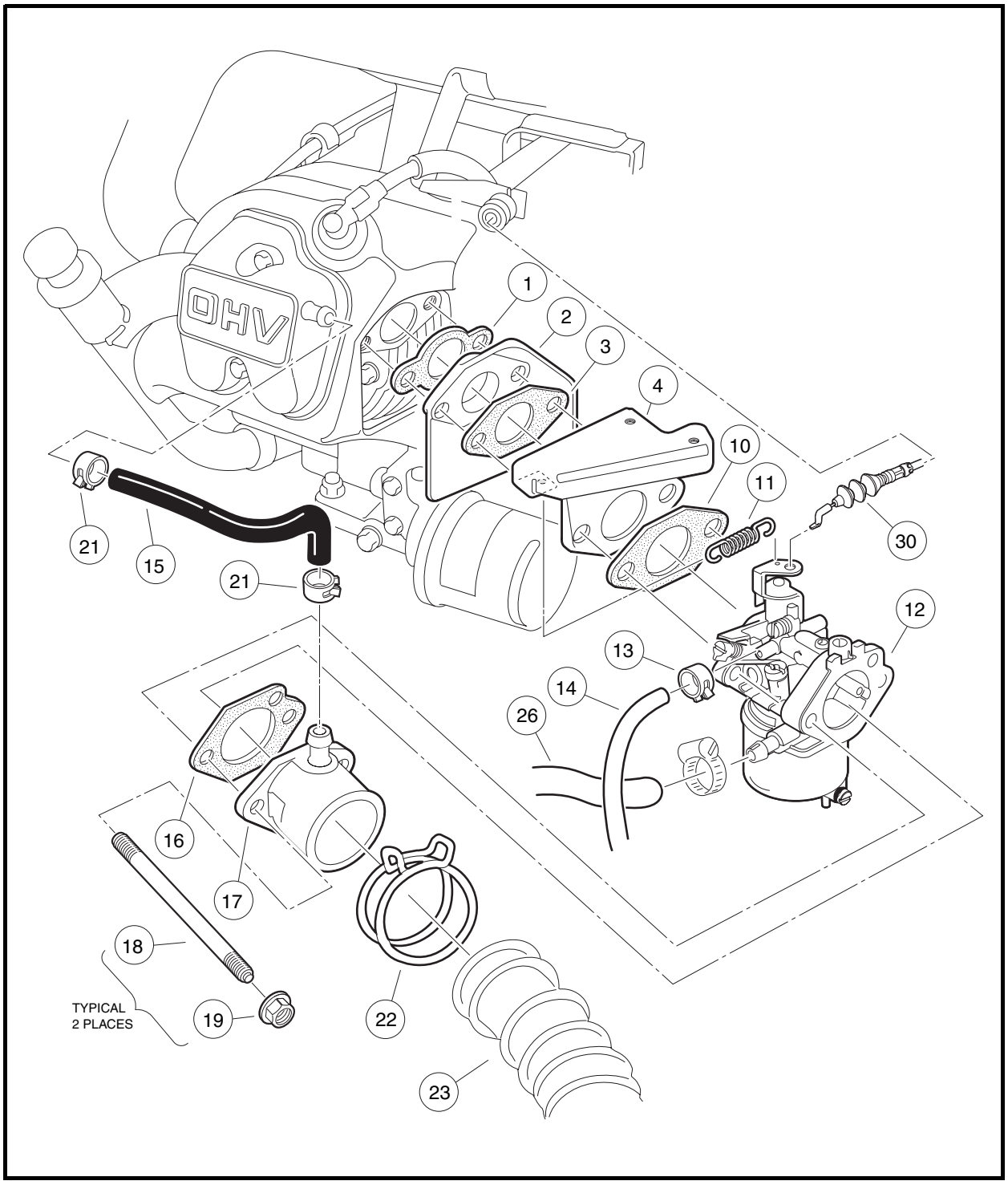


Figure 14-1 Carburetor Installation

Changing the Main Jet, Continued:

6. Remove the main jet (8) from the carburetor body and discard it **(Figure 14-2, Page 14-4)**.

NOTE: *Make sure the fuel nozzle (7) does not fall out of the carburetor body after removal of the main jet. This is best accomplished by positioning the carburetor upside down during main jet removal* ***(Figure 14-2, Page 14-4)****.*

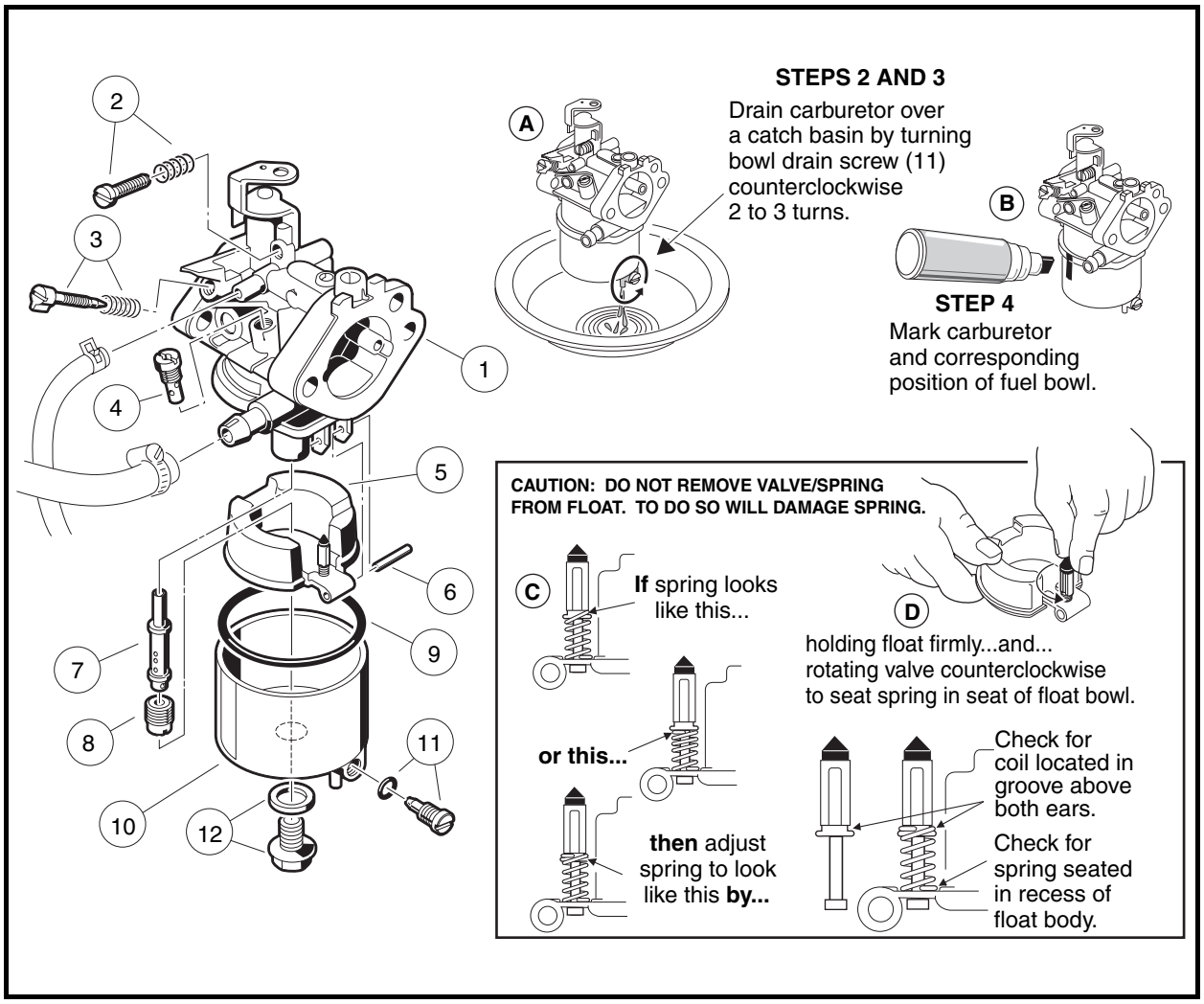


Figure 14-2 Changing the Main Jet

7. Select the proper size main jet. **See Main Jet Elevation/Size Chart on page 14-2.** Check the size designation on the jet to make sure it is the correct part.

8. Install the new main jet and tighten it to 12 in-lb (1.4 N·m). **See following CAUTION and NOTE.**

⚠ CAUTION

- **Do not remove the valve/spring assembly from the float assembly. Doing so will damage the spring.**

NOTE: *Inspect the main jet nozzle (7), and pilot jet (4) to ensure they are free from contamination. Replace any part that is clogged with contamination. Replace the float if it is damaged, or if the float valve is damaged or worn. Examine the float valve/spring assembly to make sure the spring is installed correctly* ***(Figure 14-2, Page 14-4)****.*

9. Install the fuel bowl. Make sure that it is positioned properly by aligning the marks applied in step 4. **See following CAUTION.**

⚠ CAUTION

- **Make sure the fuel bowl is properly seated against the carburetor fuel bowl gasket, and the gasket is not pinched.**

10. Install the fuel bowl retaining screw and tighten it to 61 in-lb (6.9 N·m).
11. Write the size of the main jet on the fuel bowl with an indelible ink marker. This should be written in a location that will be visible when the carburetor is installed on the engine.
12. Install the carburetor on the engine **(Figure 14-1, Page 14-3)**.
    12.1. Attach the throttle return spring (11) to the carburetor and then to the throttle bracket (4) just before positioning the carburetor and securing it to the engine **(Figure 14-1, Page 14-3)**.
    12.2. Install the intake pipe gasket (16) (check for proper orientation) and intake pipe (17).
    12.3. Install the carburetor retaining nuts (19) and tighten them to 50 in-lb (5.7 N·m).
13. Connect fuel supply line (26) and tighten screw clamp to 9 in-lb (1.0 N·m) (if equipped) **(Figure 14-1, Page 14-3)**.
14. Install carburetor vent line (14) and clamp (13).
15. Install the governor cable (30).
16. Install the governor guard (5), flat washer and nylon lock nut. Tighten to 30 in-lb (3.4 N·m).
17. Install the intake hose (23) and secure with hose clamp.

NOTE: *Make sure the intake hose is not twisted during installation.*

18. Turn fuel shut-off valve on top of fuel tank to the ON position **(Figure 14-16, Page 14-24)**.
19. Connect battery cables, positive (+) cable first, and tighten hardware to 12 ft-lb (16 N·m). **See Figure 10-1, Section 10, Page 10-1.** Coat terminals with Battery Terminal Protector Spray (CCI P/N 1014305) to minimize corrosion
20. Test drive the vehicle.

ENGINE CONTROL LINKAGE

See General Warning, Section 1, Page 1-1.

GENERAL INFORMATION

For proper vehicle operation, it is important the accelerator pedal, governor linkage, and throttle adjustments are done correctly and in the proper sequence. **See following CAUTION.**

⚠ CAUTION

- **Improper adjustment can result in poor vehicle performance and/or damage to the engine components.**

ACCELERATOR ROD

⚠ DANGER

- **To ensure the vehicle does not run over you while you disconnect or adjust the accelerator push rod, do the following:**
- **Turn key switch OFF and remove key, place Forward/Reverse handle in the NEUTRAL position, and chock wheels prior to servicing the vehicle.**
  - **Disconnect battery cables, negative (–) cable first.**
  - **Disconnect the spark plug wire from the spark plug.**

Accelerator Rod Removal

1. Raise the front of the vehicle. Place chocks at the rear wheels and lift the front of the vehicle with a chain hoist or floor jack. Place jack stands under the round frame cross tube to support the vehicle. **See preceding DANGER. See also WARNING "Lift only one end of the vehicle..." in General Warning, Section 1, Page 1-1.**
2. Remove the accelerator rod by disconnecting the ball joint (1) from the ball stud (2) on the accelerator pedal **(Figure 14-3, Page 14-6)** and from the bell crank at the electrical box **(Figure 14-5, Page 14-8)**.

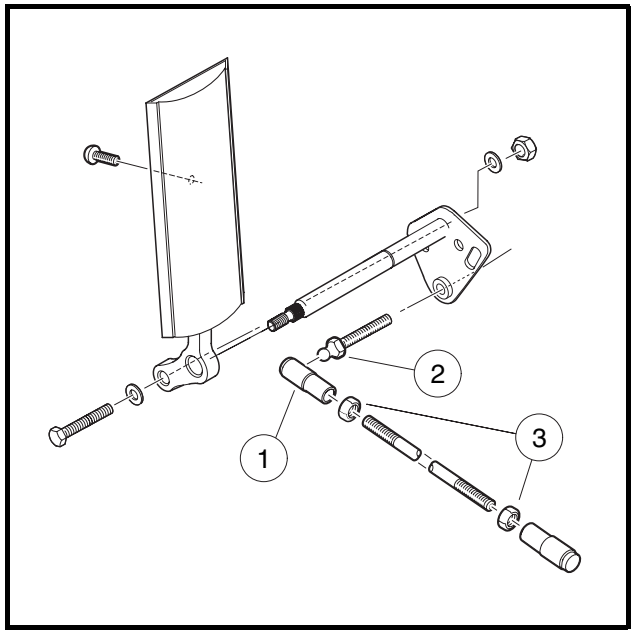


Figure 14-3 Accelerator Rod

Accelerator Rod Installation and Adjustment

1. Before installing the accelerator rod, adjust accelerator pedal position. **See Accelerator Pedal – Gasoline Vehicles, Section 5, Page 5-5.**

2. Install the ball joint on the ball stud at the accelerator pedal **(Figure 14-3, Page 14-6)**.
3. Access the engine compartment.
4. Remove the electrical box screw and cover.
5. Adjust length of accelerator rod:
   5.1. With the ball joint jam nuts (3) loose **(Figure 14-3, Page 14-6)**, adjust the length of the accelerator rod so the indicated cam edge is parallel with the edge of the electrical component box as shown **(Figure 14-4, Page 14-7)**.

⚠ CAUTION

- **Be sure that approximately an equal number of threads are exposed at each end of the accelerator rod.**

6. Install the accelerator rod on the bell crank ball joint on the electrical component box **(Figure 14-5, Page 14-8)**. **See following CAUTION.**

⚠ CAUTION

- **Inspect the limit switch inside the electrical box. If the limit switch lever is bent, replace the switch.**

7. Before tightening the jam nuts, set the park brake to the first latch and pawl position and check for proper activation of switches.

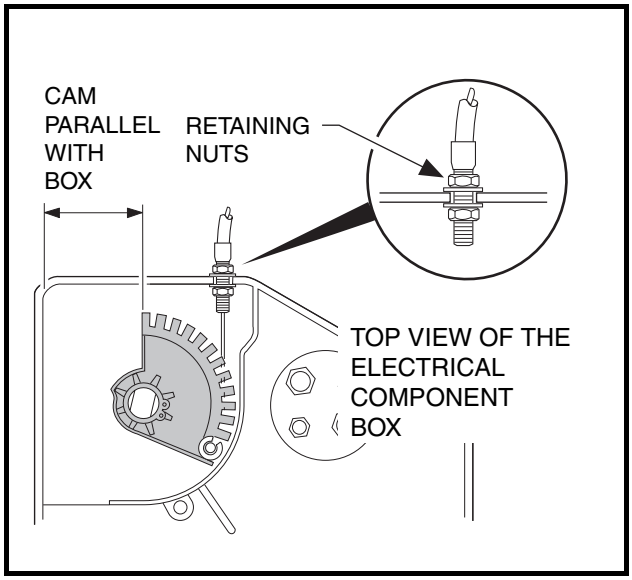


Figure 14-4 Accelerator Cable Adjustment

Accelerator Rod Installation and Adjustment, Continued:

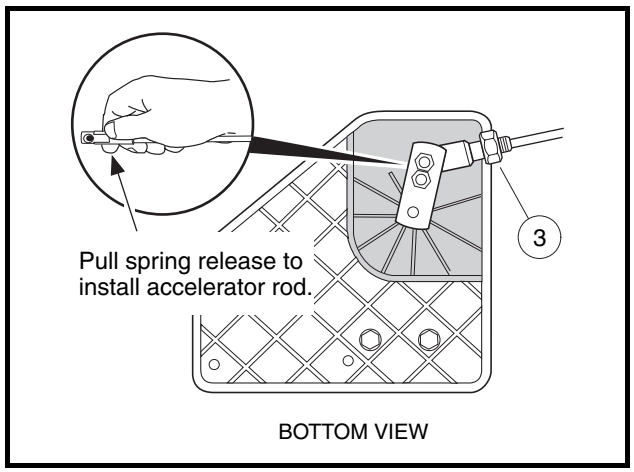


Figure 14-5 Accelerator Rod Attachment

8. While pressing the accelerator pedal, the following events should occur in *exactly the order shown:*

EVENT	APPROXIMATE PEDAL TRAVEL
Park brake release	0°-4°
Solenoid activation	4°-8°
Carburetor throttle actuation	8°-12°

9. While holding the accelerator ball joint with pliers, tighten the jam nuts against the ball joints, accelerator ball joint first, at each end of the accelerator rod.
10. Check rod adjustment for proper switch activation.
11. After the pedal group and accelerator rod are properly adjusted, adjust the engine RPM setting. **See Engine RPM Adjustment on page 14-11.**
12. Install the electrical box cover and tighten retaining screw to 18 in-lb (2.0 N·m).
13. Connect battery cables, positive (+) cable first, and tighten hardware to 12 ft-lb (16 N·m). **See Figure 10-1, Section 10, Page 10-1.** Coat terminals with Battery Terminal Protector Spray (CCI P/N 1014305) to minimize corrosion.

GOVERNOR CABLE

Governor Cable Removal

1. Turn the key switch to the OFF position and remove the key, place the Forward/Reverse handle in the NEUTRAL position, and chock the wheels.
2. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.**
3. Remove the governor guard (5) **(Figure 14-1, Page 14-3)**.
4. Disconnect the governor cable (2) at the carburetor throttle **(Figure 14-6, Page 14-10)**.

5. Disconnect the governor cable (2) from the governor lever arm (15).
6. Remove the governor cable (2) from the governor cable engine bracket (11), and governor cable support bracket (10) **(Figure 14-6, Page 14-10)**. Remove the cable (2) from the vehicle.

Governor Cable Installation and Adjustment

1. Install the cable onto the governor cable support bracket (10) and the engine bracket (11) **(Figure 14-6, Page 14-10)**.
2. Push the cable dust shields onto the ends of the cable conduit.
3. Connect the governor cable to the carburetor throttle at the carburetor.
4. Connect the governor cable to the governor lever arm (15).
5. With the governor lever arm loose on the governor shaft, use a 1/8-inch punch or scratch awl to turn the governor arm shaft counterclockwise until it stops. Then pull the governor lever arm rearward until the carburetor throttle is in the “wide open throttle” (WOT) position.
6. While holding the arm and shaft in the fully counterclockwise position, tighten the governor arm lever nut to 36 in-lb (4.0 N·m).
7. Check engine RPM adjustment. **See Engine RPM Adjustment on page 14-11.**

ACCELERATOR CABLE

Accelerator Cable Removal

1. Remove the electrical box screw and cover and loosen the accelerator cable housing retaining nuts **(Figure 14-4, Page 14-7 or Figure 14-4, Page 14-7)**.
2. Disconnect the accelerator cable (1) from cam (17) in the electrical box **(Figure 14-6, Page 14-10)**.
3. Disconnect the spring (16) from the engine governor arm.
4. Remove the accelerator cable from the accelerator cable bracket (5). Remove the cable assembly from the vehicle.

Accelerator Cable Installation

1. Connect the cable to the cam (17) in the electrical box **(Figure 14-6, Page 14-10)**.
2. Insert the cable housing into the mounting slot in the wall of the electrical box, with approximately the same number of threads visible between the jam nuts as are visible from the nut inside the box to the end of the cable housing **(Figure 14-4, Page 14-7 or Figure 14-4, Page 14-7)**. Tighten the nuts finger tight.
3. Connect the spring (16) to the engine governor arm **(Figure 14-6, Page 14-10)**.
4. Install cable in accelerator cable bracket (5).
5. Push the cable dust shield onto the spring end of the cable conduit.
6. Before tightening the cable housing retaining nuts, make sure the engine RPM adjustment is correct. **See Engine RPM Adjustment on page 14-11.**
7. Install the electrical box cover, and tighten the retaining screw to 18 in-lb (2.0 N·m).
8. Connect battery cables, positive (+) cable first, and tighten hardware to 12 ft-lb (16 N·m). **See Figure 10-1, Section 10, Page 10-1.** Coat terminals with Battery Terminal Protector Spray (CCI P/N 1014305) to minimize corrosion.

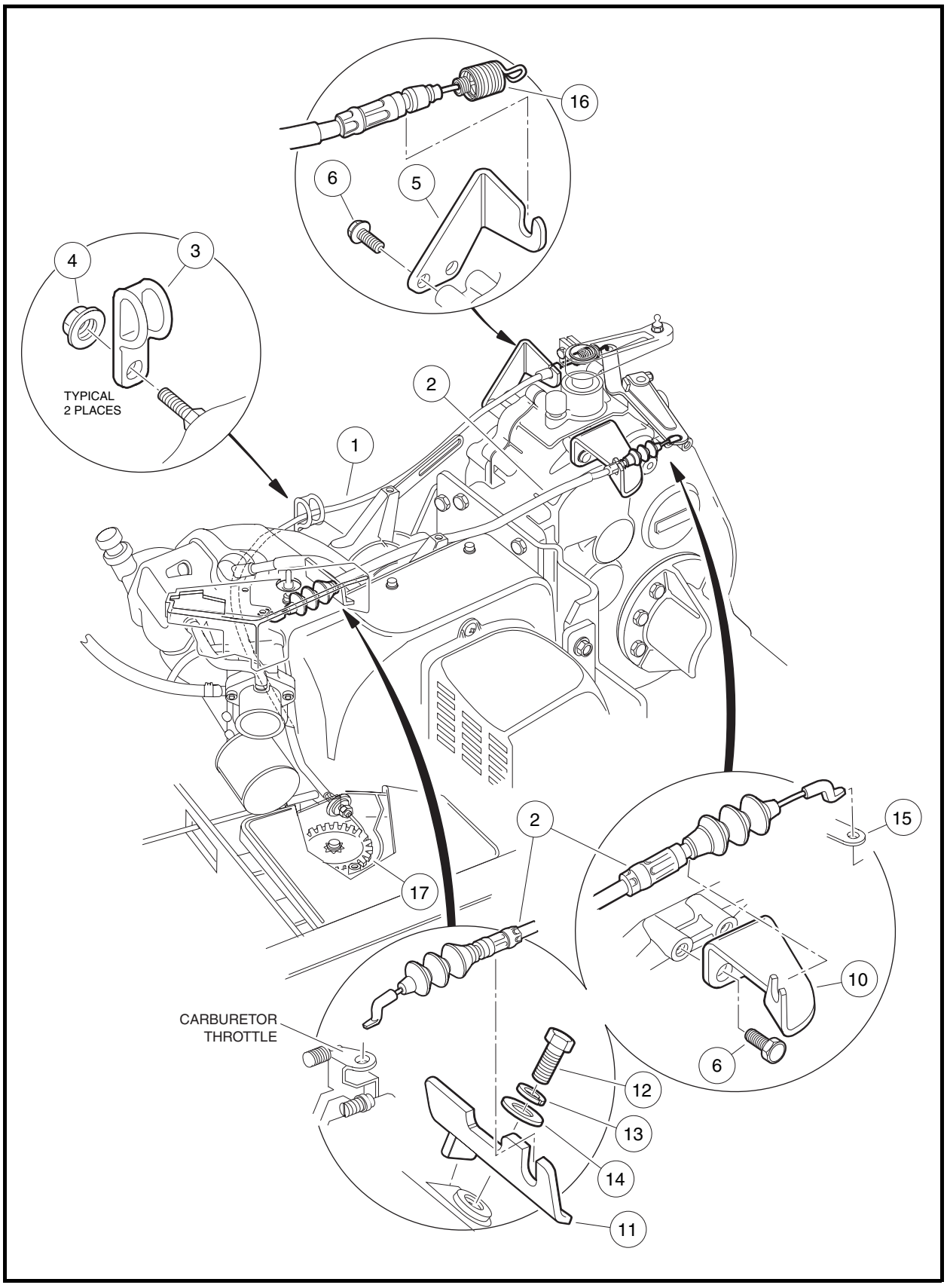


Figure 14-6 Governor and Accelerator Cables

CLOSED THROTTLE OR IDLE ADJUSTMENT

When the accelerator pedal is released, the engine will stop. Therefore, it is not possible to measure or set idling speed under normal vehicle operating conditions. Set throttle valve as follows:

1. Loosen the carburetor idle screw so that it is not touching the throttle lever **(Figure 14-7, Page 14-11)**.
2. Slowly tighten the idle screw until it lightly touches the throttle lever, then tighten it an additional 3/4 turn.

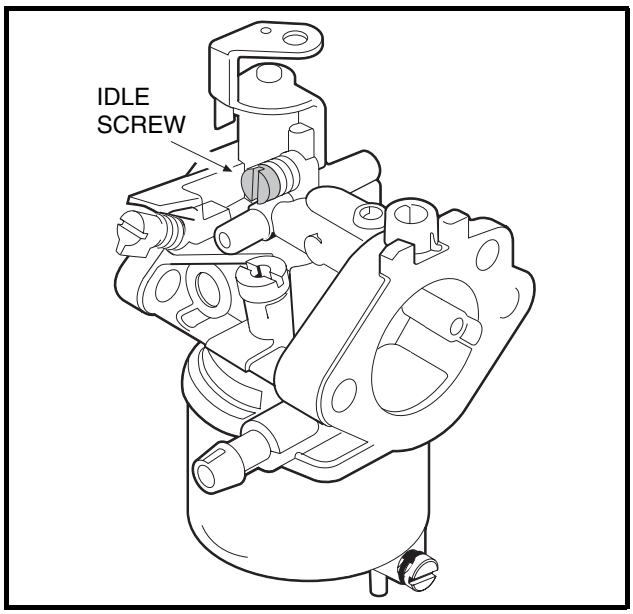


Figure 14-7 Idle Screw

ENGINE RPM ADJUSTMENT

⚠ DANGER

- **Do not operate gasoline vehicle in an enclosed area without proper ventilation. The engine produces carbon monoxide, which is an odorless, deadly poison.**

1. If the governor is adjusted, proceed to step 2; otherwise, adjust the governor. **See Governor Cable Installation and Adjustment on page 14-9.**
2. Connect battery cables, positive (+) cable first, and tighten hardware to 12 ft-lb (16 N·m). **See Figure 10-1, Section 10, Page 10-1.** Coat terminals with Battery Terminal Protector Spray (CCI P/N 1014305) to minimize corrosion
3. Place the Forward/Reverse handle in the NEUTRAL position, chock the wheels, and place the neutral lockout cam in the SERVICE (MAINTENANCE) position.
4. Connect a tachometer (CCI P/N 1016112) to the spark plug lead.
5. With the tachometer connected, and the engine at normal operating temperature, check high speed RPM. With the accelerator pedal pressed to the floor, the tachometer should read 2700 ±30 RPM
6. To **reduce** RPM, loosen the accelerator cable retaining nut on the outside of the electrical box wall and tighten the retaining nut on the inside of the wall until the specified RPM is reached (**Figure 14-4, Page 14-7)**. To **increase** RPM, loosen the cable retaining nut inside the electrical box and tighten the nut outside the box until the specified RPM is reached.

Engine RPM Adjustment, Continued:

7. Be sure both retaining nuts are locked against the electrical box and then check the RPM again. If the RPM needs to be adjusted, repeat step 6.
8. If more adjustment is required than the cable housing will allow, make sure the spring on the other end of the accelerator cable is properly positioned. Excessive belt and torque converter wear can also prevent proper RPM adjustment. Check them for excessive wear. **See Section 17 – Torque Converter: gasoline Vehicle.**

CHOKE AND AIR INTAKE SYSTEM

See General Warning, Section 1, Page 1-1.

CHOKE BUTTON REMOVAL

1. Remove the mounting screws (22) from the back side of the choke. Remove the choke assembly from the vehicle body **(Figure 14-9, Page 14-14)**.

CHOKE BUTTON INSTALLATION

1. Position the choke assembly (2) on the vehicle body. Install the mounting screws (22) from inside the vehicle body and tighten to 18 in-lb (2.0 N·m) **(Figure 14-9, Page 14-14)**.
2. Check for proper operation. If the choke button does not adequately engage the choke lever (20), loosen the screw (30) and adjust the choke bracket (23) on the choke lever (20). Move the bracket toward the choke button to increase choke engagement and away from the choke button to reduce choke engagement.

AIR BOX REMOVAL

1. Turn the key switch to the OFF position and remove the key, place the Forward/Reverse handle in the NEUTRAL position, and chock the wheels.
2. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.**
3. Remove the air intake box from the vehicle by removing intake hose (21) and three screws (1) and washers (29) that mount the intake box to the vehicle **(Figure 14-9, Page 14-14)**.

AIR BOX INSTALLATION

NOTE: *The intake duct must be in place before the air box can be installed.*

1. Check to be sure the intake seal (11) is seated correctly **(Figure 14-9, Page 14-14)**. The seal fits tightly onto the bottom side of the air box. If seal is not in place, moisture will enter the air intake system.
2. Place the air box assembly into vehicle and install three flat washers (29) and screws (1) from underside of air box mounting plate into air box **(Figure 14-9, Page 14-14)**. Tighten to 33 in-lb (3.7 N·m).
3. Place hose onto air box and secure with wire clamp. If equipped with screw clamp, tighten to 17 in-lb (1.9 N·m).
4. Test choke for proper operation.

INTAKE DUCT REMOVAL

1. Remove the front body. **See Front Body Removal, Section 4, Page 4-4.**
2. Remove the front left wheel. **See Wheel Removal, Section 8, Page 8-1.**
3. Remove the steering joint assembly **(Figure 14-8, Page 14-13)**.

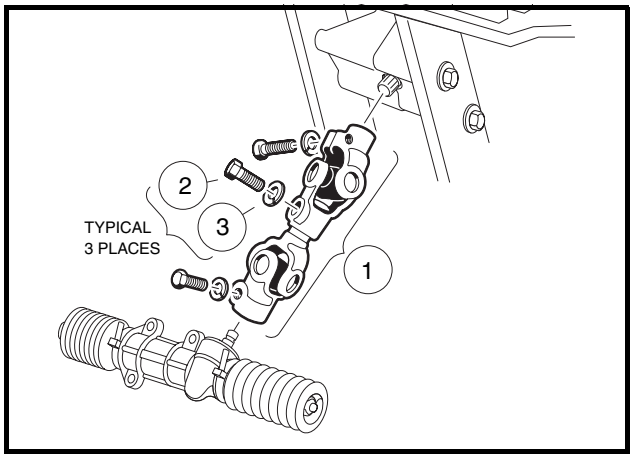


Figure 14-8 Compound Steering Joint

4. Drill out the two pop rivets (27) securing the intake duct to the floorboard **(Figure 14-9, Page 14-14)**.
5. Remove three screws (1) and flat washers (29) from the bottom of the air box assembly.
6. Lift air box assembly off the intake duct. Be careful that the intake seal on the bottom of the air box assembly is not dislodged in the process.
7. Pull the intake duct forward and out of the vehicle.

INTAKE DUCT INSTALLATION

The intake duct assembly is installed from the front of the vehicle.

1. Slide the intake duct between the round crossmember and the floorboard, moving it to the rear along the underside of the floorboard. Insert the end of the intake duct through the slot in the front of the air box mounting plate.
2. Secure the front of the duct to the underside of the floorboard with two pop rivets (27) and flat washers (28) **(Figure 14-9, Page 14-14)**.
3. Install air box. **See Air Box Installation on page 14-12.**
4. Install steering joint assembly. **See following NOTE.**

NOTE: *Make sure steering wheel and front wheels are properly aligned before installing steering joint.*

   4.1. Position steering joint assembly (1) on vehicle as shown. Install three lock washers (3) and three bolts (2) and tighten to 15 ft-lb (20.3 N·m) **(Figure 14-8, Page 14-13)**.

   4.2. Align the flat portion of the steering shaft spline with the bolt hole in the universal joint and then slide the shaft into the upper universal joint. Install the bolt and lock washer on the upper universal joint and tighten to 15 ft-lb (20 N·m).

5. Install front left wheel. Tighten the wheel rim mounting nuts to 55 ft-lb (75 N·m).
6. Install front body.

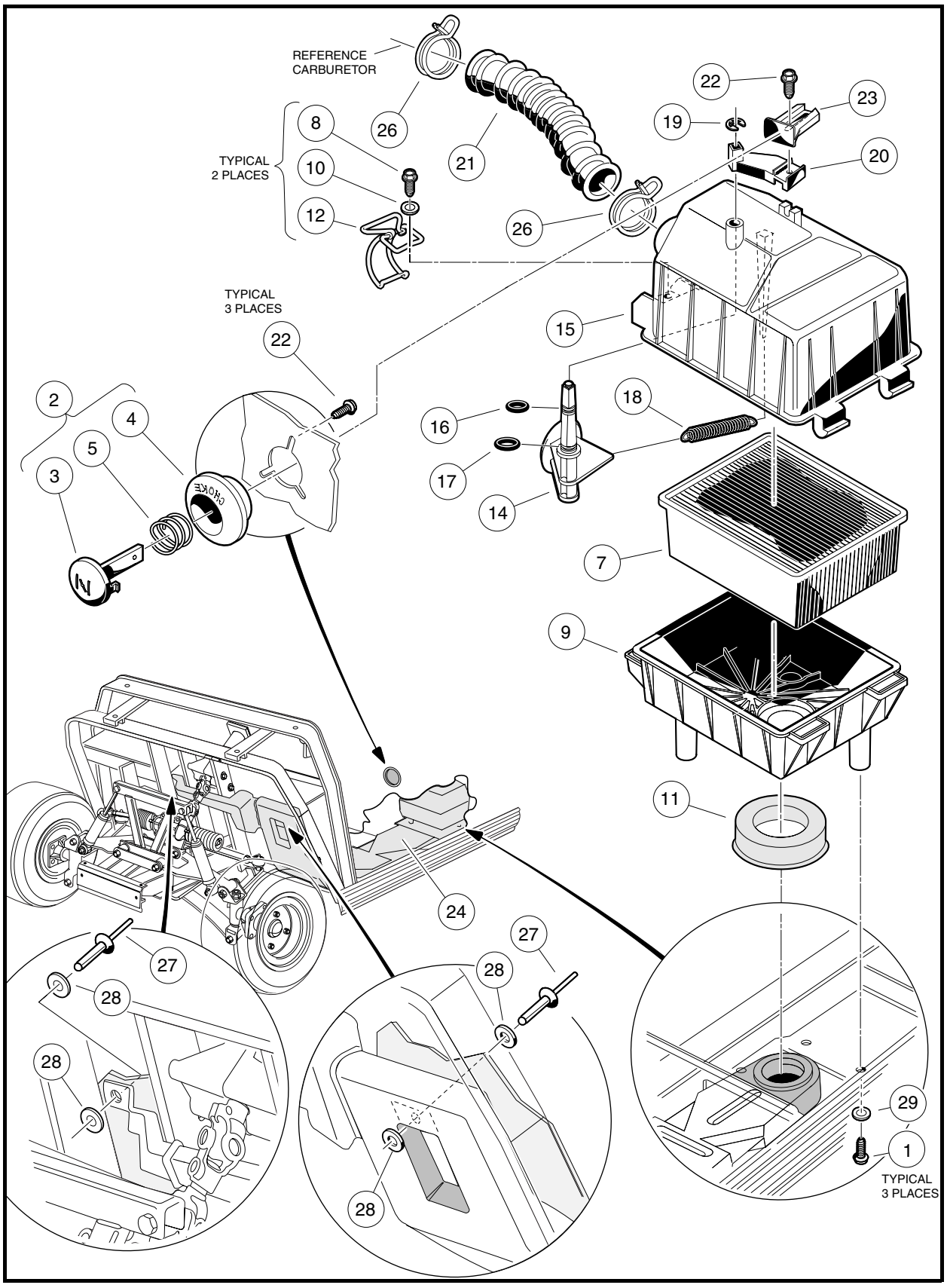


Figure 14-9 Air Intake and Choke Assemblies

AIR FILTER

Air Filter Replacement

1. Lift two latches (12) on the side of the air box **(Figure 14-9, Page 14-14)**.
2. Remove the hose clamp (26) from the air hose (21) and remove hose from the air box assembly.
3. Standing on driver side of vehicle, grasp air hose mounting inlet and open box fully. Remove filter element (7).
4. Using a clean cloth, wipe away any dust or dirt from inside the air box. Remove all dirt build-up around the inside lip of the box or the box will not seal properly.
5. Install new air filter by inserting back edge first, and pushing down using the palm of your hand to seat filter evenly onto inside lip of air box. Ensure filter fits correctly and that the wire latches are not caught between lid and air box. Close the lid.
6. Fasten wire latches (12). Make sure latches securely engage the bottom half of the box. **See following CAUTION.**

⚠ CAUTION

- **Engine damage will occur if the air box cover is not properly secured.**
- **If air box is extremely dirty, remove air box from vehicle and clean thoroughly.**
- **Use only Club Car recommended replacement air filters (603 00 00-04). The use of other air filters could result in engine damage. If the air filter is too thin, the cover will seat before the filter can seal, leaving space for dirt to pass into the engine on all sides of the element. This will damage the engine and void the warranty.**

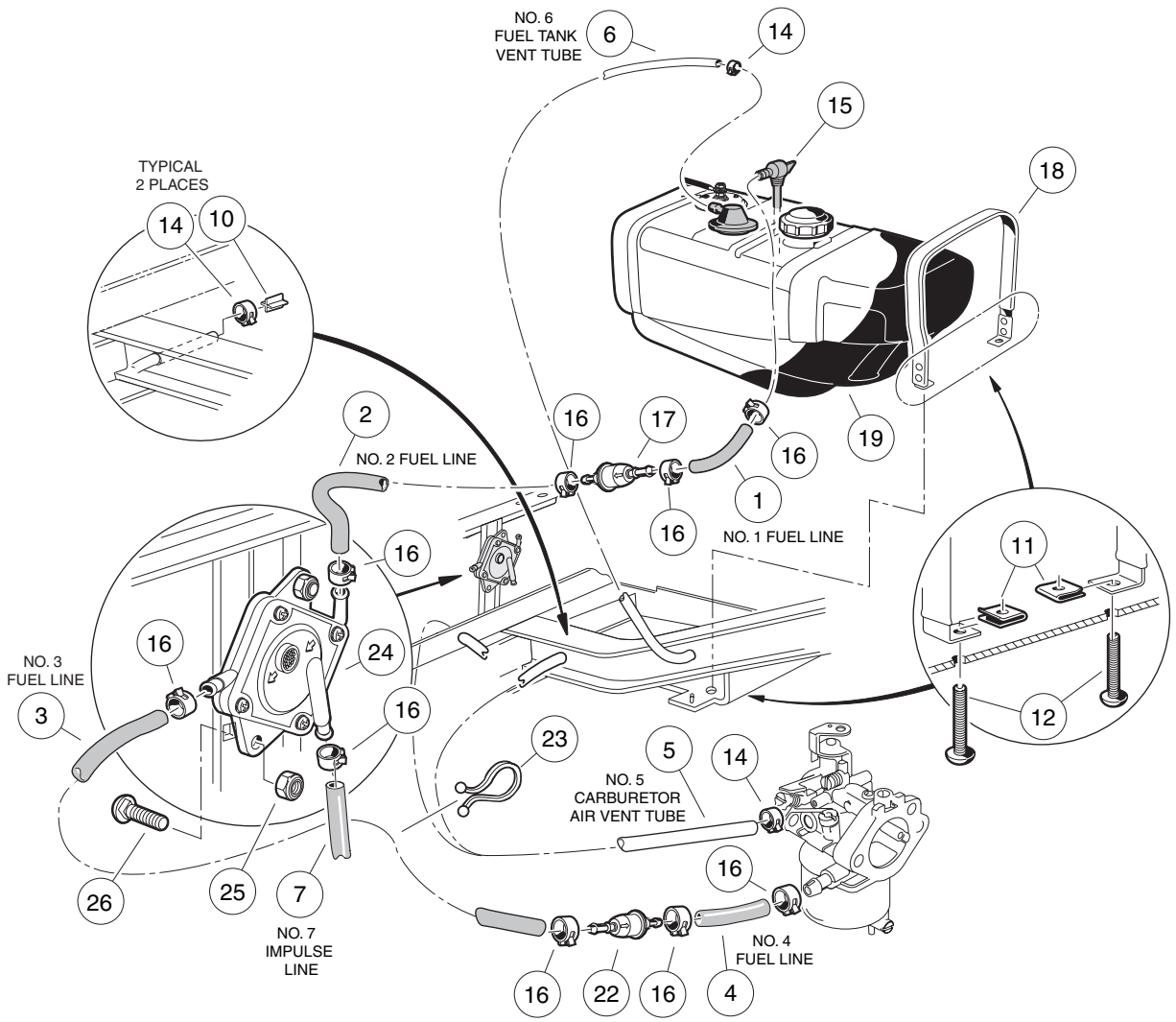
7. Install hose (21) and hose clamp (26) **(Figure 14-9, Page 14-14)**. If equipped with screw clamp, tighten to 17 in-lb (1.9 N·m). Make sure clamp ends are located in the 12:00 o'clock position.

FUEL FILTERS

See General Warning, Section 1, Page 1-1.

FUEL FILTER REMOVAL

1. Turn the key switch to the OFF position and remove the key, place the Forward/Reverse handle in the NEUTRAL position, and chock the wheels.
2. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.**
3. To prevent fuel drainage, turn the fuel shut-off valve (15) on the fuel tank (19) **(Figure 14-10, Page 14-16)** to the closed (OFF) position **(Figure 14-15, Page 14-24)**.
4. Remove the primary fuel filter (17) **(Figure 14-10, Page 14-16)**.
   4.1. Remove the clamps (16) and fuel lines (1 and 2) from the filter and plug the fuel lines.
5. Remove the secondary filter (22):
   5.1. Remove the clamps (16) and fuel lines (3 and 4) from the filter and plug the fuel lines (3 and 4).



FUEL LINE No.	ROUTING	LENGTH	
		Solid Color	Clear
1	Fuel tank to primary fuel filter	7.0 in. (17.8 cm)	
2	Primary fuel filter to fuel pump	6.5 in. (16.5 cm)	
3	Fuel pump to secondary fuel filter	11.5 in. (29.2 cm)	
4	Secondary fuel filter to carburetor	2.75 in. (7.0 cm)	
5	Vent tube (Carburetor)		11.0 in. (27.9 cm)
6	Vent tube (Fuel Tank)		18.0 in. (45.7 cm)
7	Impulse line	16.0 in. (43.2 cm)	
	Totals	43.75 in. (123.2 cm)	29.0 in. (99.1 cm)

Figure 14-10 Fuel and Vent Lines

FUEL FILTER INSTALLATION

⚠ CAUTION

- **Fuel filters are marked with flow direction arrows. Make sure that filters are installed with arrows pointing in the direction of fuel flow from tank to carburetor.**

1. Install the primary fuel filter (17) in the fuel line. Use new clamps (16) **(Figure 14-10, Page 14-16)**.
2. Install the secondary fuel filter (22) in the fuel line. Use new clamps (16).
3. Turn the fuel shut-off valve to the ON position **(Figure 14-16, Page 14-24)**.
4. Connect battery cables, positive (+) cable first, and tighten hardware to 12 ft-lb (16 N·m). **See Figure 10-1, Section 10, Page 10-1.** Coat terminals with Battery Terminal Protector Spray (CCI P/N 1014305) to minimize corrosion
5. Place the Forward/Reverse handle in the NEUTRAL position and chock the wheels. Start the engine and check for fuel leaks. **See following DANGER.**

⚠ DANGER

- **Repair all fuel leaks before operating the vehicle.**

FUEL PUMP

See General Warning, Section 1, Page 1-1.

GENERAL INFORMATION

The gasoline vehicle is equipped with an impulse fuel pump. If the fuel pump is not operating properly, perform the following tests:

- Make sure all hose clamps are tight.
- Inspect the impulse line and fuel lines for damage or clogging.
- Make sure the air vent on the fuel pump is not clogged with dirt.
- Make sure the fuel filters are not clogged.

To clean the air vent, the fuel pump must be disassembled.

FUEL PUMP REMOVAL

1. Turn the key switch to the OFF position and remove the key, place the Forward/Reverse handle in the NEUTRAL position, and chock the wheels.
2. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.**
3. Turn fuel shut-off valve on top of the fuel tank to the closed (OFF) position **(Figure 14-15, Page 14-24)**.
4. Remove hardware attaching the fuel pump (24) and lift the fuel pump out of the engine compartment **(Figure 14-10, Page 14-16)**.
5. Remove the clamp and impulse line (7) from fuel pump.

Fuel Pump Removal, Continued:

6. Disconnect the fuel lines (2 and 3) from the pump and plug them to prevent fuel leakage**. See following WARNING.**

⚠ WARNING

- **Carefully drain any fuel remaining in the pump into an approved container. Add drained fuel back into fuel tank or dispose of properly.**

FUEL PUMP DISASSEMBLY

⚠ CAUTION

- **Fuel pump gaskets and diaphragms must be installed in exactly the same positions and orientations they were in before disassembly, or the pump could leak. If leaking occurs, all new gaskets and diaphragms must be installed.**

NOTE: *A fuel pump rebuild kit is available from your distributor/dealer (CCI P/N 1014524). This kit includes all gaskets, diaphragms, and valves.*

1. Match mark the fuel pump and cover before disassembly.
2. Remove four screws (24) and lock washers (25) from front of the fuel pump **(Figure 14-11, Page 14-19)**.
3. Remove the front cover of the fuel pump while holding the rest of the pump intact.
4. Note the orientations of the impulse gasket (27), the diaphragm (28), and the gasket (29), then remove them from the pump.
5. If the impulse gasket (27) and the diaphragm (28) come off with the front cover, note their orientations and remove them **(Figure 14-11, Page 14-19)**.
6. Remove the pumping chamber (30).
7. Remove the back cover (36), the fuel diaphragm (34), and gasket (35) **(Figure 14-11, Page 14-19)**.

FUEL PUMP CLEANING AND INSPECTION

1. Using a nonflammable solvent, clean the front cover, pumping chamber, and back cover. Be sure the vent on the front cover is clean both inside and out.
2. Inspect the valve assemblies (31, 32, and 33) and all gaskets and diaphragms for damage **(Figure 14-11, Page 14-19)**.
3. If a valve assembly is damaged, the rubber retaining plug (33) and valve assembly must be replaced.

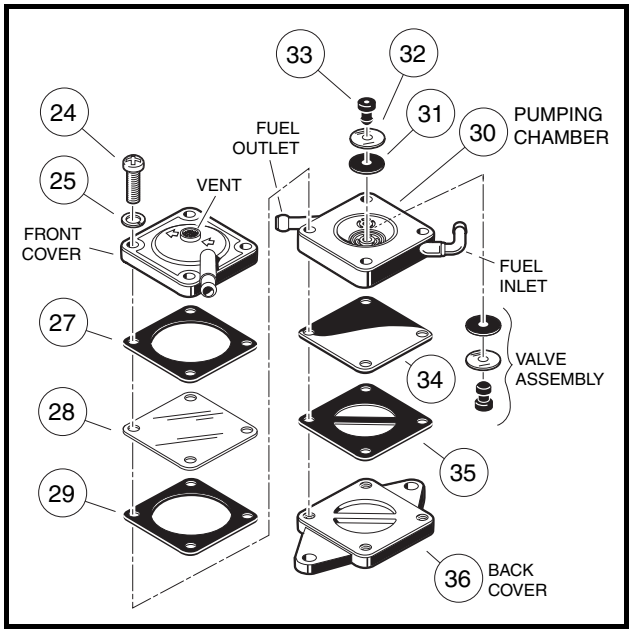


Figure 14-11 Fuel Pump

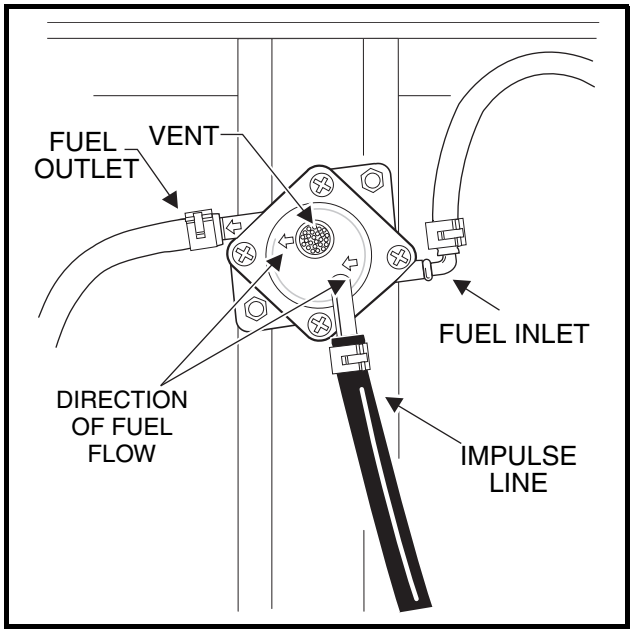


Figure 14-12 Fuel Pump Orientation

FUEL PUMP ASSEMBLY

1. Install the fuel gasket (35) and diaphragm (34) on the back cover (36) **(Figure 14-11, Page 14-19)**.
2. Install the valve assembly in the pumping chamber (30). **See following CAUTION.**

⚠ CAUTION

- **If the valve assembly is not installed exactly as shown (Figure 14-11, Page 14-19), the impulse fuel pump will not operate properly.**

3. Install the pumping chamber (30) on top of the fuel diaphragm (34). Be sure the fuel inlet and the fuel outlet align with the arrows on the front of the front cover **(Figure 14-11, Page 14-19)**.
4. Install the gasket (29), clear impulse diaphragm (28), and the paper impulse gasket (27) to the pumping chamber (30).
5. Install the front cover and then the lock washers (25) and four screws (24) on the assembly **(Figure 14-11, Page 14-19)**. Be sure the arrows on the front cover point from the fuel inlet to the fuel outlet **(Figure 14-12, Page 14-19)**. Tighten the screws to 26 in-lb (3.0 N·m).

FUEL PUMP INSTALLATION

1. Connect to the fuel pump the fuel line (2) that comes from the primary fuel filter (17). Install a new clamp (16). Route the fuel lines as shown **(Figure 14-10, Page 14-16).**

NOTE: *Be sure to connect the fuel line (2), that comes from the primary fuel filter (17), to the inlet nipple on the pump. Direction of fuel flow is indicated by the arrows on the fuel pump* ***(Figure 14-10, Page 14-16)****.* ***See also Figure 14-12, Page 14-19****.*

2. Connect to the output side of the fuel pump, the fuel line (3) that goes to the secondary fuel filter **(Figure 14-10, Page 14-16)**.
3. Connect the impulse line (7) to the bottom nipple on the fuel pump. Use a new clamp (16).

Fuel Pump Installation, Continued:

4. Install the fuel pump. Tighten nylon lock nuts to 38 in-lb (4.3 N·m).
5. Connect battery cables, positive (+) cable first, and tighten hardware to 12 ft-lb (16 N·m). **See Figure 10-1, Section 10, Page 10-1.** Coat terminals with Battery Terminal Protector Spray (CCI P/N 1014305) to minimize corrosion
6. Turn the fuel shut-off valve on top of the fuel tank to the open position **(Figure 14-16, Page 14-24)**.
7. Place the Forward/Reverse handle in the NEUTRAL position and chock the wheels.
8. Start the engine and check for fuel leaks. If the fuel pump leaks, a rebuild kit must be installed to replace all gaskets and diaphragms. **See following DANGER**.

⚠ DANGER

- **Repair all fuel leaks before operating the vehicle.**

FUEL TANK

See General Warning, Section 1, Page 1-1.

GENERAL INFORMATION

The vehicle is equipped with a high impact plastic, seven gallon (26.5 liter) fuel tank.

⚠ WARNING

- **If the fuel tank is damaged, replace it. Do not attempt to repair it. See the following tank removal and disposal procedure.**

⚠ CAUTION

- **Add only unleaded fuel to the tank. Do not put oil in the fuel tank.**

FUEL TANK REMOVAL

1. Remove the cargo bed, rear body and seat back support. **See Cargo Bed Removal, Section 4, Page 4-6.**
2. Place the Forward/Reverse handle in the NEUTRAL position and chock the wheels and remove the key.
3. Turn fuel shut-off valve to the closed (OFF) position and run the engine until fuel remaining in the carburetor, fuel pump, and fuel lines is used up and the engine stalls **(Figure 14-15, Page 14-24)**.
4. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.**
5. Loosen, but do not remove, the carburetor drain screw (11) and drain fuel remaining in the carburetor bowl into an approved container **(Figure 14-2, Page 14-4)**. Retighten carburetor drain screw.
6. Using a siphon with a suction device, siphon all fuel out of the tank and into an approved container. **See following DANGER and WARNING**.

⚠ DANGER

- **Gasoline – Flammable! Explosive! Do not smoke. Keep sparks and flames away from the vehicle and service area. Service only in a well-ventilated area.**

⚠ WARNING

- **Do not attempt to siphon fuel using a hose that does not have a built-in suction device.**
- **Do not attempt to siphon fuel using your mouth.**

7. If vehicle is equipped with a fuel gauge, disconnect the black wire and orange wire from the fuel level sending unit on the tank **(Figure 14-13, Page 14-21)**. Do not remove the lower nut on the center stud of the sending unit. **See following WARNING.**

⚠ WARNING

- **Make sure the key switch is off before disconnecting wiring.**

8. Remove the vent tube (6) and fuel line (1) from the fuel tank **(Figure 14-10, Page 14-16)**
9. Loosen the straps (13 and 18) by removing the screws (12) from the speed nuts (11).
10. Lift the fuel tank out of the vehicle.

FUEL TANK DISPOSAL

1. Remove the cap from the tank and thoroughly rinse it with water. The cap may be discarded or kept as a spare.
2. In a well-ventilated area, flush the fuel tank with water to remove any remaining fuel.
3. In a well-ventilated area, set the tank upside down so that the water can drain out of it. To make sure that the tank dries completely, allow the tank to sit for 24 hours. **See following CAUTION**.

⚠ CAUTION

- **Dispose of wastewater and fuel tank in accordance with local, state, and federal laws and ordinances.**

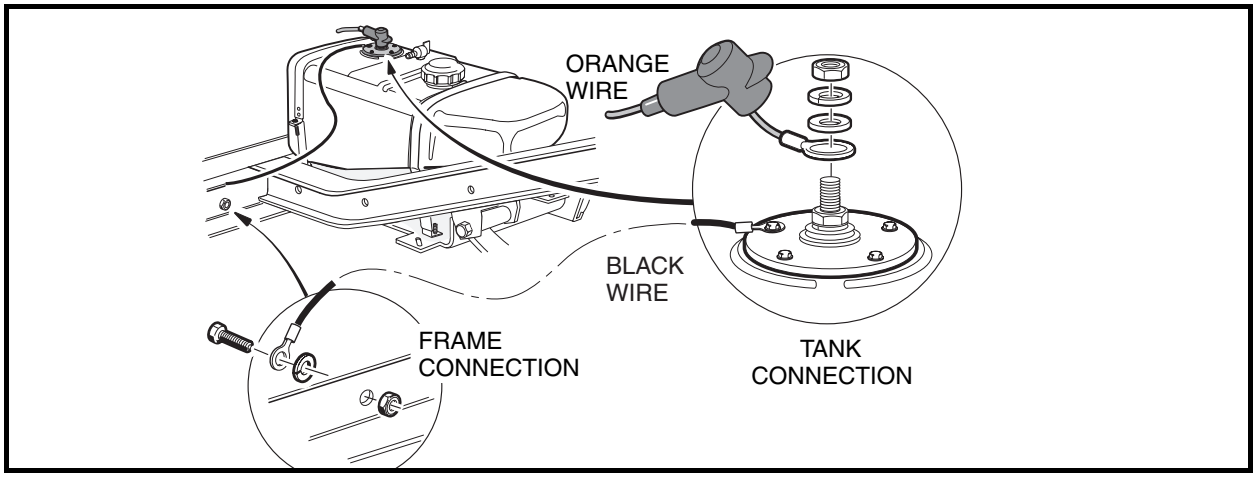


Figure 14-13 Fuel Level Sending Unit

FUEL TANK STORAGE

1. Remove the cap from the tank and thoroughly rinse it with water.
2. In a well-ventilated area, flush the fuel tank with water to remove any remaining fuel.
3. In a well-ventilated area, set the tank upside down so that the water can drain out of it. To make sure that the tank dries completely, allow the tank to sit for 24 hours.
4. Store the tank upside down, with the cap installed, in a well-ventilated area.

FUEL TANK INSTALLATION

1. With the retaining straps correctly positioned, install the fuel tank in the vehicle.
2. Secure the tank with the retaining straps (13 and 18) **(Figure 14-10, Page 14-16)**.
   2.1. Position the straps in the indentions on the tank.
   2.2. Install the screws (12) into the speed nuts (11). Tighten screws and nuts to 25 in-lb (2.8 N·m) **(Figure 14-10, Page 14-16)**.
3. Install the rear body on the vehicle if removed. **See Rear Body Installation, Section 4, Page 4-13.**
4. Install seat back support if removed. **See Seat Back Support Bracket Installation, Section 4, Page 4-9.**
5. Connect the vent tube (6) to the fuel tank vent **(Figure 14-10, Page 14-16)**.
6. Connect the fuel line (1) to the fuel tank shut-off valve (15). Use a new clamp **(Figure 14-10, Page 14-16)**.
7. Connect the black wire from the fuel gauge to one of the fuel level sending unit screws. Connect the orange wire to the center stud and install the flat washer, lock washer, and nut. Tighten to 18 in-lb (2.0 N·m).
8. Slide the rubber boot over the stud **(Figure 14-13, Page 14-21)**.
9. Add fuel to the tank.
10. Connect battery cables, positive (+) cable first, and tighten hardware to 12 ft-lb (16 N·m). **See Figure 10-1, Section 10, Page 10-1.** Coat terminals with Battery Terminal Protector Spray (CCI P/N 1014305) to minimize corrosion
11. Check to be sure the fuel shut-off valve on top of the fuel tank is in the open (ON) position **(Figure 14-16, Page 14-24)**.
12. Turn the key switch to the START position and start the engine. **See following DANGER.**

⚠ DANGER

- **Do not operate gasoline vehicle in an enclosed area without proper ventilation. The engine produces carbon monoxide, which is an odorless, deadly poison.**
- **After installing the fuel tank and adding fuel, carefully check all fuel lines and connections for leaks. Repair any fuel leaks before operating the vehicle.**

13. Allow the engine to run for a few minutes to ensure that the fuel lines are full of fuel.
14. Inspect each fuel line for leaks.
    14.1. Check all of the fuel line clamps at the carburetor, fuel filters, fuel pump, and fuel tank for leaks.
    14.2. Inspect each fuel line to ensure that the lines are not cracked, cut, or worn.

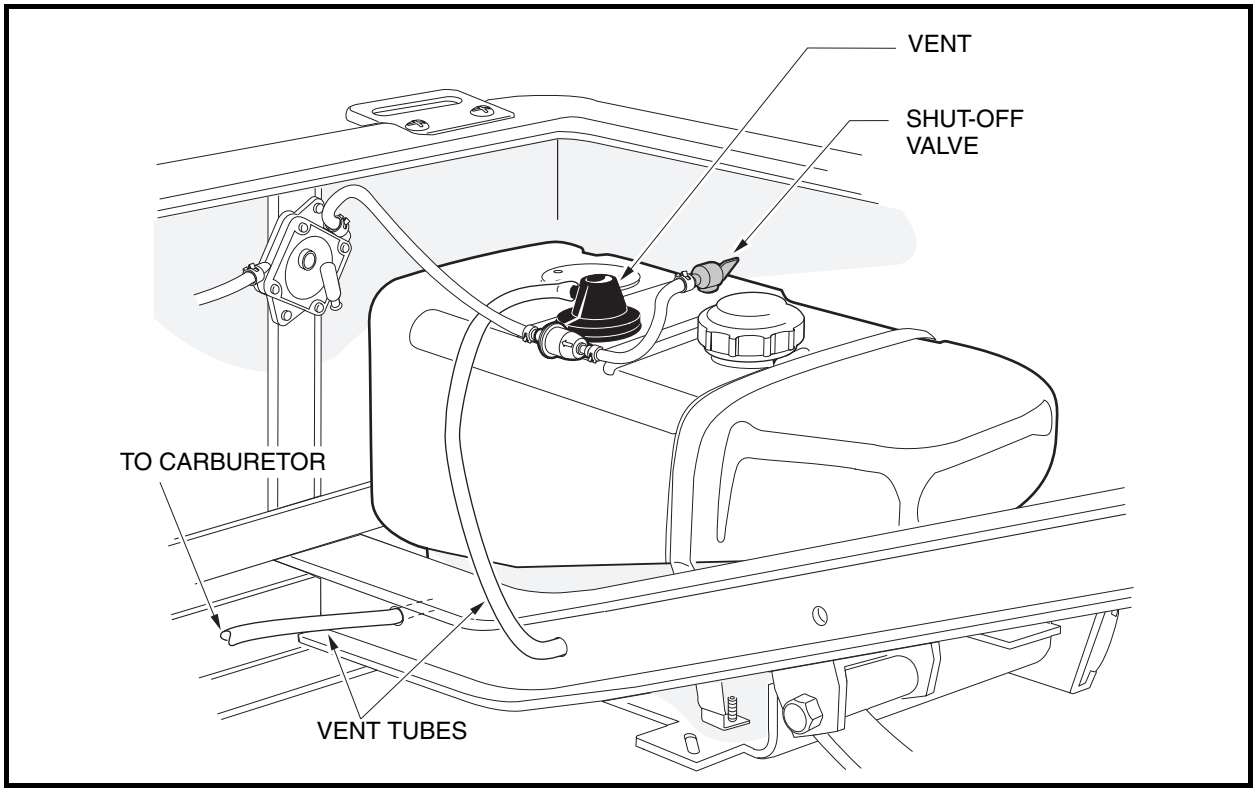


Figure 14-14 Fuel Tank

FUEL LINES

See General Warning, Section 1, Page 1-1.

The fuel lines must be properly routed, and all hose clamps must be tight. The fuel lines should be kept clean. **See following WARNING.**

⚠ WARNING

- **Make sure fuel lines are the right length and are properly routed. Failure to heed this warning could result in damage to fuel lines and fire.**

Fuel line no. 1 runs directly from the fuel tank to the primary fuel filter (17). The primary fuel filter has an arrow indicating fuel flow direction **(Figure 14-10, Page 14-16)**.

Fuel line no. 2 runs directly from the primary fuel filter to the fuel inlet of the fuel pump.

Fuel line no. 3 runs directly from the fuel outlet of the fuel pump to the secondary fuel filter **(Figure 14-10, Page 14-16)**. The secondary fuel filter has an arrow indicating fuel flow direction and is identical to the primary fuel filter.

Fuel line no. 4 runs from the outlet of the secondary fuel filter to the carburetor **(Figure 14-10, Page 14-16)**.

Small spring steel band clamps are used on all hose connections except at the carburetor. A screw band clamp (16) should be used at the carburetor **(Figure 14-10, Page 14-16)**.

FUEL SHUT-OFF VALVE

See General Warning, Section 1, Page 1-1.

The fuel shut-off valve is located on top of the fuel tank **(Figure 14-14, Page 14-23)**. The fuel shut-off valve should always be turned to the closed (OFF) position during vehicle storage, towing or trailering **(Figure 14-15, Page 14-24)**. Unless the engine will be run as part of a procedure, the fuel shut-off valve should also be closed (OFF) before performing maintenance or service procedures.

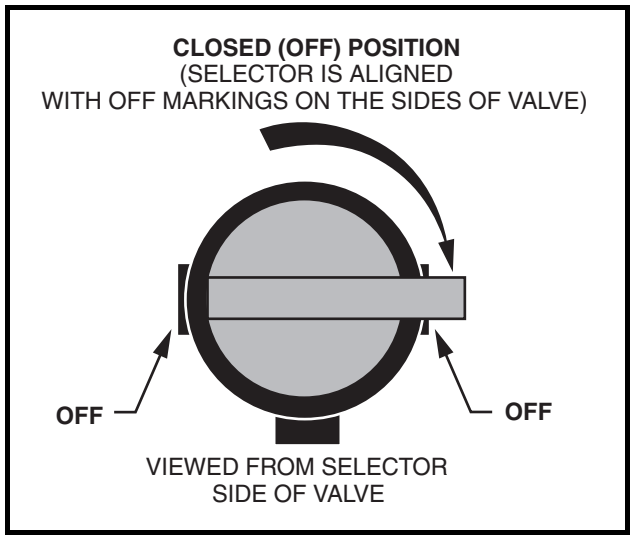


Figure 14-15 Closed Fuel Shut-off Valve

Fully Open Position

The valve's open position differs from standard valve configurations. For the valve to be fully open, it must be turned approximately 120° from the closed (OFF) position (until it cannot be turned any further) **(Figure 14-16, Page 14-24)**. If the valve becomes partially closed **(Figure 14-17, Page 14-24)**, the engine will not run properly due to fuel starvation.

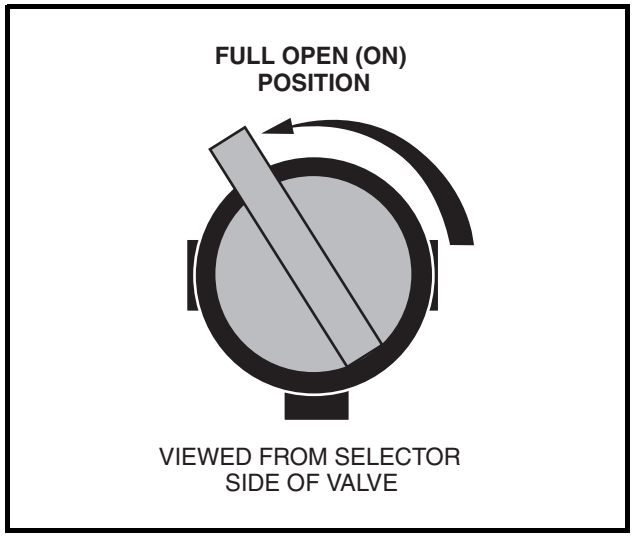


Figure 14-16 Open Fuel Shut-off Valve

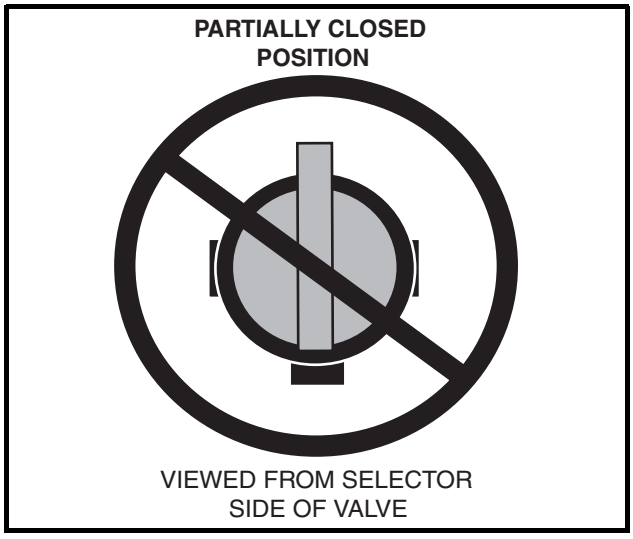


Figure 14-17 Incorrect Fuel Shut-off Valve

SECTION 15 – EXHAUST SYSTEM: GASOLINE VEHICLES

⚠ DANGER

- **See General Warning, Section 1, Page 1-1.**

⚠ WARNING

- **See General Warning, Section 1, Page 1-1.**

MUFFLER

MUFFLER REMOVAL

1. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.**
2. Disconnect the spark plug wire from the spark plug. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.**
3. Remove the muffler clamp (6) from the muffler (1) and clamp bracket (2) **(Figure 15-1, Page 15-2)**.
4. Remove the hex-head cap screw (7), lock washer (8), and flat washer (9) from mounting bracket. Retain the governor cable bracket (13).
5. Remove the hex nuts (10) and lock washers (11) from the manifold.
6. Remove the muffler (1) from the vehicle.

MUFFLER INSTALLATION

NOTE: *Any time the muffler is removed from the vehicle, install a new muffler clamp (6) (CCI P/N 1017689) and muffler gasket (12) FE290 (CCI P/N 1015330), FE350 (CCI P/N 1016904)* ***(Figure 15-1, Page 15-2)****.*

1. Loosely secure muffler (1) to muffler bracket (2) with clamp (6).
2. Place a new gasket (12) on the cylinder block exhaust stud bolts.
3. Attach muffler manifold with lock washers (11) and hex nuts (10) and finger tighten.
4. Loosely secure muffler (1), mounting bracket, and governor cable bracket (13) using hex-head cap screw (7), lock washer (8), and flat washer (9).
5. Tighten manifold hex nuts (10) to 11 ft-lb (14.9 N·m).
6. Tighten the hex cap screw (7) to 14 ft-lb (18.9 N·m).
7. Tighten the muffler clamp (6) to 40 in-lb (4.5 N·m).

NOTE: *Removing and installing the governor cable bracket may change the RPM setting.* ***See Engine RPM Adjustment, Section 14, Page 14-11.***

8. Connect the spark plug wire.

Muffler Installation, Continued:

9. Connect battery cables, positive (+) cable first, and tighten hardware to 12 ft-lb (16 N·m). **See Figure 10-1, Section 10, Page 10-1.** Coat terminals with Battery Terminal Protector Spray (CCI P/N 1014305) to minimize corrosion
10. Place the Forward/Reverse handle in the NEUTRAL position. Start the engine and check for exhaust leaks and proper engine operation. **See following DANGER.**

⚠ DANGER

- **Do not operate gasoline vehicle in an enclosed area without proper ventilation. The engine produces carbon monoxide, which is an odorless, deadly poison.**

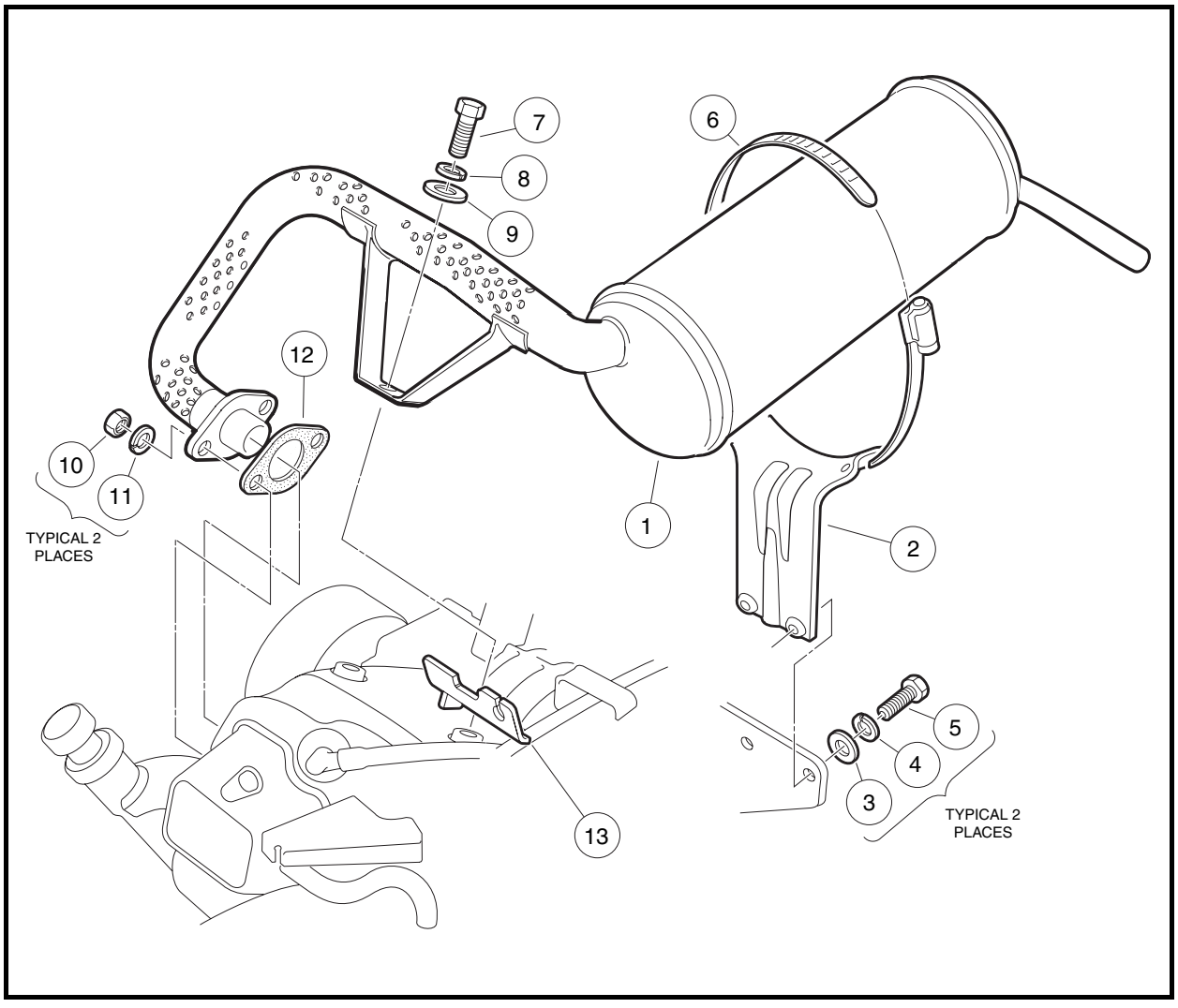


Figure 15-1 Exhaust System

SECTION 16 – UNITIZED TRANSAXLE: GASOLINE VEHICLE

⚠ DANGER

- **See General Warning, Section 1, Page 1-1.**

⚠ WARNING

- **See General Warning, Section 1, Page 1-1.**

GENERAL INFORMATION

Shifter Lever

A shifter lever, connected to a shifter arm, is used to change the gears to one of three shift positions: FORWARD (F), NEUTRAL (N), or REVERSE (R) **(Figure 16-1, Page 16-1).** Bring the vehicle to a complete stop before changing FORWARD or REVERSE direction.

Governor System

The governor system regulates vehicle ground speed. It is mounted inside the unitized transaxle and is driven by transaxle gears. If any of the governor linkages are removed in order to service other components, readjustment of the governor linkage is required. **See Governor Cable Installation and Adjustment, Section 14, Page 14-9.**

Unitized Transaxle Service

The unitized transaxle is extremely durable and should require very little service under normal operating conditions. The only service required is to maintain proper lubricant level. **See Periodic Lubrication Schedules, Section 10, Page 10-4.**

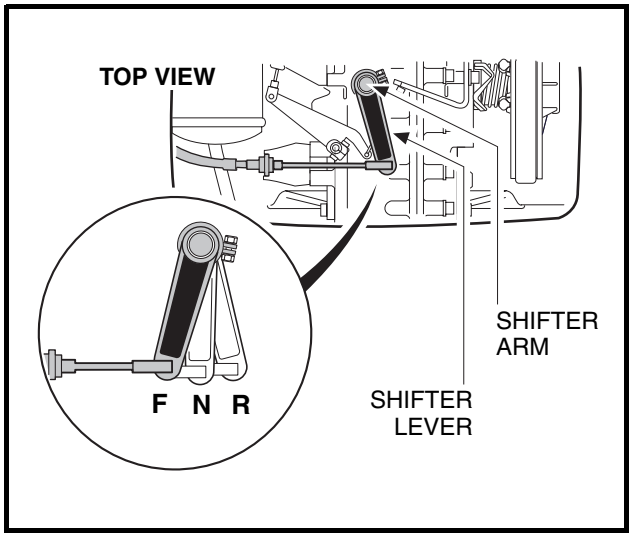


Figure 16-1 Shifter Positions

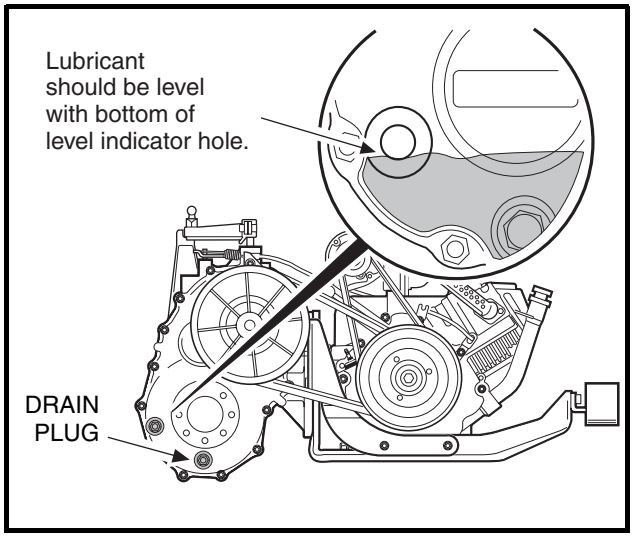


Figure 16-2 Lubricant Level

Tools Required For This Section

Hydraulic floor jack (or chain hoist)	Torque wrench, 3/8-in. drive	1/2-in. combination wrench
Jack stands (2) (one ton capacity)	3/8-in. socket, 3/8-in. drive	9/16-in. combination wrench
Standard slip joint pliers	7/16-in. socket, 3/8-in. drive	Small flat blade screwdriver
External snap ring pliers (.047-in. tip)	1/2-in. socket, 3/8-in. drive	Medium flat blade screwdrivers (2)
90° Internal snap ring pliers (.090-in. tip)	9/16-in. socket, 3/8-in. drive	No. 2 phillips-head screwdriver
16-in. rolling head prybar	5/8-in. socket, 3/8- in. drive	1/4-in. nut driver
Plastic or rubber mallet	Axle seal tool (CCI P/N 1014162)	5/16-in. nut driver
Ratchet wrench, 3/8-in. drive	7/16-in. combination wrench	

LUBRICATION

There are two oil port plugs located on the right (driven clutch) side of the unitized transaxle **(Figure 16-2, Page 16-1)**. When the vehicle is on a level surface, use the upper plug as a lubricant level indicator. Lubricant level should be even with the bottom of level indicator hole. Use the lower plug for draining. When draining lubricant, remove both plugs to allow the lubricant to drain faster. Clean and reinstall the drain plug and gasket before filling the transaxle with new lubricant. Use a funnel when filling the transaxle through the lubricant level indicator hole. Fill with 27 oz. (0.8 liter) 80-90 WT. API class GL or 80-90 WT. AGMA class 5 EP gear lubricant (or until lubricant begins to run out of the level indicator hole). Tighten the plug to 20 ft-lb (27.1 N·m).

AXLE SHAFT

See General Warning, Section 1, Page 1-1.

Removal of the unitized transaxle is not required for servicing or replacing axle shafts, axle bearings, or axle shaft oil seals. If the unitized transaxle is to be removed from the vehicle, do not remove the wheels, axle shafts, or axle tubes first. Instructions for removing the unitized transaxle from the vehicle begin on page 16-6.

AXLE SHAFT AND OIL SEAL REMOVAL

1. Turn the key switch to the OFF position and remove the key, place the Forward/Reverse handle in the NEUTRAL position, and chock the wheels.
2. Disconnect the battery cables as instructed. **See WARNING “To avoid unintentionally starting...” in General Warning, Section 1, Page 1-1.**
3. Loosen the lug nuts on the wheel to be removed.
4. Place chocks at the front wheels and lift the rear of the vehicle with a floor jack. Then place jack stands under the axle tubes to support the vehicle. **See WARNING “Lift only one end of the vehicle...” in General Warning, Section 1, Page 1-1.**
5. Remove the rear wheel and brake drum.
6. Use 90° internal snap ring pliers (0.090-in. tip) to remove internal retaining ring (1) from axle tube **(Figure 16-3, Page 16-3)**.
7. Carefully pull the axle shaft (2) straight out of the axle tube **(Figure 16-3, Page 16-3)**.

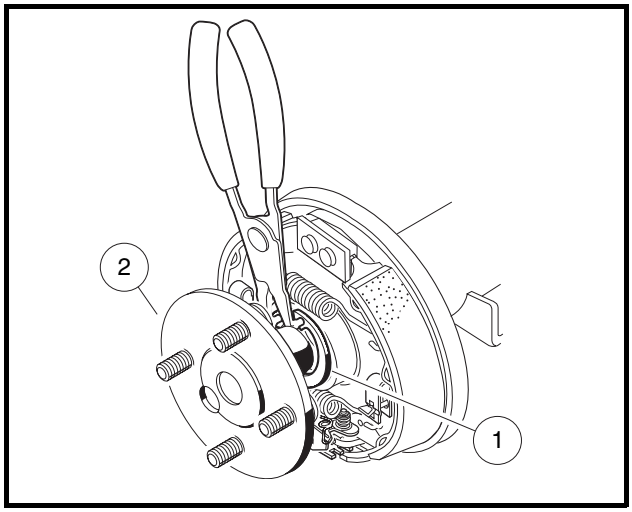


Figure 16-3 Retaining Ring

8. Position a 16-inch (40 cm) rolling head prybar **(Figure 16-4, Page 16-3)** under the inside lip of the seal and pull the oil seal out **(Figure 16-5, Page 16-3)**. **See following CAUTION.**

⚠ CAUTION

- **Do not scar or damage the inside surfaces of the tube when removing the oil seal. A damaged tube might have to be replaced.**

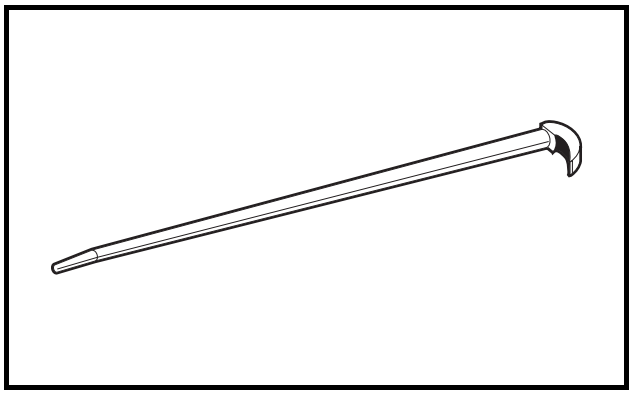


Figure 16-4 Rolling Head Prybar

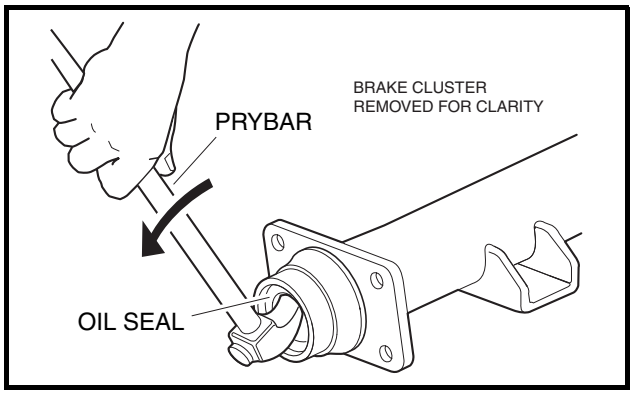


Figure 16-5 Seal Lip

9. Inspect the axle shaft assembly to be sure the bearing (71) and collar (73) have not slipped and are still seated against the shoulder on the axle shaft **(Figure 16-6, Page 16-4)**.
10. Inspect the bearing. If the bearing is damaged or worn, replace it.

AXLE BEARING

Axle Bearing Removal

1. Use external retaining ring pliers (0.047-inch tip) to remove the retaining ring (74). Place a bearing puller wedge attachment (CCI P/N 1012812) on the axle shaft between the wheel mounting flange and the bearing **(Figure 16-6, Page 16-4)**. **See also Figure 16-7, Page 16-6**. **See following CAUTION.**

Axle Bearing Removal, Continued:

⚠ CAUTION

- **Do not tighten the bearing puller wedge attachment against the axle shaft. This could damage the axle shaft when pressing the bearing and collar off.**

2. Press the bearing (71) and collar (73) off together **(Figure 16-6, Page 16-4). See also Figure 16-7, Page 16-6**. **See following NOTE.**

NOTE: *It may be necessary to heat the collar to remove it.*

*Do not remove the large axle retaining ring (70) from the axle **(Figure 16-6, Page 16-4)**. Since the inner diameter of the retaining ring (70) is smaller than the outer diameter of the bearing (71), the ring must be in place on the axle before a new bearing and collar are pressed on.*

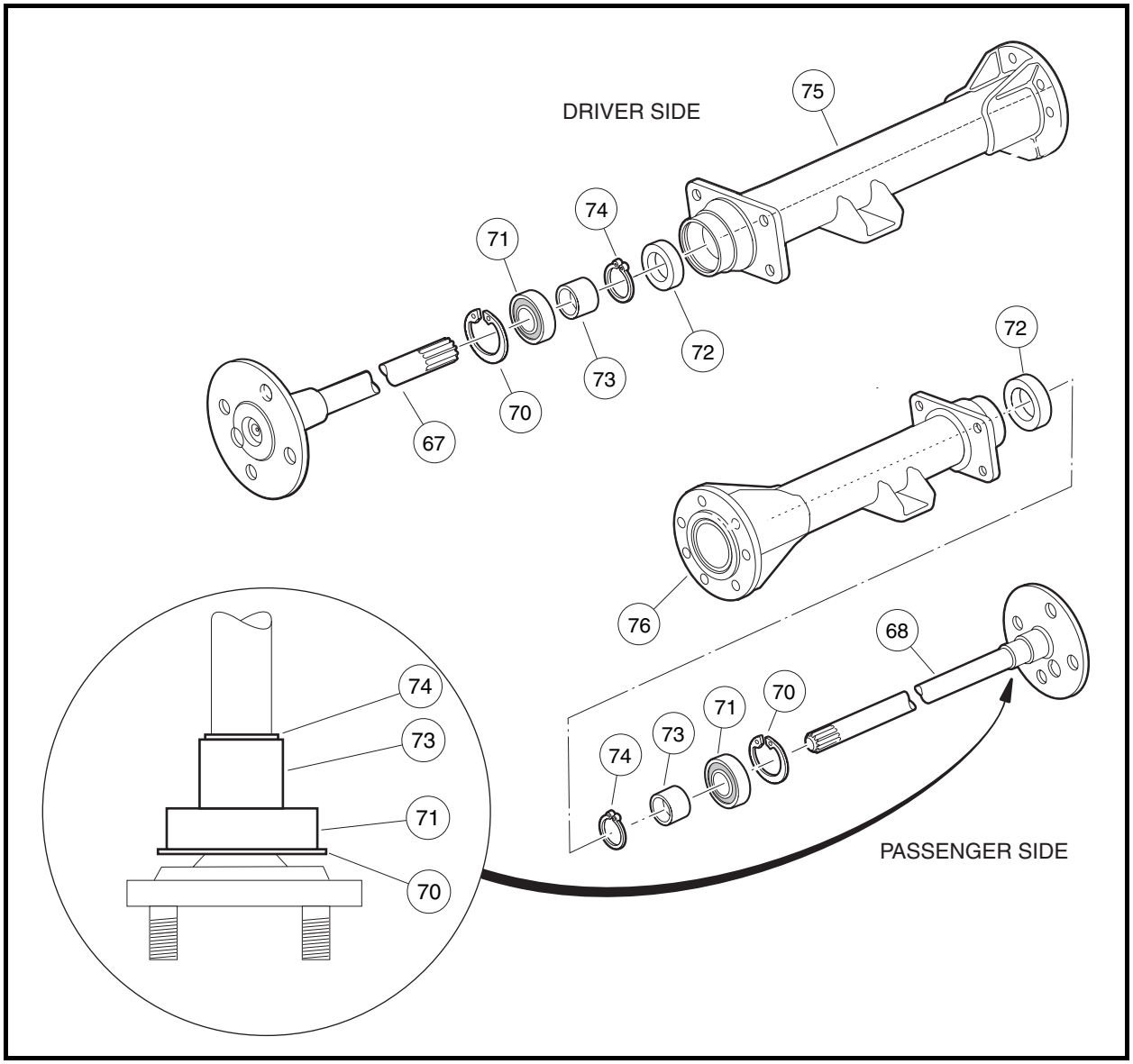


Figure 16-6 Differential Gear Case/Axle Tubes

Axle Bearing Installation

1. Ensure that the retaining ring (70) is loosely placed on the axle shaft. **See preceding NOTE.**
2. Install a new axle bearing (71) on axle (67 or 68). Push bearing onto axle until bearing is flush against axle shoulder **(Figure 16-6, Page 16-4)**.
3. Apply two drops of Loctite 271® to inside of the collar. **See following CAUTION.**

⚠ CAUTION

- **Apply Loctite 271 to the inside of the collar only, not to the shaft, so that the Loctite will be pushed away from the bearing as the collar and bearing are pressed on. If Loctite gets on or in the bearing, the bearing must be replaced.**
- **The collar should be removed no more than two times. If a collar is removed a third time, the shaft and collar will not fit properly.**

Axle Bearing Installation, Continued:

4. Place a new sealed bearing (71) on shaft (67 or 68) **(Figure 16-6, Page 16-4)**.
5. Install collar (73) onto axle shaft. Place axle assembly on bearing puller wedge attachment and press collar onto axle.
6. Place the bearing puller wedge attachment against collar and press both bearing and collar onto shaft. **See following CAUTION.**

⚠ CAUTION

- **If the bearing was removed from the shaft, replace it with a new one.**
- **Do not tighten the bearing puller wedge attachment against the axle shaft. This could damage the axle shaft when the bearing and collar are pressed on.**

7. Use external snap ring pliers (0.047-in. tip) to install collar retaining ring (74) **(Figure 16-6, Page 16-4)**.

AXLE SHAFT INSTALLATION

1. Clean bearing and seal seats in axle tube (75 or 76) **(Figure 16-6, Page 16-4)**.
2. Place a new oil seal (72) in axle tube with seal lip facing inside of the axle tube **(Figure 16-6, Page 16-4)**. Use an axle seal tool (CCI P/N 1012811) to press it in until it seats firmly in position **(Figure 16-8, Page 16-6)**. **See following NOTE.**

NOTE: *The new seal can be installed by tapping the axle seal tool with a mallet.*

⚠ CAUTION

- **Clean any residual oil from the exposed end of the axle shaft and from the oil seal area prior to installing the axle shaft.**

3. Clean the axle shaft and splines and then insert the shaft, splined end first, through the seal and into the axle tube. Be careful not to damage the seal. Then advance the shaft through the inner bearing and rotate it to align the shaft splines with the splined bore of the differential side gear. Continue advancing the shaft until the bearing seats against the axle tube shoulder.

Axle Shaft Installation, Continued:

4. Install the bearing retaining ring (70) in the axle tube **(Figure 16-6, Page 16-4). See also Figure 16-3, Page 16-3**.

5. Place a 1/4 to 3/8-inch (6-10 mm) diameter rod against the retaining ring and tap lightly at four to five locations to ensure it is properly seated. **See following WARNING.**

⚠ WARNING

- **Be sure bearing retaining ring is properly seated in its groove. If ring is not properly installed, the axle assembly will separate from the transaxle and damage the axle assembly and other components. Loss of vehicle control could result in severe personal injury or death.**

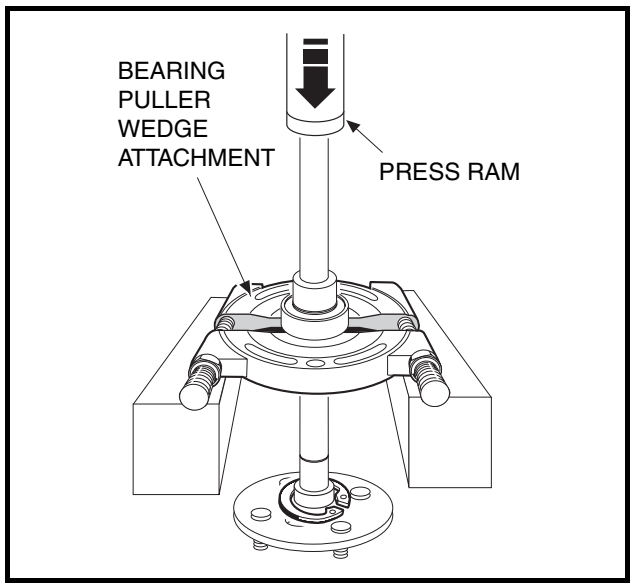


Figure 16-7 Bearing and Collar

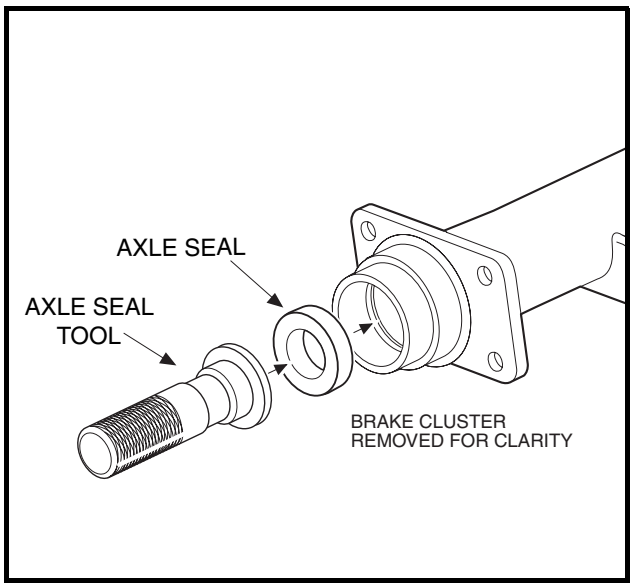


Figure 16-8 Axle Seal Tool

UNITIZED TRANSAXLE REMOVAL

See General Warning, Section 1, Page 1-1.

1. Turn the key switch to the OFF position and remove the key, and place the Forward/Reverse handle in the NEUTRAL position.

2. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.**

3. Close the fuel shut-off valve on fuel tank. **See Figure 14-15, Section 14, Page 14-24.**

4. Detach all wires, hoses, etc. connecting the powertrain to the vehicle.

   4.1. Disconnect the carburetor vent tube from the carburetor **(Figure 16-9, Page 16-7)**.

   4.2. Disconnect the air intake hose from the carburetor **(Figure 16-10, Page 16-7).**

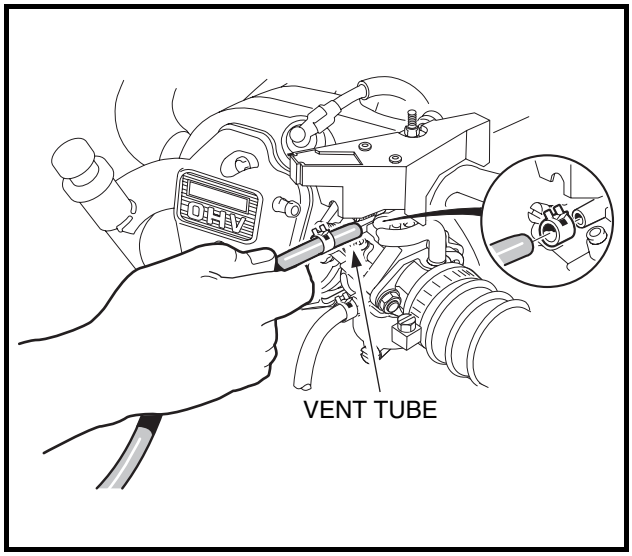


Figure 16-9 Fuel Vent Tube

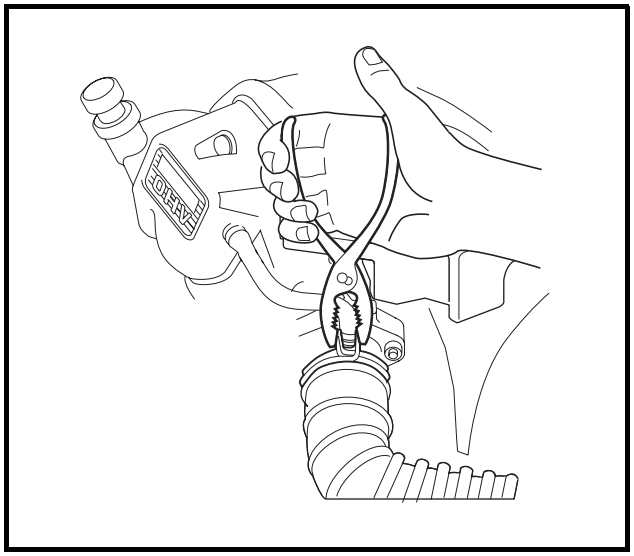


Figure 16-10 Air Intake Hose

4.3. Disconnect impulse line from fuel pump **(Figure 16-11, Page 16-7)**.

4.4. Loosen the hose clamp and then disconnect the fuel line from the carburetor. To prevent spilling fuel, the disconnected end of the line can be plugged with a 1/4-inch bolt **(Figure 16-12, Page 16-7)**.

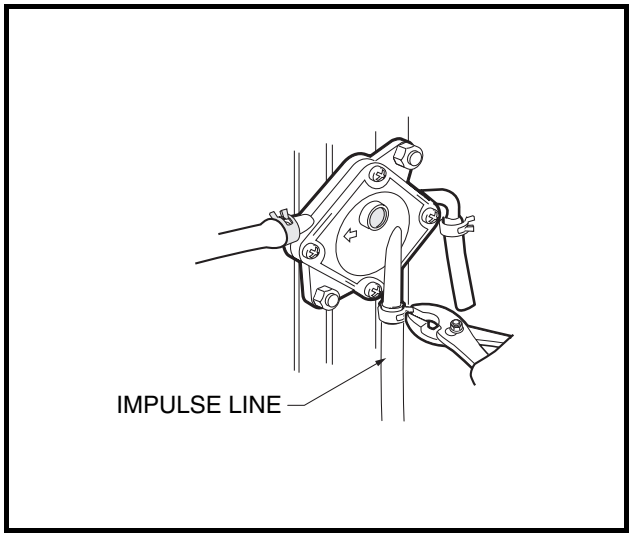


Figure 16-11 Impulse Line

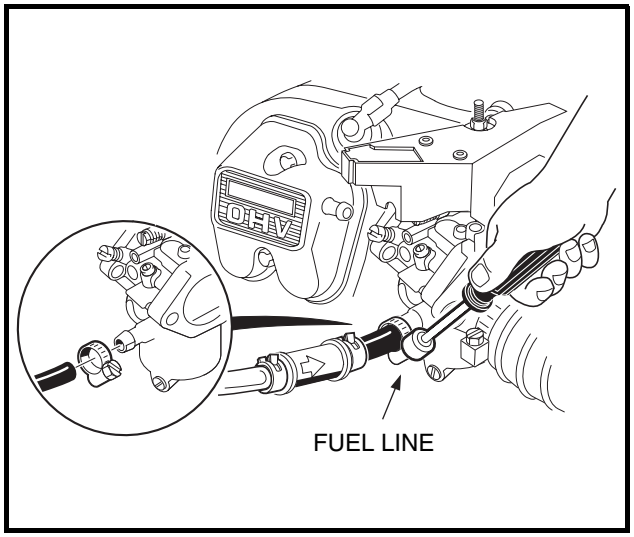


Figure 16-12 Fuel Line

4.5. Remove the cover from the electrical component box. Then loosen the hardware securing the accelerator cable to the box. Disconnect the cable from the actuator cam and remove it from the box **(Figure 16-13, Page 16-8)**.

4.6. Remove retaining nut and disconnect the engine ground wire from the oil filler tube mounting bracket **(Figure 16-14, Page 16-8)**.

Unitized Transaxle Removal, Continued:

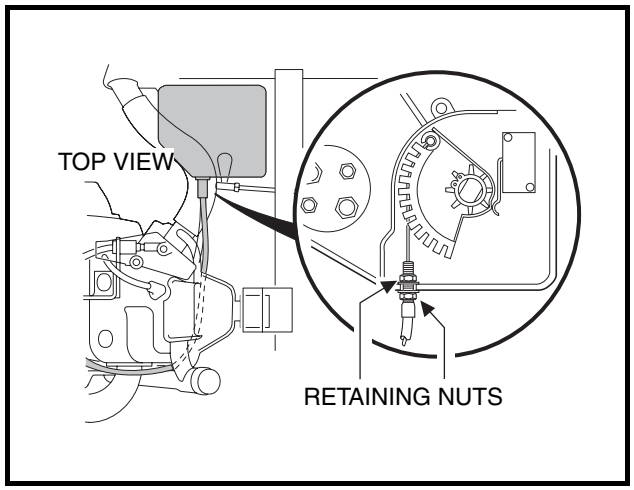


Figure 16-13 Throttle Cable

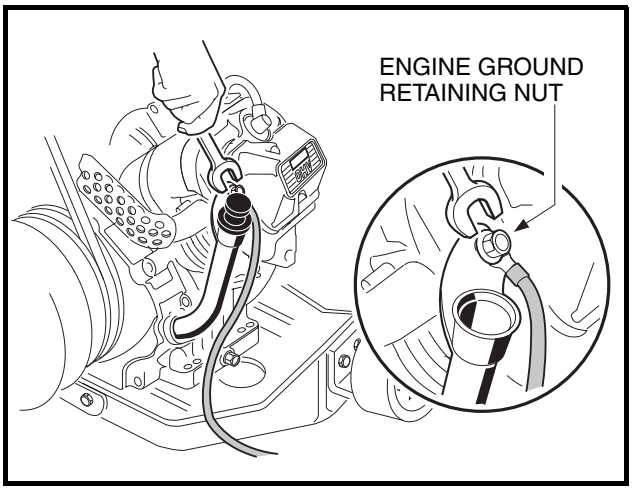


Figure 16-14 Engine Ground Wire

4.7. Loosen nuts securing shifter cable to shifter cable mounting bracket. Then disconnect the shifter cable rod end from the shifter arm on the unitized transaxle and remove the cable from the cable mounting bracket **(Figure 16-15, Page 16-8)**.

4.8. Mark for identification and then disconnect the 6-gauge white wire (F2 post), 6-gauge black ground wire (A2 post), and 16-gauge yellow wire (DF post) from starter/generator **(Figure 16-16, Page 16-8)**.

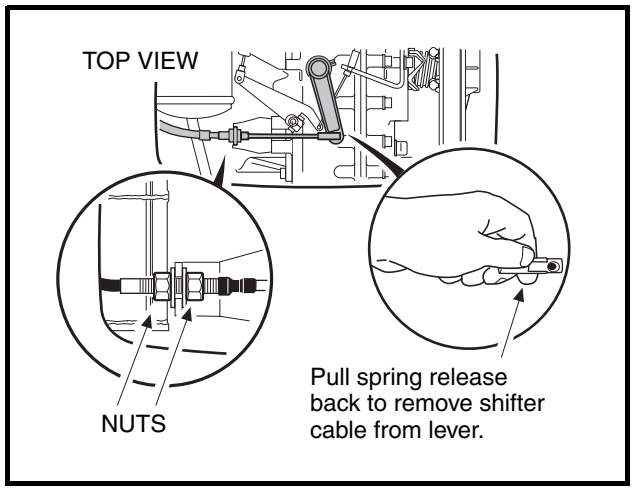


Figure 16-15 Shifter Cable

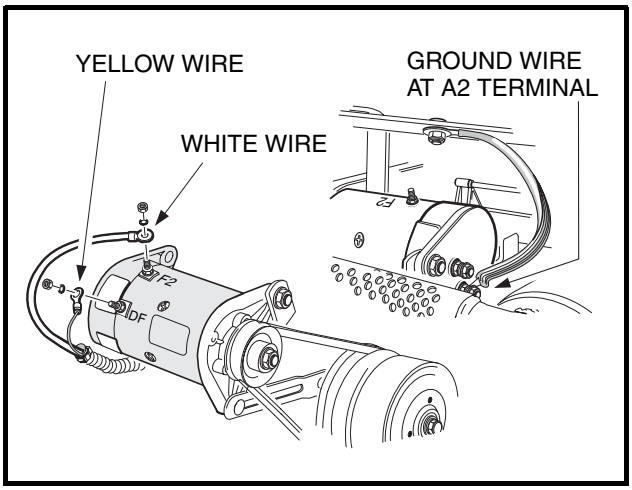


Figure 16-16 Generator Wires

4.9. Disconnect the engine oil level sensor wire (18-gauge yellow) at the connector just to the rear of the starter/generator) **(Figure 16-17, Page 16-9)**.

4.10. Disconnect the engine kill switch wire (18-gauge white/black) from the bullet connector at the lower right front of the engine **(Figure 16-18, Page 16-9)**.

4.11. Cut away the wire ties securing the engine kill wire at the lower right front of the engine (below the exhaust header), the wire harness at the governor cable bracket, and the wire harness to the plate beneath the muffler.

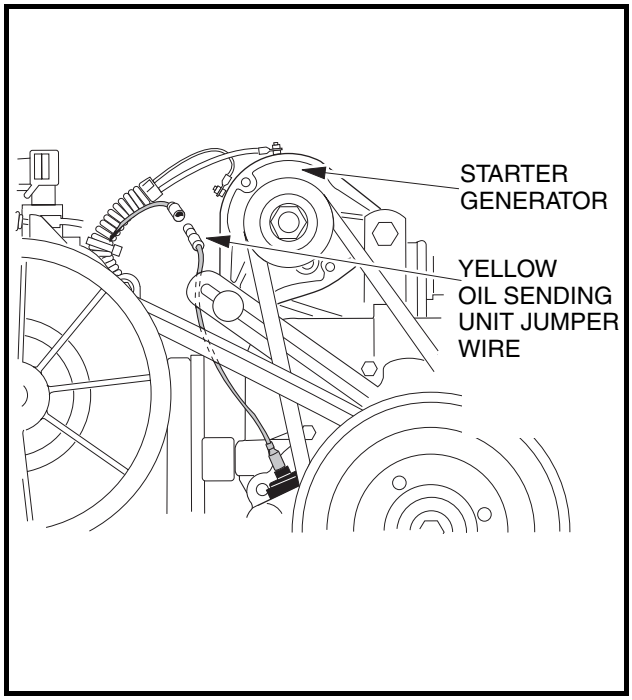


Figure 16-17 Oil Level Sensor Jumper Wire

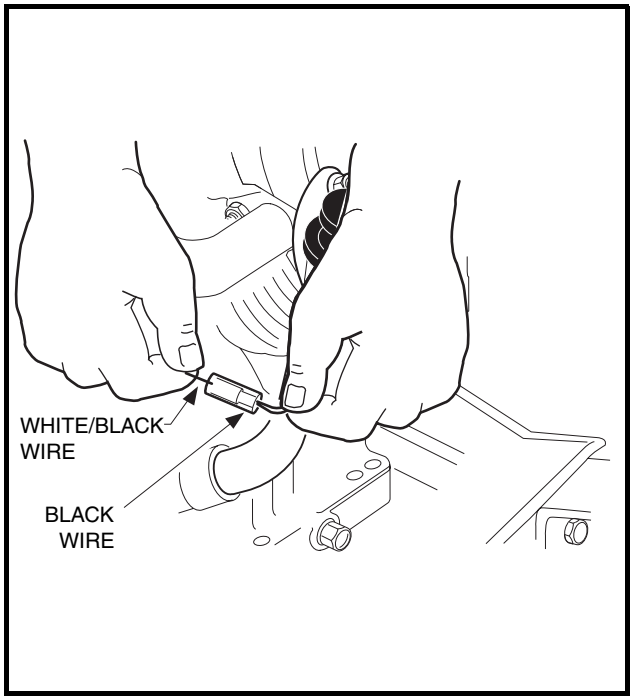


Figure 16-18 Ignition Kill Wire

5. Disconnect the brake cables.

   5.1. Remove bow tie pins (1), brake cable clevis pins (2), and E-clips (3) **(Figure 16-19, Page 16-9)**.

   5.2. Remove the cable from the cable support bracket **(Figure 16-19, Page 16-9)**.

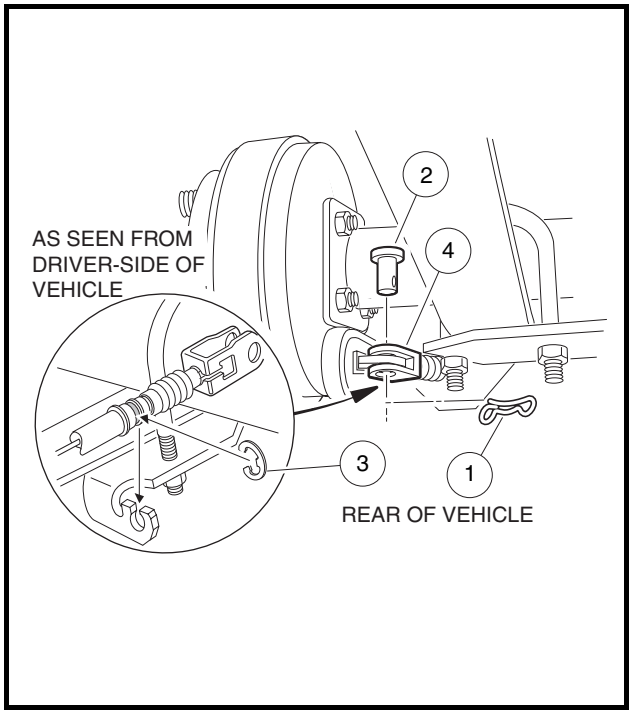


Figure 16-19 Brake Cable

Unitized Transaxle Removal, Continued:

6. Remove the lower shock mounting hardware from both rear shocks **(Figure 16-20, Page 16-10)**.

7. Position a floor jack under the vehicle frame crossmember or trailer hitch mount **(Figure 16-21, Page 16-10)**.

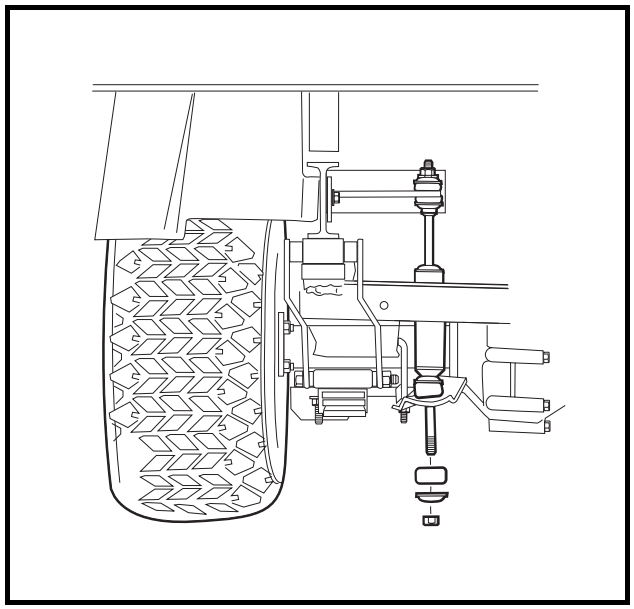


Figure 16-20 Shock Absorbers

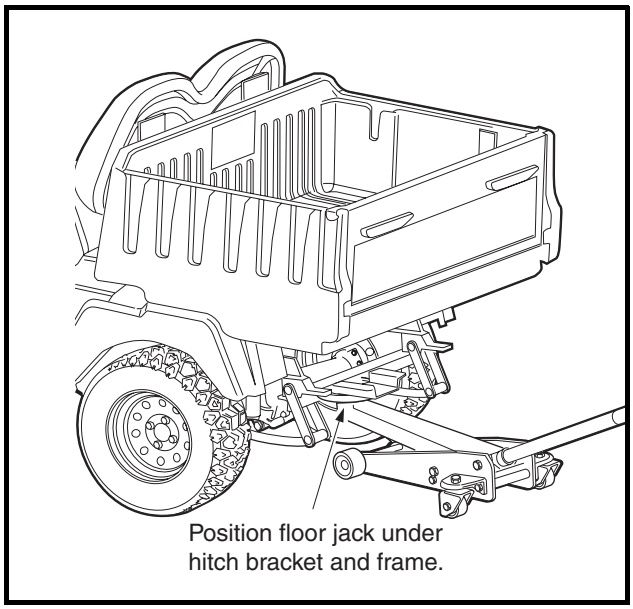


Figure 16-21 Floor Jack

8. Raise vehicle just enough to relieve tension from leaf springs, then remove the bolts securing the leaf springs to the shackles **(Figure 16-22, Page 16-10)**.

9. Remove the bolts securing the leaf springs to their front mounts **(Figure 16-23, Page 16-10)**.

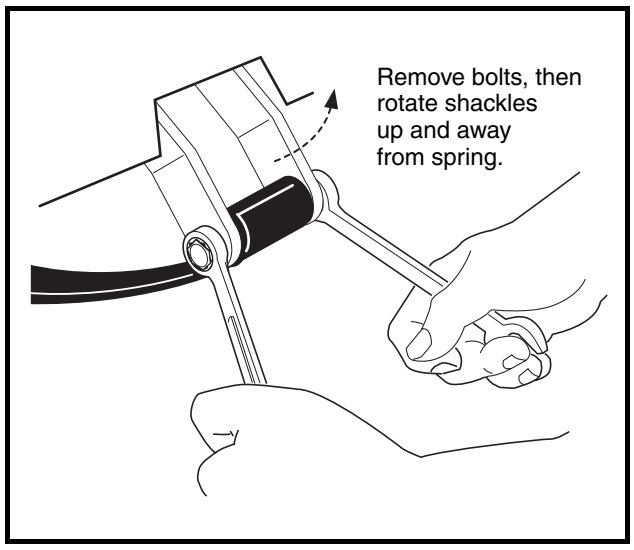


Figure 16-22 Rear Shackles

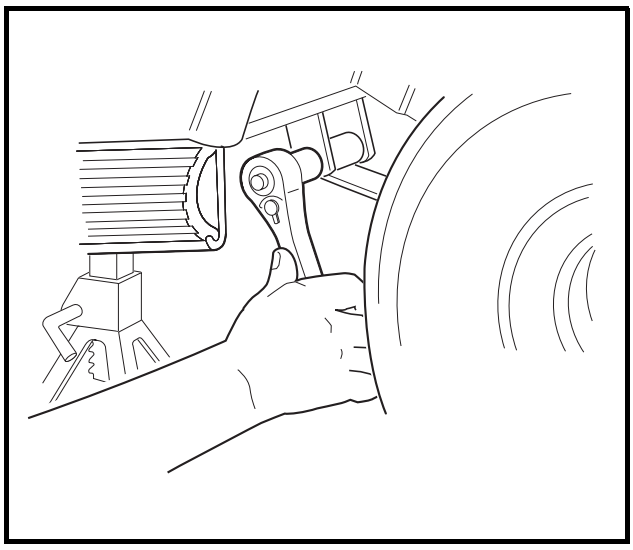


Figure 16-23 Spring Retainer Bolts

10. Continue raising vehicle until frame or trailer hitch is higher than the top of the unitized transmission (enough to allow transaxle and engine to be rolled under and out of vehicle) **(Figure 16-24, Page 16-11)**.

11. Position jack stands, adjusted to support the vehicle at this height, under the frame crossmember between the leaf spring mounts and side stringers, just forward of each rear wheel. Lower the floor jack to allow the jack stands to support the vehicle **(Figure 16-25, Page 16-11)**.

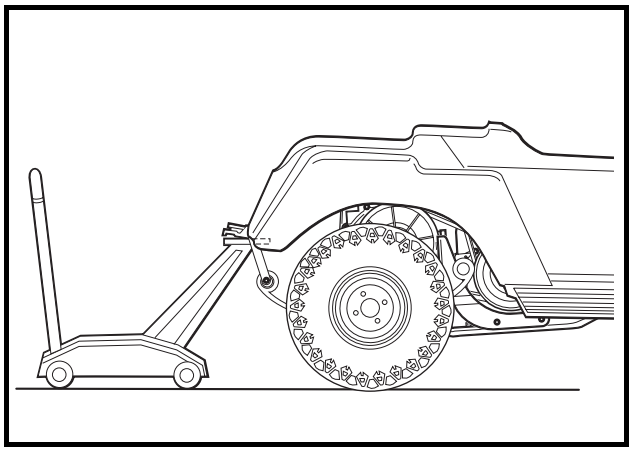


Figure 16-24 Raise Vehicle

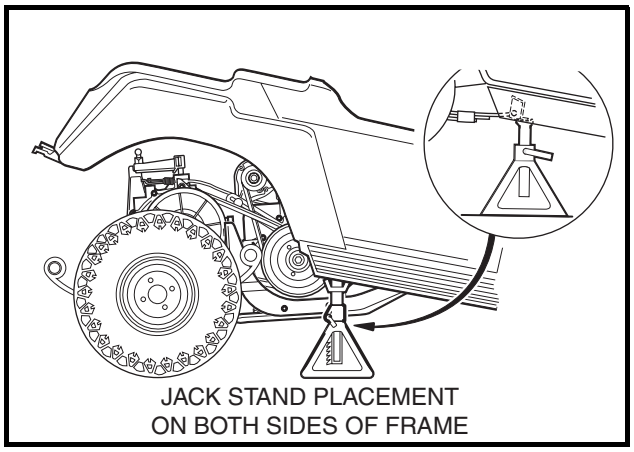


Figure 16-25 Position Jack Stands

12. Pull the floor jack from beneath the vehicle and move it away.

13. Carefully lift the snubber out of the snubber bracket in the vehicle frame and lower it to the floor **(Figure 16-26, Page 16-11)**. The powertrain should be completely disconnected from the vehicle and resting on the floor.

14. Grasp the ends of the leaf springs at the rear of the vehicle and roll the powertrain out from under the vehicle **(Figure 16-27, Page 16-11)**.

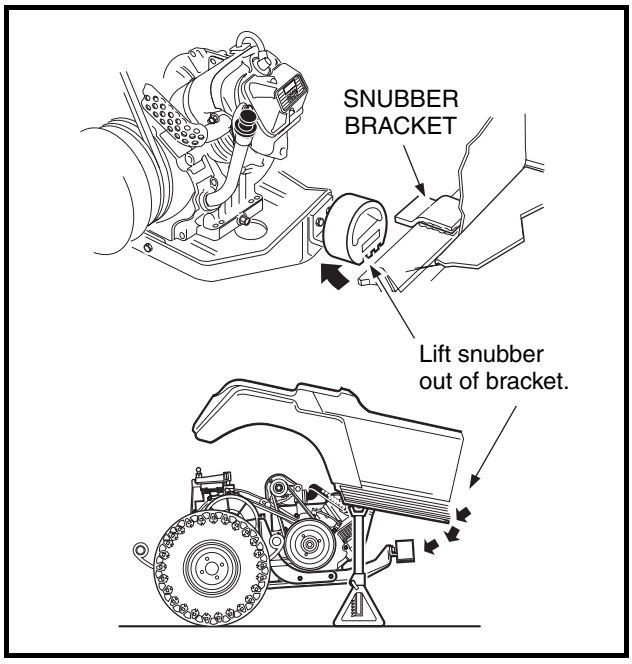


Figure 16-26 Snubber

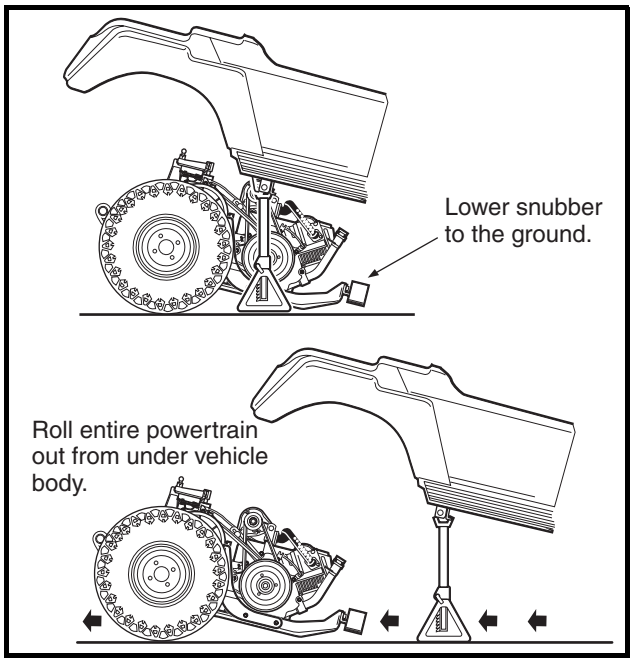


Figure 16-27 Remove Powertrain

Unitized Transaxle Removal, Continued:

15. Place blocks under the engine pan so they will completely support the engine and keep it **level to the floor (Figure 16-28, Page 16-12)**. **See following NOTE.**

NOTE: *Place the blocks so they will support the engine when the transaxle is detached and moved away from the engine.*

16. Remove the drive belt.

    16.1. Grasp belt midway between drive and driven clutch and pull up on belt to force the driven clutch sheaves apart. Roll the belt counterclockwise while pulling it off driven clutch **(Figure 16-29, Page 16-12)**.

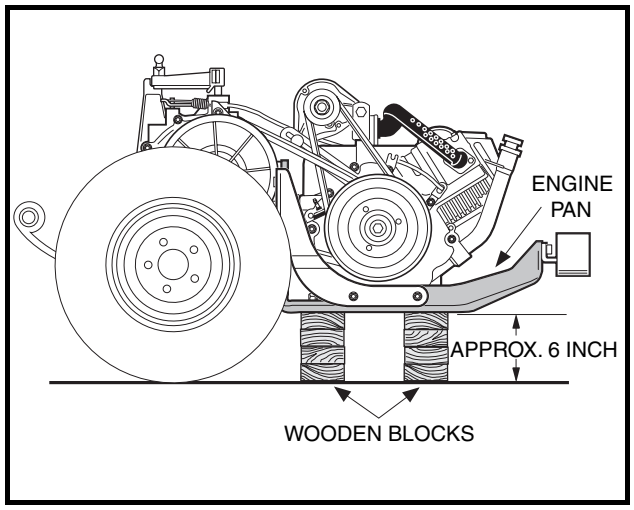


Figure 16-28 Position Powertrain

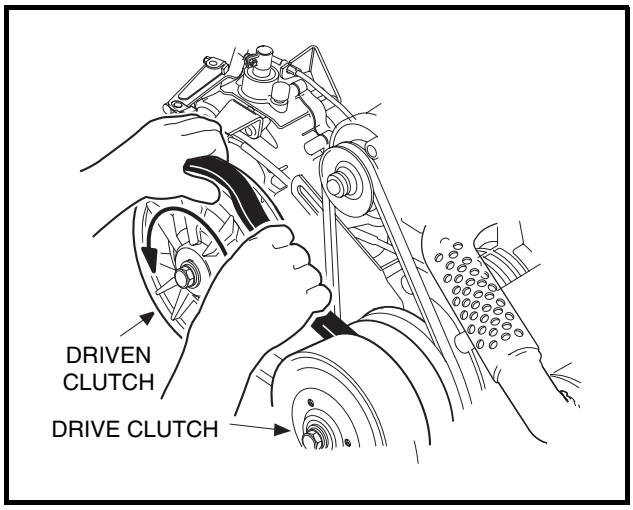


Figure 16-29 Remove Drive Belt

17. Remove the driven clutch retaining bolt and remove the driven clutch from the unitized transaxle **(Figure 16-30, Page 16-12)**.

18. Loosen, but do not remove, the governor arm retaining bolt (1) **(Figure 16-31, Page 16-12)**. Remove the governor arm from the shaft. Do not disconnect cables.

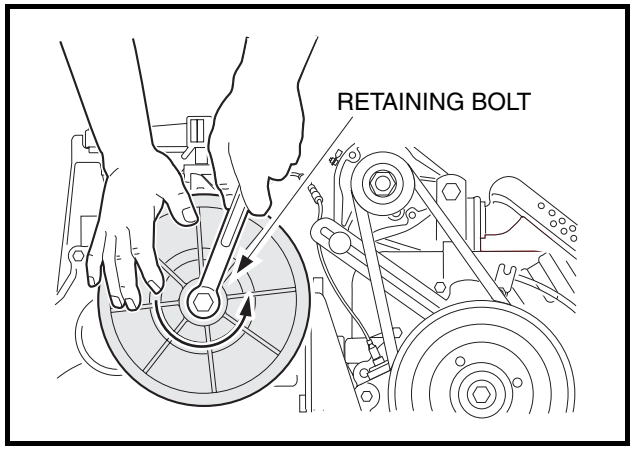


Figure 16-30 Driven Clutch

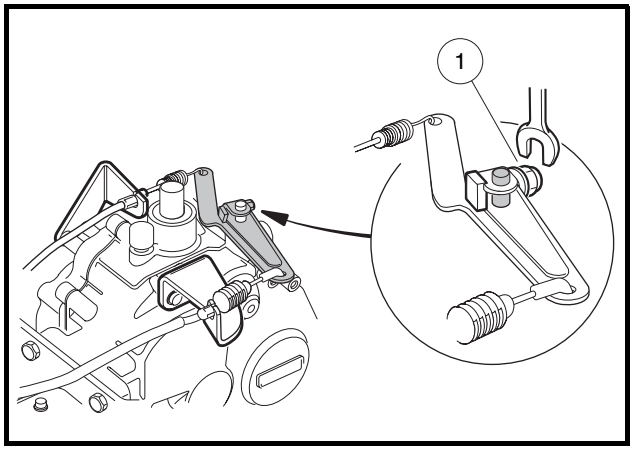


Figure 16-31 Governor Arm

19. Remove screws (1) securing the governor cable bracket to transaxle **(Figure 16-32, Page 16-13)**.

20. Remove screws (1) securing the accelerator cable bracket to transaxle **(Figure 16-33, Page 16-13)**.

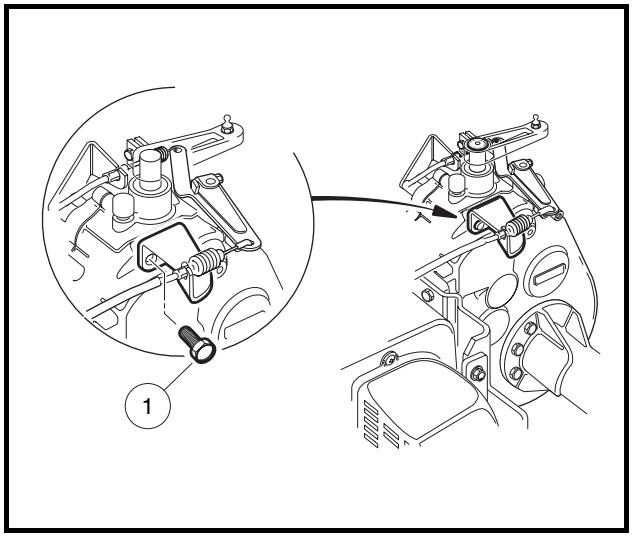


Figure 16-32 Governor Cable Bracket

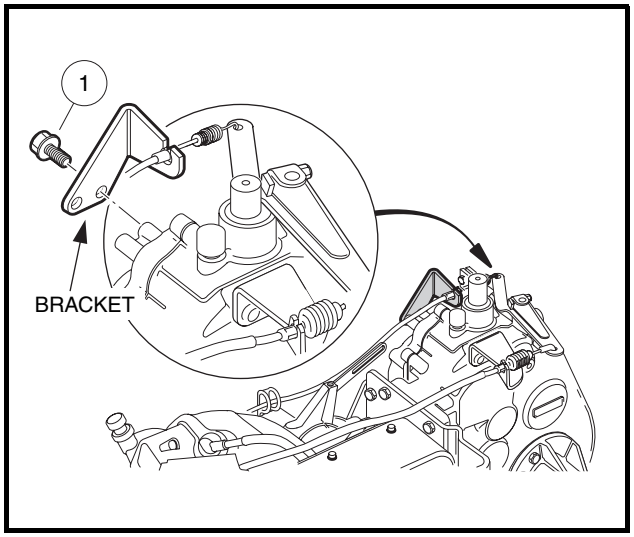


Figure 16-33 Accelerator Cable Bracket

21. Remove screws (2) securing the transmission shift cable bracket (1) to transaxle **(Figure 16-35, Page 16-13)**. **See following NOTE.**

NOTE: *The governor cable and the accelerator cable should remain attached to the governor arm.*

22. Remove the six bolts mounting the unitized transaxle to the engine.

    22.1. Remove four transaxle mounting bolts (one at each corner of the transaxle mounting plate) **(Figure 16-34, Page 16-13)**.

    22.2. Remove two middle transaxle mounting nuts from the engine block studs.

23. Remove leaf springs, wheels and brake assemblies from the transaxle.

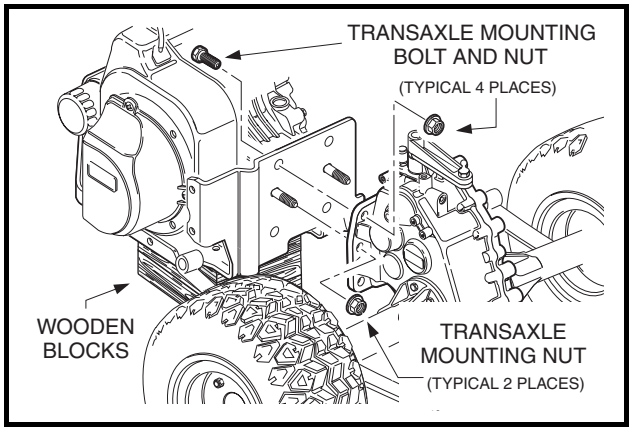


Figure 16-34 Transaxle Mounting

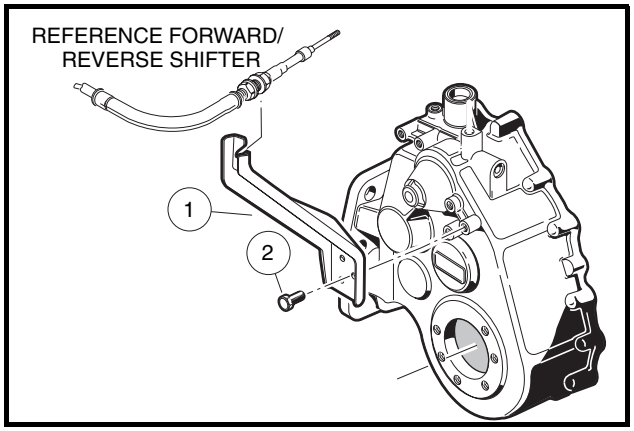


Figure 16-35 Gear Case and Cable Bracket

UNITIZED TRANSAXLE INSTALLATION

See General Warning, Section 1, Page 1-1.

1. Install the wheels. **See Wheel Installation, Section 8, Page 8-1.**
2. Install the leaf springs. **See Leaf Spring Installation, Section 9, Page 9-4.**
3. Position the transaxle mounting plate on the two mounting studs at the rear of the engine, and then install the two mounting nuts finger tight **(Figure 16-36, Page 16-14)**.
4. Install the remaining four mounting bolts and four nuts (one bolt and nut at each corner of the mounting plate) finger tight.
5. Tighten the four corner nuts (with bolts) to 30 ft-lb (40.7 N·m). Tighten the two center nuts (on the engine block studs) to 17 ft-lb (23.1 N·m) **(Figure 16-36, Page 16-14)**.
6. Install the accelerator cable bracket on transaxle case. Tighten the mounting screws to 134 in-lb (15.1 N·m) **(Figure 16-33, Page 16-13)**.

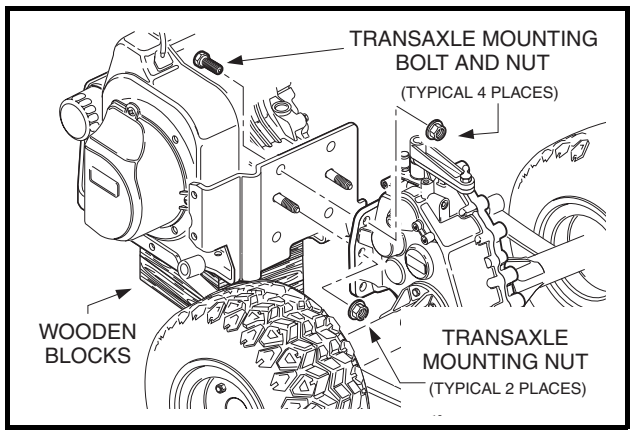


Figure 16-36 Transaxle Mounting

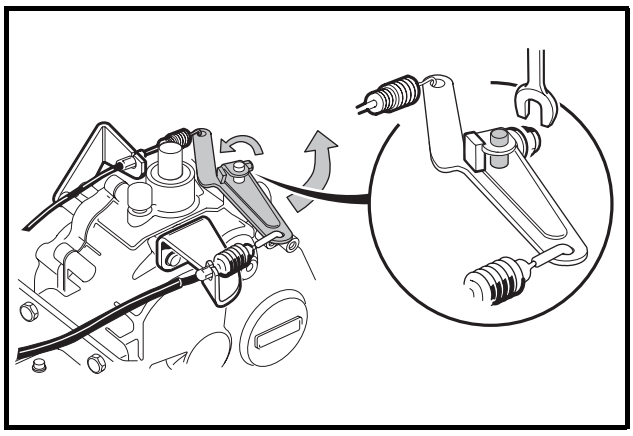


Figure 16-37 Governor Arm

7. Install the governor cable bracket on transaxle case. Tighten the mounting screws to 134 in-lb (15.1 N·m) **(Figure 16-32, Page 16-13)**.
8. Install governor lever arm on governor shaft **(Figure 16-37, Page 16-14)**.
   8.1. With the governor lever arm loose on the governor shaft, turn the governor arm shaft counterclockwise until it stops. Then pull the governor lever arm rearward until the carburetor throttle is in the “wide open throttle” (WOT) position **(Figure 16-37, Page 16-14)**.
   8.2. While holding the arm and shaft in the fully counterclockwise position, tighten the governor arm lever nut to 35 in-lb (4.0 N·m) **(Figure 16-37, Page 16-14)**.
9. Install the key onto the input shaft **(Figure 16-38, Page 16-15)**.
10. Position the driven clutch on the transaxle input shaft and install the washer (yellow side facing out) and mounting bolt. Tighten the mounting bolt to 14 ft-lb (19.0 N·m) **(Figure 16-38, Page 16-15)**.
11. Install the drive belt. **See Drive Belt Installation, Section 17, Page 17-3.**

12. Remove the blocks from under the engine and roll the powertrain into position under the vehicle. Then lift the front of the powertrain and place the snubber into the snubber bracket in the vehicle frame **(Figure 16-39, Page 16-15)**.

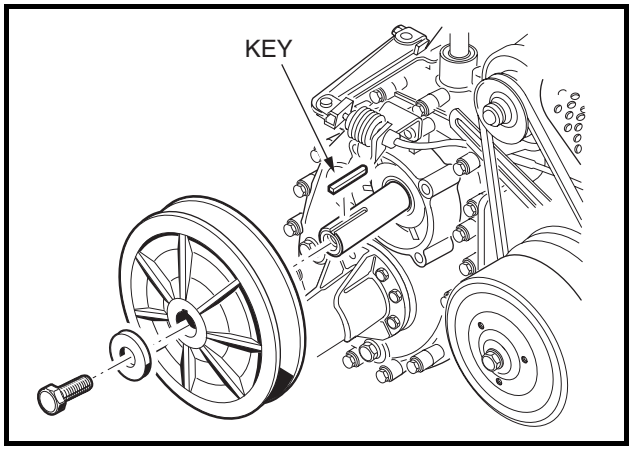


Figure 16-38 Driven Clutch

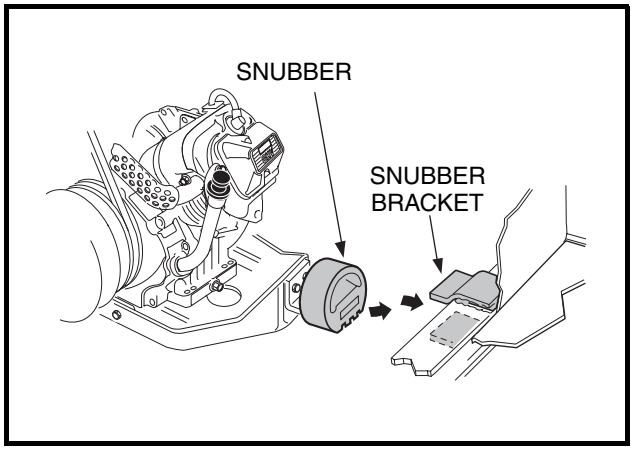


Figure 16-39 Snubber

13. Position the floor jack under the rear frame crossmember and raise the jack high enough to support the vehicle **(Figure 16-40, Page 16-15)**. Make sure the vehicle is stable on the jack, then remove the jack stands.

14. After the jack stands are removed, lower the vehicle to approximately its normal height. Position the leaf springs in the front spring mounts and install the bolts and lock nuts. Tighten to 15 ft-lb (20.3 N·m).

15. Adjust the vehicle height with the floor jack to position the leaf springs for mounting in the shackles. Install the mounting bolts, and lock nuts **(Figure 16-41, Page 16-15)**.

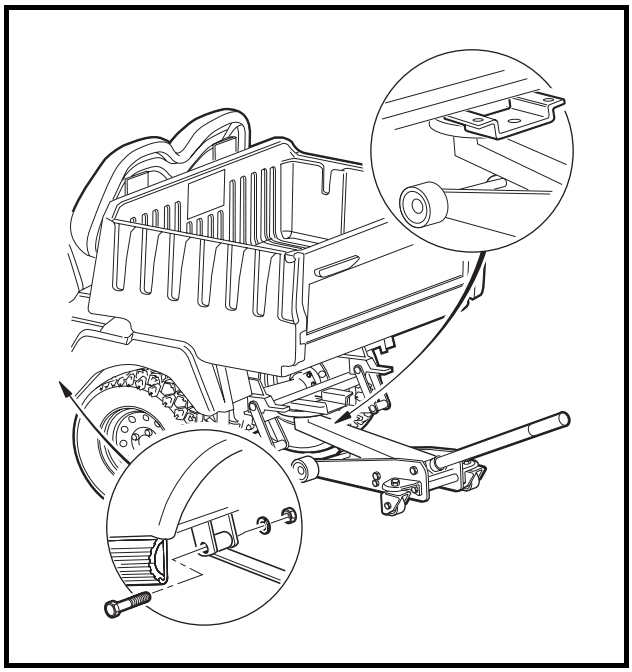


Figure 16-40 Leaf Springs

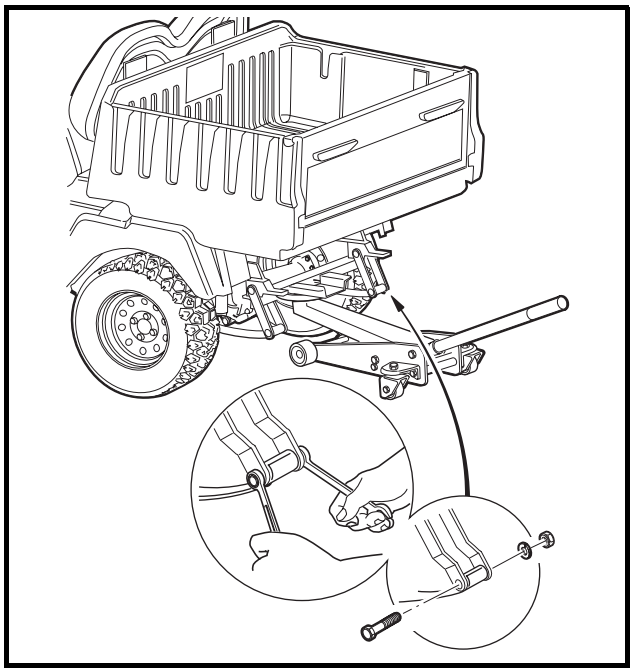


Figure 16-41 Leaf Springs and Shackles

Unitized Transaxle Installation, Continued:

16. Position shocks in the shock mounts and install cushions, mounting washers and nuts **(Figure 16-42, Page 16-16)**. Tighten nuts until cushions expand to be the same diameter as the mounting washers.
17. Connect brake cables. **See Brake Cable Installation, Section 6, Page 6-10.**
18. Connect the engine kill switch wire (18-gauge white/black) to the bullet connector at the lower right front of the engine **(Figure 16-43, Page 16-16)**.
19. Install three wire ties to secure the engine kill wire to the accelerator cable where they both route together on the passenger side of the engine.

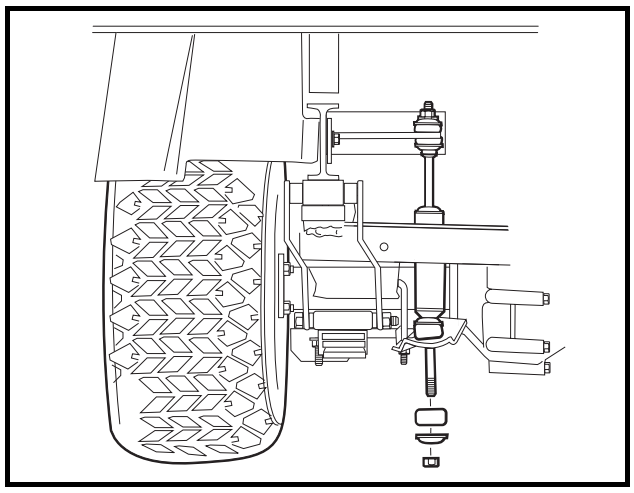


Figure 16-42 Shock Absorber

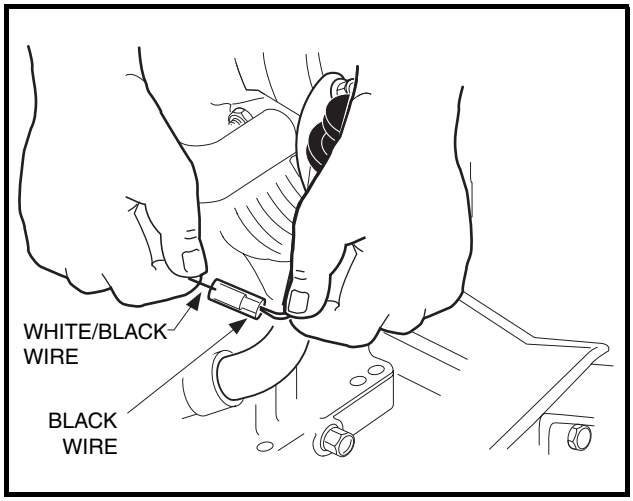


Figure 16-43 Ignition Kill Wire

20. Connect the oil level sensor wire (18-gauge yellow) to the jumper wire **(Figure 16-44, Page 16-16)**.
21. Connect the 6-gauge white wire to the F2 post, the 6-gauge black ground wire to the A2 post and tighten both wires to 48 in-lb (5.4 N·m). Connect the 16-gauge yellow wire to the DF post on the starter/generator and tighten to 30 in-lb (3.4 N·m) **(Figure 16-45, Page 16-16)**.

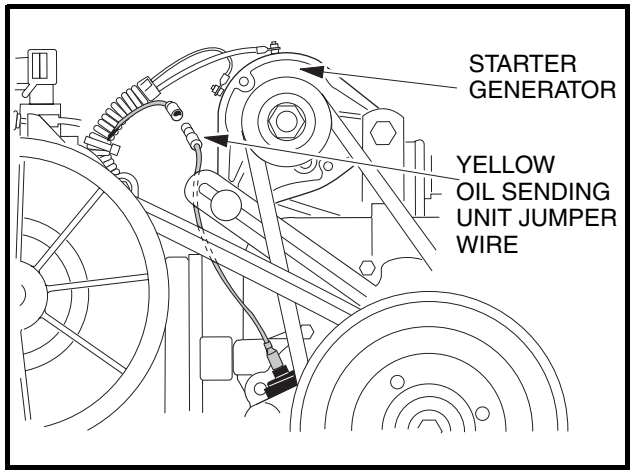


Figure 16-44 Oil Level Sensor Jumper wire

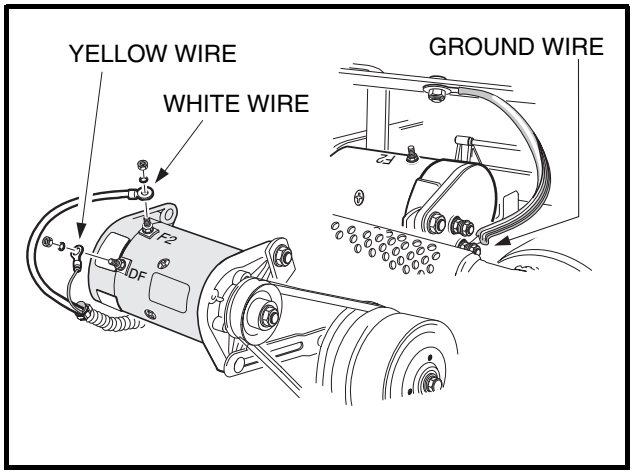


Figure 16-45 Starter/Generator

22. Connect the Forward/Reverse shifter and bracket to the transaxle.
    22.1. Install the three screws (2) securing the Forward/Reverse shifter cable bracket (1) to the transaxle and tighten them to 135 in-lb (15.3 N·m) **(Figure 16-35, Page 16-13)**.
    22.2. Place the woodruff key (10) on the shifter shaft (9).
    22.3. Place the shifter lever (6) (aligned with the woodruff key) onto the Forward/Reverse shaft (9).
    22.4. Install the nut (3), washer (4), and bolt (7) on the Forward/Reverse shifter lever and tighten to 23 in lb (4.1 N·m).
23. Position the shifter cable in the shifter cable mounting bracket on the transaxle and tighten the mounting nuts to 22 ft-lb (29.8 N·m). Connect shifter cable rod end to the shifter arm **(Figure 16-46, Page 16-17)**.
24. Attach the ground wire to the mounting screw on the oil filler tube mounting bracket and tighten to 50 in-lb (5.7 N·m) **(Figure 16-47, Page 16-17)**.

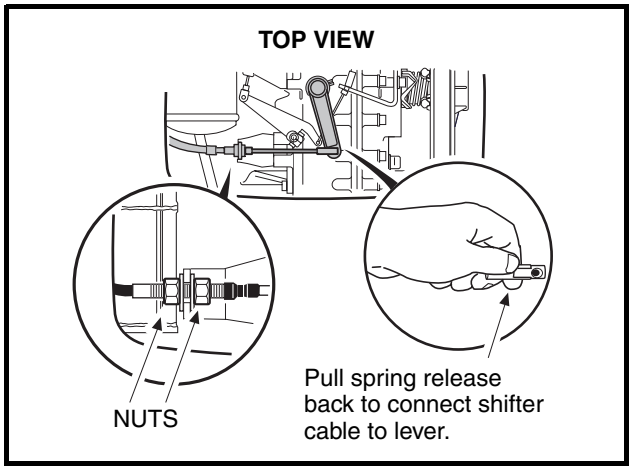


Figure 16-46 Connect Shifter Cable

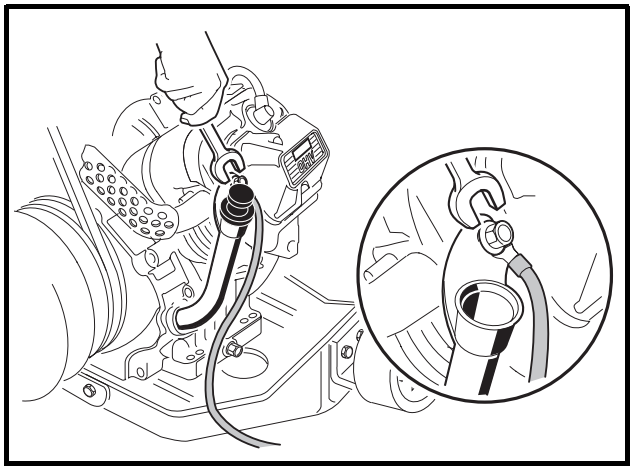


Figure 16-47 Engine Ground Wire

25. Connect accelerator cable to actuator cam in the electrical box. Position the accelerator cable in the mounting slot in the wall of the electrical box and tighten mounting nuts to 18 in-lb (2.0 N·m) **(Figure 16-48, Page 16-17)**. Install electrical box cover and tighten mounting screw.
26. Remove the 1/4-inch bolt from the fuel line and connect the fuel line to the carburetor and secure with a hose clamp **(Figure 16-49, Page 16-17)**.

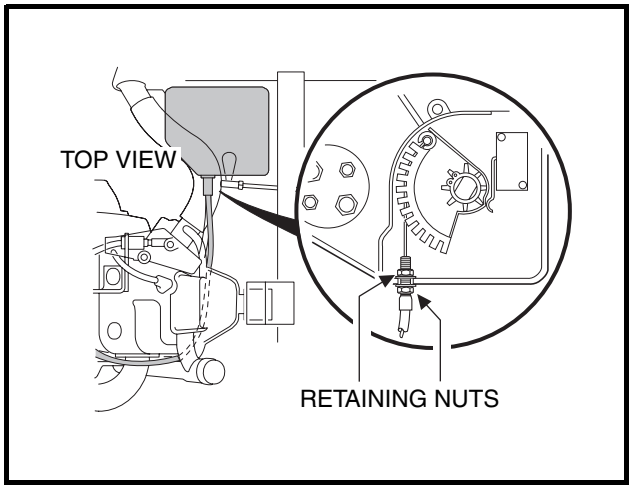


Figure 16-48 Connect Cable to Cam

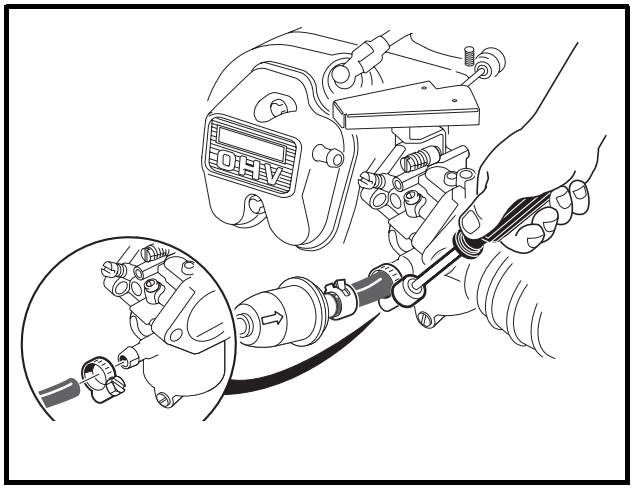


Figure 16-49 Connect Fuel Line

Unitized Transaxle Installation, Continued:

27. Connect the impulse line to the fuel pump and secure it with the hose clamp **(Figure 16-50, Page 16-18)**.
28. Connect air intake hose to carburetor and secure hose clamp **(Figure 16-51, Page 16-18)**.

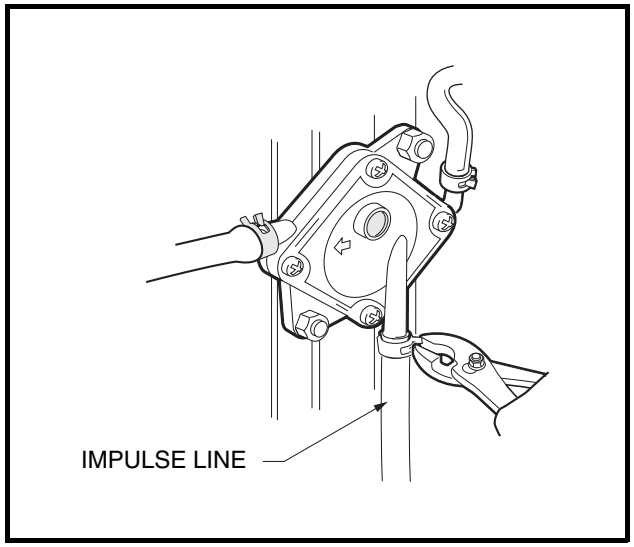


Figure 16-50 Impulse Line

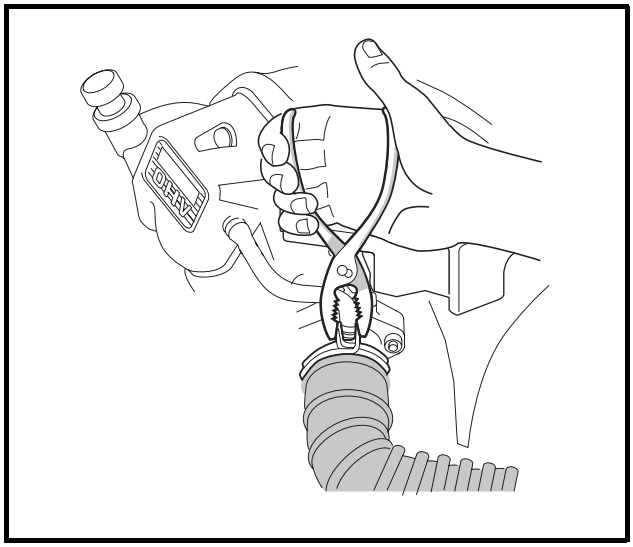


Figure 16-51 Air Intake Hose

29. Connect carburetor vent tube to carburetor and secure with hose clamp **(Figure 16-52, Page 16-18).**

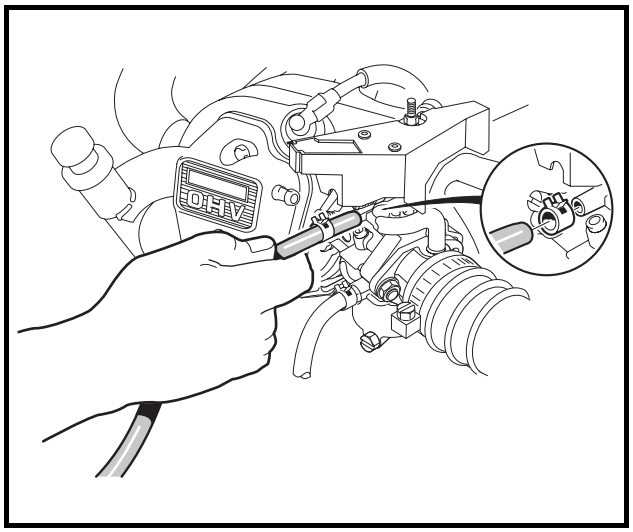


Figure 16-52 Carburetor Tube

30. Install transaxle drain plug and tighten to 21 ft-lb (28.5 N·m).
31. Fill transaxle with 27 oz. (0.8 liter) 80-90 Wt. API class GL-3 or 80-90 WT. AGMA class EP gear lube. Install and tighten the level indicator hole plug to 21 ft-lb (28.5 N·m).
32. Ensure that all wiring is secured properly. **See following WARNING**.

⚠ WARNING

- **If wires are removed or replaced make sure wiring and wiring harness is properly routed and secured to vehicle frame. Failure to properly route and secure wiring could result in vehicle malfunction, property damage or personal injury.**

33. Connect the spark plug wire.
34. Connect battery cables, positive (+) cable first, and tighten hardware to 12 ft-lb (16 N·m). **See Figure 1-1, Section 1, Page 1-3.** Coat terminals with Battery Terminal Protector Spray (CCI P/N 1014305) to minimize corrosion
35. Adjust the engine RPM setting. **See Engine RPM Adjustment, Section 14, Page 14-11.**

FORWARD/REVERSE SHIFTER CABLE

See General Warning, Section 1, Page 1-1.

If the Forward/Reverse shifter cable is damaged in any way, it must be replaced.

FORWARD/REVERSE SHIFTER CABLE REMOVAL

NOTE: *Before removing cable, note cable routing and positions of wire ties or other devices securing the cable to the vehicle. When installed, cable must be routed and secured as it was originally.*

1. Turn the key switch to the OFF position and remove the key, place the Forward/Reverse handle in the NEUTRAL position, and chock the wheels.
2. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.**
3. Remove the ball joint socket (2) from the Forward/Reverse shifter assembly ball stud (3) **(Figure 16-54, Page 16-21)**.
4. Remove the ball joint socket (10) from the shifter arm ball stud (11) on the transaxle.
5. Loosen the retaining nuts (5) on both ends of the cable and remove the wire tie.
6. Remove cable from the vehicle.

FORWARD/REVERSE SHIFTER CABLE INSTALLATION

1. From the Forward/Reverse shifter, route the cable toward the driver side of the vehicle so it lies against the side of the front body, turns 90° and passes to the driver side of air intake box, over the battery, beside the fender and then turns again to connect with the shifter arm on the transaxle **(Figure 16-53, Page 16-20)**. Make sure cable does not touch muffler.
2. Secure the cable with a retaining nut (5) on each side of the shifter cable support bracket at the transaxle **(Figure 16-54, Page 16-21)**. Tighten nuts to 22 ft-lb (29.8 N·m).
3. Secure the cable with a retaining nut (5) on each side of the shifter cable support bracket at the Forward/Reverse assembly. Tighten nuts to 43 in-lb (4.9 N·m).

Forward/Reverse Shifter Cable Installation, Continued:

4. Install the ball joint socket (10) on the shifter lever ball stud (11) on the transaxle.

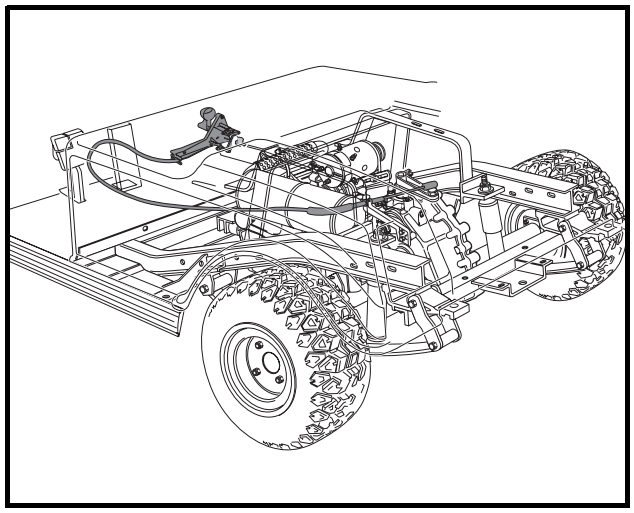


Figure 16-53 Forward/Reverse Cable Routing

5. Install the ball joint socket (2) on the Forward/Reverse shifter assembly ball stud (3) **(Figure 16-54, Page 16-21)**.

6. Attach Forward/Reverse cable at cable retainer (7).

7. Install wire tie (8) to secure wire harness to cable at the support bracket near the Forward/Reverse shifter assembly. **See following WARNING.**

⚠ WARNING

- **If wires are removed or replaced, make sure wiring and wiring harness is properly routed and secured. Failure to properly route and secure wiring could result in vehicle malfunction, property damage, personal injury, or death.**

FORWARD/REVERSE SHIFTER CABLE ADJUSTMENT

With the shifter lever of the unitized transaxle in the NEUTRAL position **(Figure 16-54, Page 16-21)**, the Forward/Reverse handle (9) should be straight up. For minor adjustments, the nut (1) may be loosened and the ball joint socket (2) rotated to get the proper adjustment **(Figure 16-54, Page 16-21). See following CAUTION.**

⚠ CAUTION

- **Be sure threads of cable are engaged in ball joint socket at least 1/4 inch (6.35 mm). If ball joint socket comes loose from the cable, the Forward/Reverse shifter will not operate properly.**

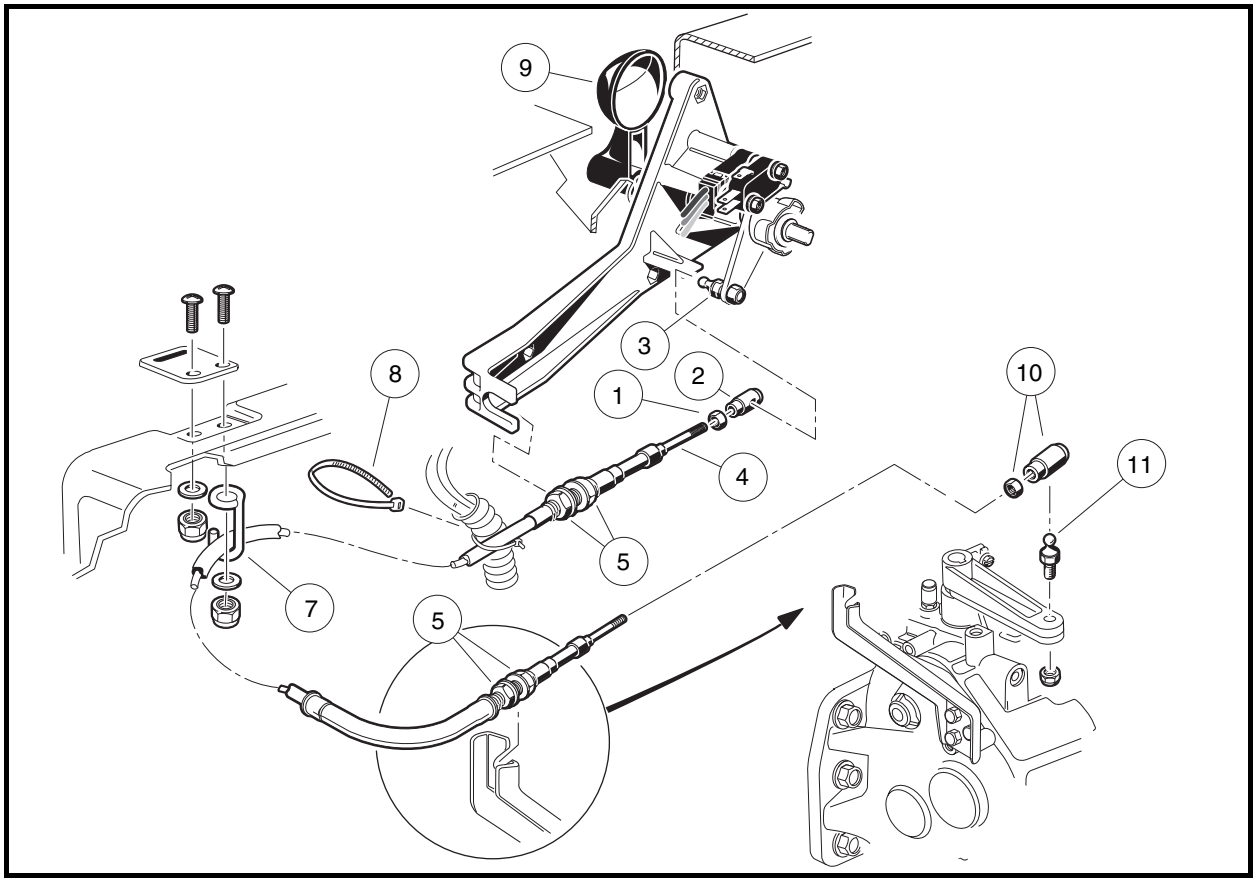


Figure 16-54 Forward/Reverse Shifter Cable

For major adjustments, the cable retaining nuts (5) must be loosened and adjusted. When the cable is properly adjusted, with the Forward/Reverse handle (9) **(Figure 16-54, Page 16-21)** in the NEUTRAL position, the shift lever of the transaxle will also be in the NEUTRAL position **(Figure 16-55, Page 16-21)**. Retighten nuts at the transaxle to 22 ft-lb (29.8 N·m); retighten nuts at the Forward/Reverse assembly to 43 in-lb (4.9 N·m).

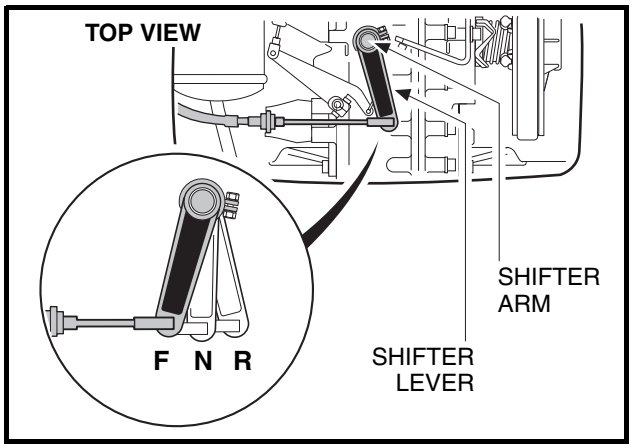


Figure 16-55 Forward/Reverse Positions

SECTION 17 – TORQUE CONVERTER: GASOLINE VEHICLE

⚠ DANGER

- **See General Warning, Section 1, Page 1-1.**

⚠ WARNING

- **See General Warning, Section 1, Page 1-1.**

GENERAL INFORMATION

The torque converter consists of a drive clutch, a driven clutch, and a drive belt. The drive clutch, which is mounted to the engine, is in the open position when the engine is at idle. At this point, the belt is riding at a low position (smaller diameter) on the drive clutch. The driven clutch is mounted on the transaxle. It is in the closed position, and the drive belt is riding at a high position (large diameter) on it when the engine is at idle.

At the point of clutch engagement, the speed ratio of the drive clutch to the driven clutch is 3.5 to 1. This ratio provides excellent starting and low-speed torque.

As engine speed increases, centrifugal force on internal weights close the drive clutch, pushing the belt up to a higher position on the clutch (increasing the diameter of the belt loop). As the diameter of the belt loop increases at the drive clutch, the driven clutch is forced open as the diameter of its belt loop decreases. At governed top speed, the ratio of drive clutch to driven clutch is 0.92 to 1.

On steep grades, or when the vehicle is heavily loaded, higher torques are achieved through the use of a torque-sensing ramp device on the driven clutch. This device overcomes the force of the centrifugal weights to close the driven clutch and open the drive clutch, thus increasing axle torque with little or no change in engine RPM.

The engine and torque converter rotate clockwise as viewed from the clutch side of the engine.

To provide optimum performance for the OHV engine and powertrain, the vehicle uses a pair of tuned clutches.

To properly assemble and disassemble the torque converter, the following tools should be used:

- Torque Converter Tool Kit (CCI P/N 1014510) **(Figure 17-1, Page 17-2).**
- Scribe or small pick (not included in torque converter tool kit).

TROUBLESHOOTING

See General Warning, Section 1, Page 1-1.

Maintaining proper adjustment of the engine and governor, as well as the torque converter, is essential to the troubleshooting process. If these adjustments are within specifications and, when climbing a steep hill, the engine begins to lose RPM before the drive belt reaches the top of the driven clutch, there is a torque converter problem.

If the torque converter is not operating properly:

1. Check the governor and throttle settings. **See Governor Cable, Section 14, Page 14-8.**

Troubleshooting, Continued:

2. Inspect the driven clutch for dirt and dust buildup on its component parts. Clean the driven clutch with water to remove any dust or dirt, then drive the vehicle and check for proper operation.
3. If cleaning the driven clutch does not solve the problem, disassemble and thoroughly clean all parts of the drive clutch. Be sure to clean the plastic drive buttons (10) **(Figure 17-5, Page 17-6)**.

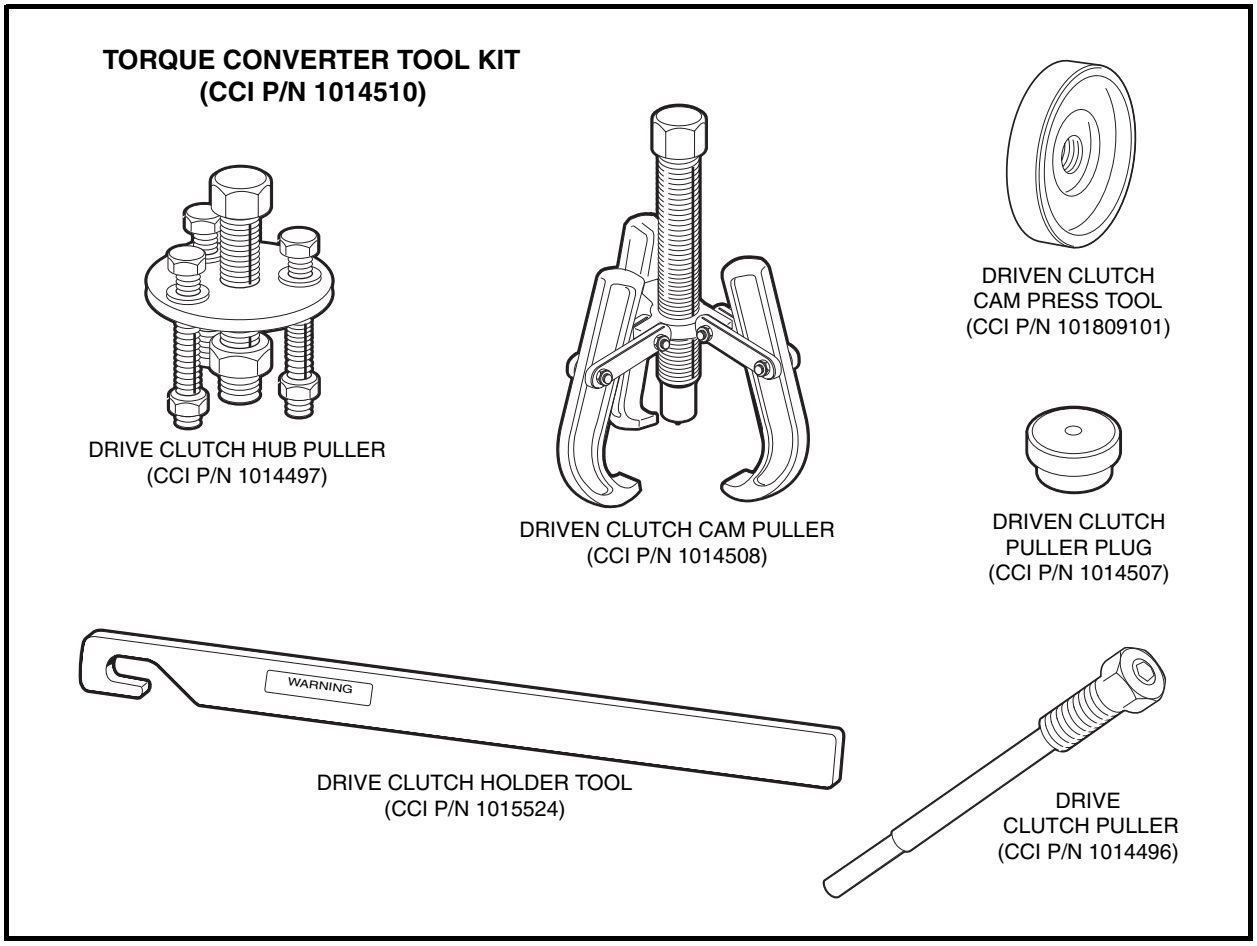


Figure 17-1 Torque Converter Tool Kit

DRIVE BELT

See General Warning, Section 1, Page 1-1.

The drive belt should be inspected semiannually for wear and (or) glazing. If it is excessively worn, frayed, or glazed, replace the belt.

As the drive belt wears, the engine RPM will increase to compensate for the change in torque converter ratio. This will keep the vehicle's maximum ground speed correct. **See Section 2 – Vehicle Specifications.**

DRIVE BELT REMOVAL

1. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.**

2. Disconnect the spark plug wire from the spark plug. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.**
3. Grasp the belt midway between the drive and driven clutches. Lift upward on the belt to force the sheaves of the DRIVEN clutch apart, then roll the belt off the DRIVEN clutch by rotating the clutch counterclockwise **(Figure 17-2, Page 17-3)**. **See following CAUTION.**

⚠ CAUTION

- **Make sure fingers are not underneath the belt when rolling the belt off the driven clutch.**

4. Remove the belt from the drive clutch.

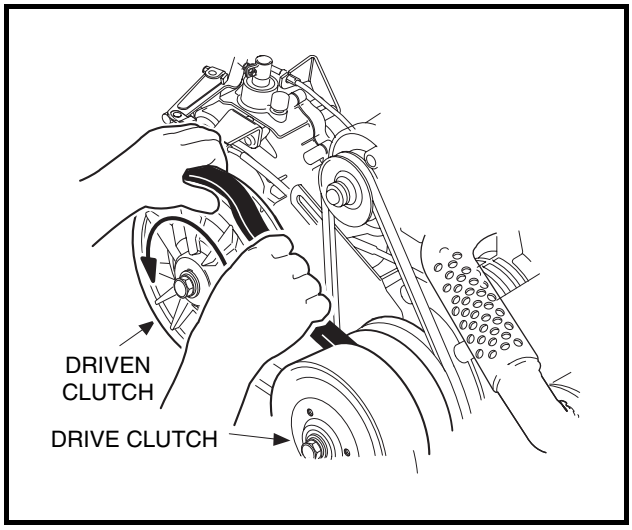


Figure 17-2 Drive Belt Removal

DRIVE BELT INSTALLATION

1. Position the new belt on the drive clutch, then start the belt over the top of the driven clutch.
2. With the belt started onto the driven clutch, rotate the driven clutch counterclockwise and roll the belt over the driven clutch sheaves and onto the clutch.
3. Connect battery cables, positive (+) cable first, and tighten hardware to 12 ft-lb (16 N·m). **See Figure 10-1, Section 10, Page 10-1.** Coat terminals with Battery Terminal Protector Spray (CCI P/N 1014305) to minimize corrosion.
4. Connect the spark plug wire to the plug.

DRIVE CLUTCH

See General Warning, Section 1, Page 1-1.

⚠ CAUTION

- **Be very careful when handling the clutches. A clutch that has been dropped will not be properly balanced. If either clutch is dropped, assume that it is damaged and replace it.**

DRIVE CLUTCH REMOVAL

1. Remove the drive belt as instructed. **See Drive Belt Removal on page 17-2.**
2. Loosen the starter/generator mounting and adjusting hardware and then remove the starter belt. **See WARNING "Moving parts! Do not..." in General Warning, Section 1, Page 1-1.**

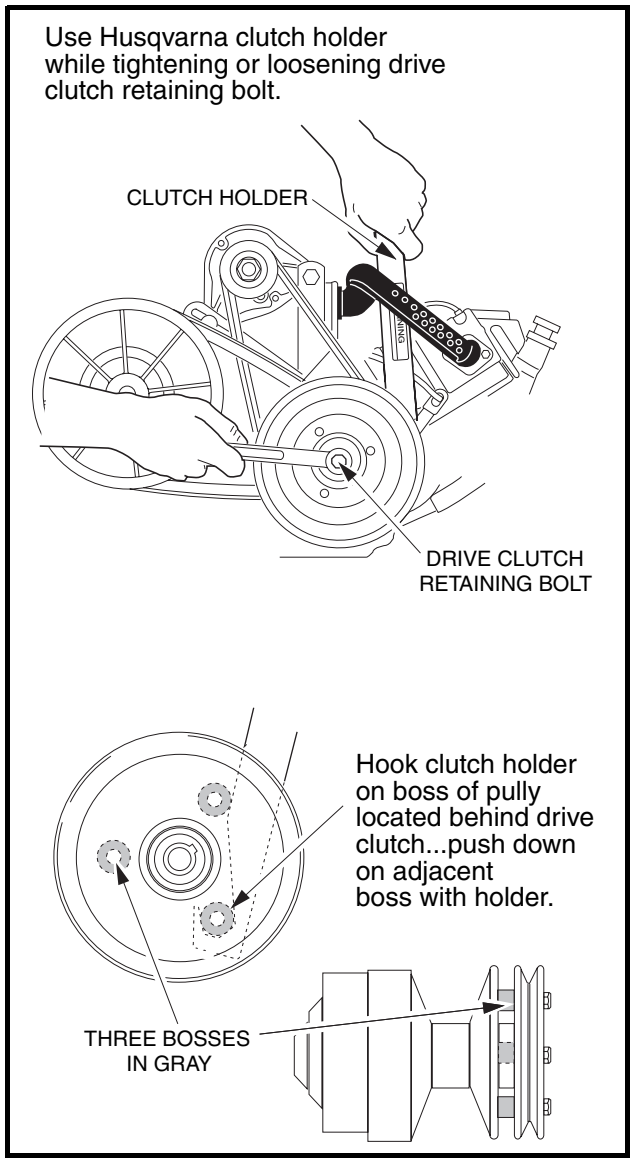


Figure 17-3 Loosen Retaining Bolt

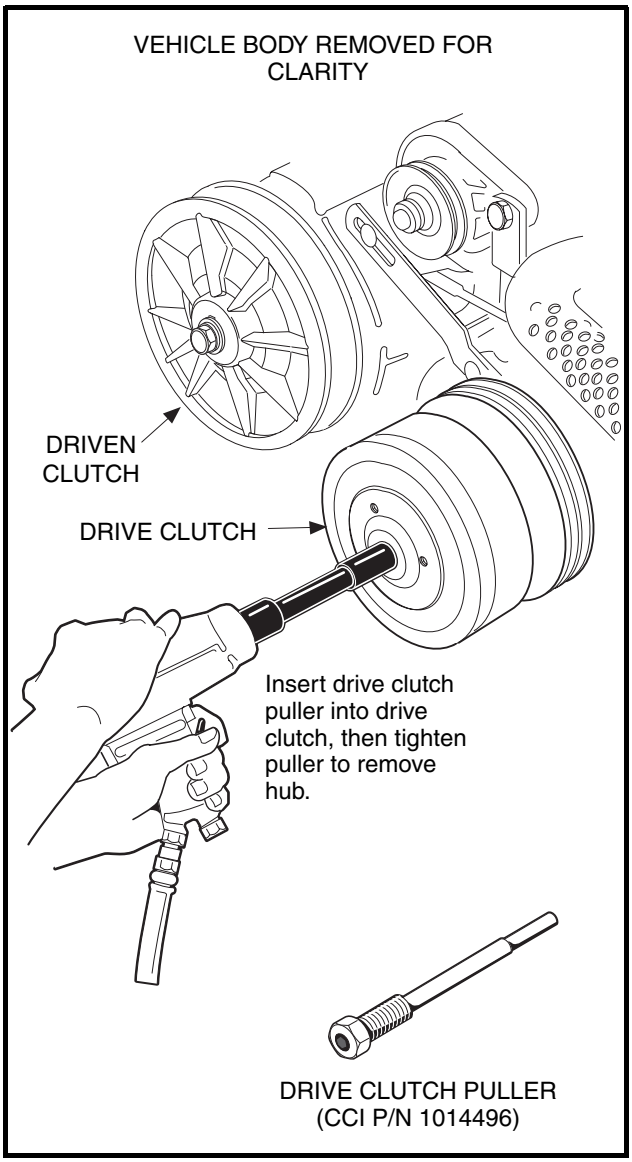


Figure 17-4 Drive Clutch Removal

3. Place chocks at the front wheels and lift the rear of the vehicle with a chain hoist or floor jack. Place jack stands under the axle tubes to support the vehicle. This will allow the weight of the centerline of the drive clutch to drop below the frame I-beam for access to the bolt securing the drive clutch. **See following WARNING**.

⚠ WARNING

- **Lift only one end of the vehicle at a time. Use a suitable lifting device (chain hoist or hydraulic floor jack) with 1000 lb. (454 kg) minimum lifting capacity. Do not use lifting device to hold vehicle in raised position. Use approved jack stands of proper weight capacity to support the vehicle and chock the wheels that remain on the floor. When not performing a test or service procedure that requires movement of the wheels, lock the brakes.**

4. Remove the drive clutch retaining bolts (17) and mounting washers (19) **(Figure 17-5, Page 17-6) See also Figure 17-3, Page 17-4**. **See following NOTE.**

NOTE: *The drive clutch mounting bolt has left-hand threads.*

The crankshaft has left-hand threads at the clutch mounting hole.

5. Lubricate the threaded portion of the clutch puller tool with a light oil and thread the clutch puller tool into the clutch retaining bolt hole.
6. Use a 1/2-inch drive air wrench to tighten the clutch puller tool. The drive clutch will come free of the crankshaft **(Figure 17-4, Page 17-4)**.
7. Support the drive clutch assembly in your hand and back the clutch puller tool out of the crankshaft.

⚠ CAUTION

- **Do not hit or tap the clutch with a hammer. Do not pry the clutch. These actions will damage the clutch.**

DRIVE CLUTCH CLEANING AND INSPECTION

1. Use a dry, lint-free cloth to clean clutch parts.

⚠ CAUTION

- **Do not lubricate the drive clutch. Lubricants attract dirt and dust, which interfere with proper clutch operation.**
- **Use only a dry cloth to lightly wipe the shaft of the fixed face assembly (7) (Figure 17-5, Page 17-6). Do not use a brush or steel wool. These will damage the surface of the shaft.**
- **Do not use solvents. Solvents will damage the lubricating characteristics of the bushings.**

2. Inspect the belt contact surfaces of the clutch sheaves for wear. If any area of a sheave contact surface has wear of 0.060 inch (1.52 mm) or more, the clutch should be replaced.

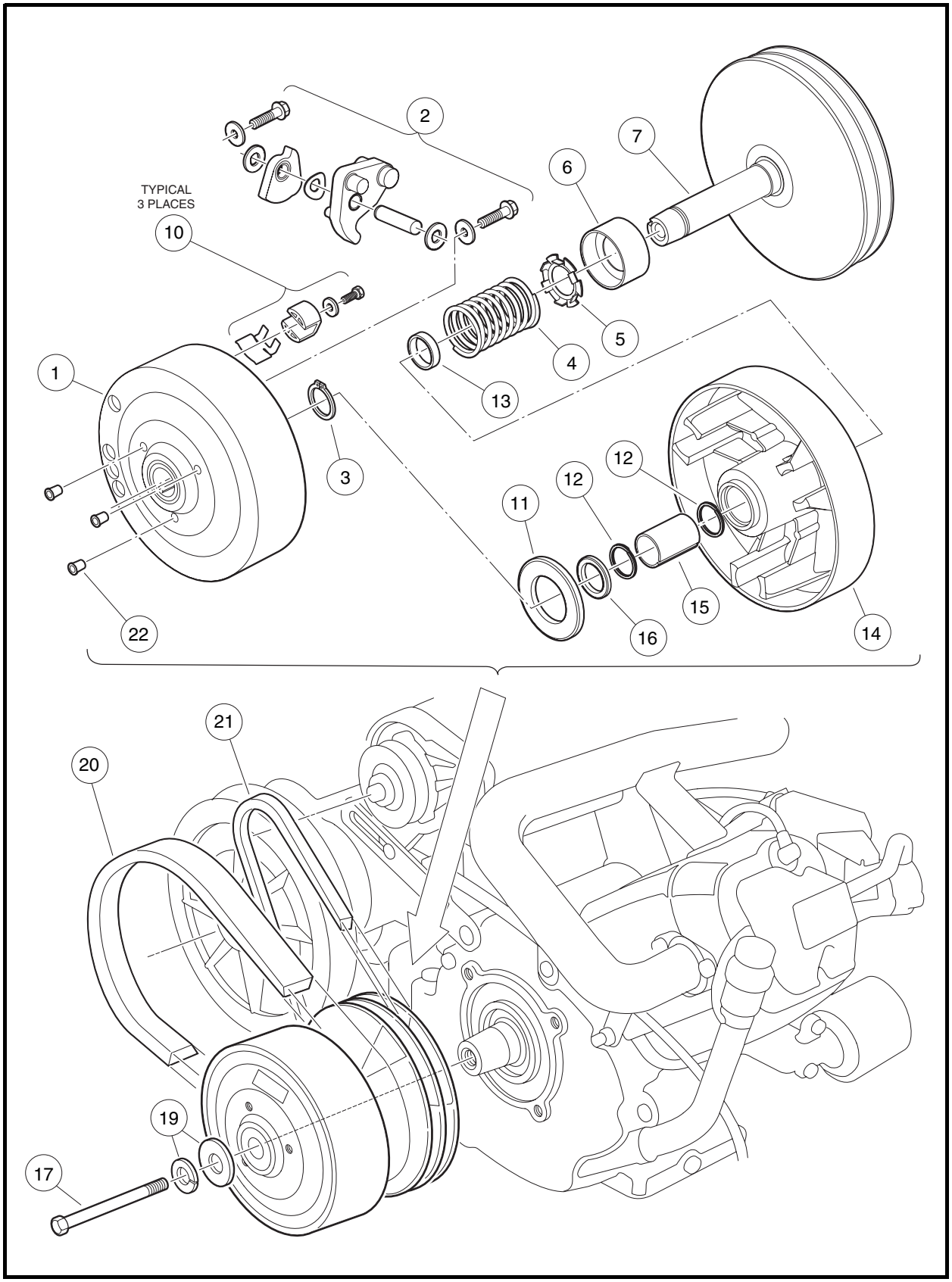


Figure 17-5 Drive Clutch Assembly

DRIVE CLUTCH DISASSEMBLY

⚠ CAUTION

- **The drive clutch is balanced as an assembly. Before disassembly, make match marks on the drive clutch hub and on the moveable face assembly so they can be reassembled in the same positions (Figure 17-6, Page 17-7).**

1. Make match marks on the drive clutch hub and on the moveable face casting **(Figure 17-6, Page 17-7)**.
2. Remove the drive clutch hub (1) **(Figure 17-5, Page 17-6)**:
   2.1. Remove the three plugs (22) from the clutch puller attachment holes **(Figure 17-5, Page 17-6)**.
   2.2. Thread the center bolt of the Drive Clutch Hub Puller (CCI P/N 1014497) into clutch until the stop nut touches the clutch, then back the bolt out one-half turn **(Figure 17-7, Page 17-7)**.
   2.3. Thread the three small bolts of the puller into corresponding holes in the clutch. Tighten bolts evenly, making sure the face of the puller plate is parallel to the face of the clutch **(Figure 17-7, Page 17-7)**.
   2.4. Unscrew the puller center bolt out of the clutch to pull drive clutch hub off.

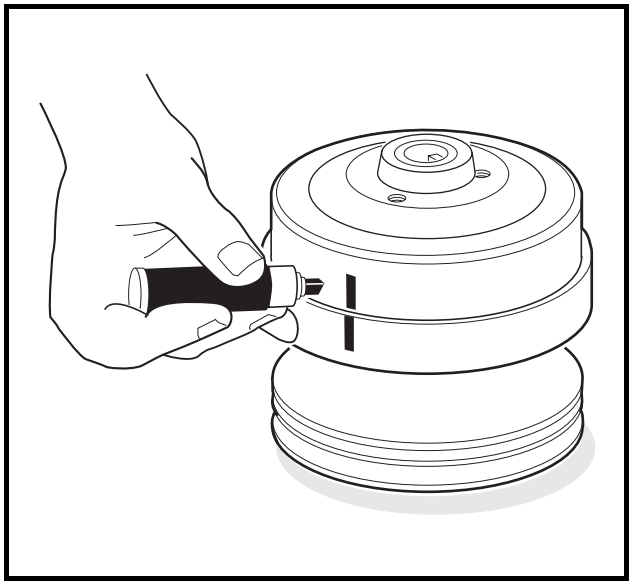


Figure 17-6 Mark Drive Clutch Hub

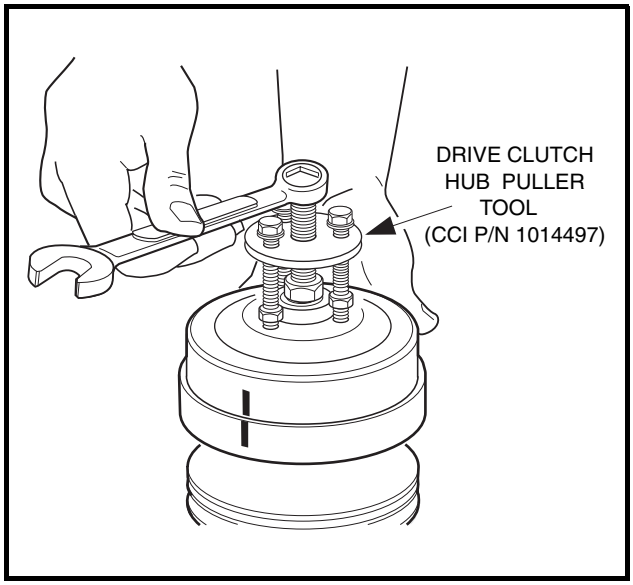


Figure 17-7 Remove Drive Clutch Hub

3. Remove the thrust washer (11) from the moveable face (14) **(Figure 17-5, Page 17-6)**.
4. Remove the drive buttons **(Figure 17-8, Page 17-8)**.
   4.1. Remove the screws, flat washers, drive button take-up springs, and drive buttons as shown **(Figure 17-8, Page 17-8)**.

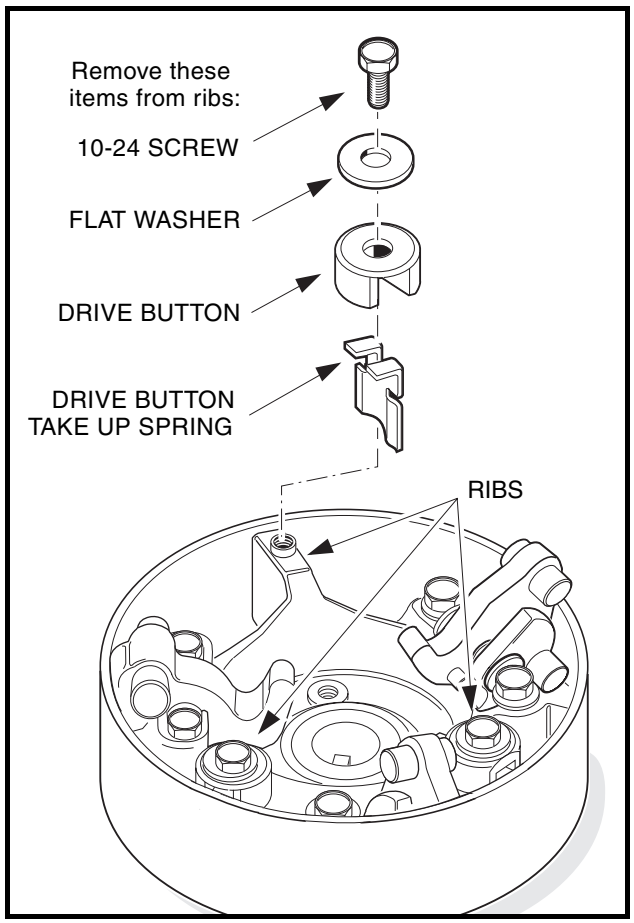


Figure 17-8 Drive Button Mounting

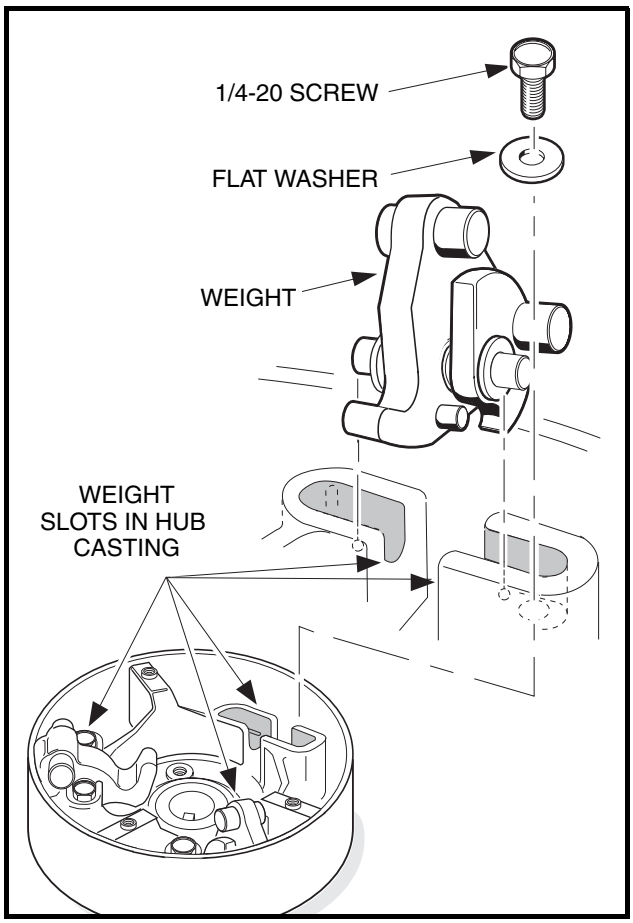


Figure 17-9 Weight Position

5. Remove the clutch weights **(Figure 17-9, Page 17-8)**:
   5.1. Remove the screws and flat washers attaching the weights as shown **(Figure 17-9, Page 17-8).**
   5.2. Pull the weight assemblies, with pins, from the clutch.
   5.3. Before removing, note the orientations of the wave washer and of the primary and secondary weights to one another **(Figures 17-10 and 17-11, Page 17-8)**. Remove the plastic washers, weights and wave washer from the pin. Retain all parts.

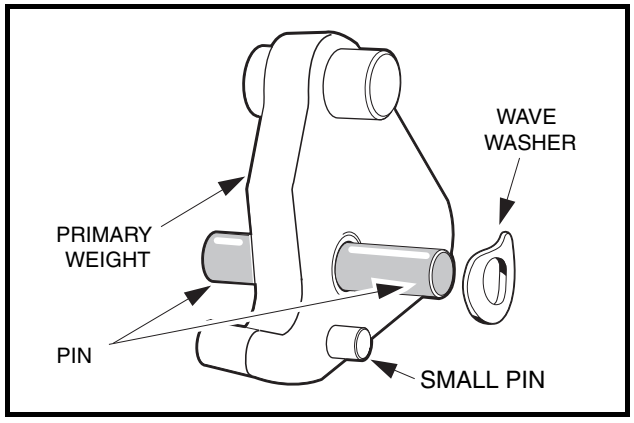


Figure 17-10 Install Pin and Washer

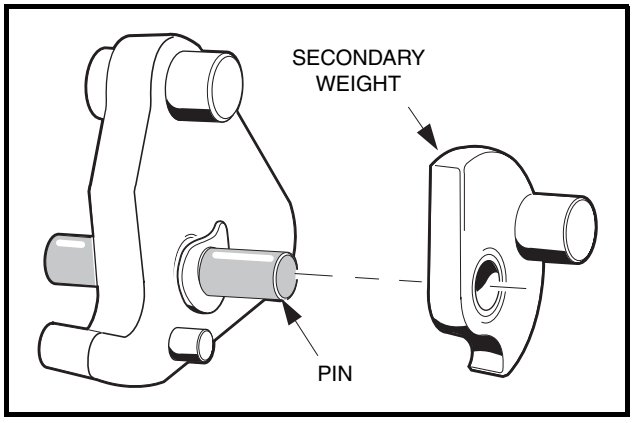


Figure 17-11 Install Secondary Weight

6. Remove the retaining ring (3) from the shaft of the fixed face assembly (7) and slide the moveable face (14) off the shaft **(Figure 17-5, Page 17-6)**. **See following NOTE.**

NOTE: *If the moveable face is removed from the hub of the fixed face, the spiral back-up rings (12) must be replaced with new ones* ***(Figure 17-5, Page 17-6)****.*

7. Remove the spacer (16), and spring (4) and retainer (5). The spring retainer can be removed from the spring if necessary **(Figure 17-5, Page 17-6)**.
8. If necessary, remove idler bearing. Use a press to remove the bearing **(Figure 17-12, Page 17-9)**. **See following NOTE.**

NOTE: *Do not remove the idler bearing unless it needs to be replaced. If idler bearing is removed, replace it with a new bearing.*

9. Use a scribe or small pick to remove the spiral backup rings (12) from each end of the bore in the fixed face assembly **(Figure 17-5, Page 17-6)**. **See also Figure 17-13, Page 17-9**. Discard the rings.

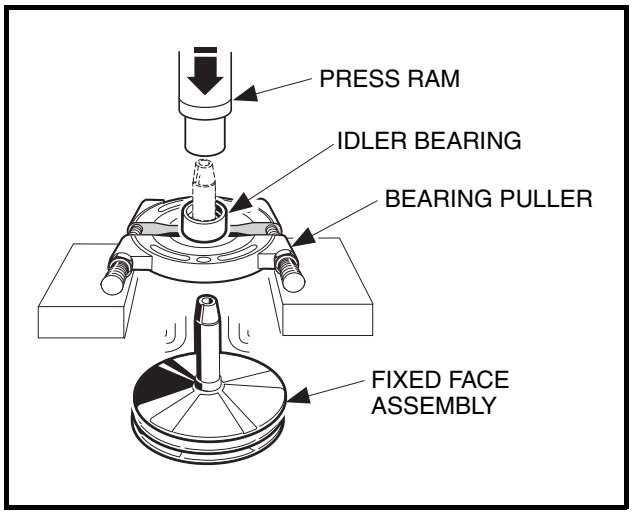


Figure 17-12 Remove Idler Bearing

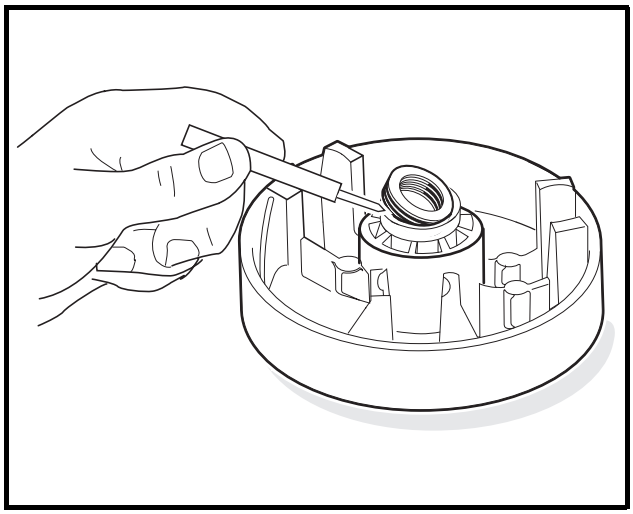


Figure 17-13 Spiral Back-up Rings

INSPECTION OF DRIVE CLUTCH PARTS

1. Inspect the idler bearing (6) for smooth rotation or seal damage **(Figure 17-5, Page 17-6). See following NOTE.**

NOTE: *It is normal for a small amount of grease to be present at the edge of seal.*

2. Inspect the bore of the moveable face assembly (14) for scarring or wear. The moveable face assembly must be replaced if the bore is worn to a diameter of 0.883 inch (22.4 mm) or larger **(Figure 17-5, Page 17-6)**.
3. Inspect the steel shaft (7) on the fixed face assembly. There should be no measurable wear anywhere on the shaft. Replace the shaft if it is worn, scratched, or damaged.
4. Inspect the thrust washer (11) for wear. If it is worn more than 0.030 inch (0.76 mm), turn it over or replace it with a new one.
5. Inspect the primary weights (2) and the hub casting for wear. If the primary weights show signs they are touching the casting, the tips of the weights have worn beyond specification and they must be replaced.

Inspection of Drive Clutch Parts, Continued:

6. Inspect the pins on the primary weights (2). There should be no measurable wear. Replace them if they are worn, scratched, or damaged**.**
7. Inspect the drive belt pulley sheaves for excessive wear or damage. If the sheaves are excessively worn or damaged, replace the entire fixed face drive assembly.

DRIVE CLUTCH ASSEMBLY

1. Press idler bearing (6) onto the shaft of the fixed face assembly (7). Press on the inner race of the bearing only. Make sure that the cup side of bearing is facing away from the fixed face **(Figure 17-5, Page 17-6)**.
2. Using needle nose pliers, install the spring retainer (5) onto the spring (4).
3. Install the spring (4) and retainer (5) into the cup of the idler bearing (6).
4. Install the spacer (13) onto the shaft of the fixed face.
5. Install a new spiral backup ring (12) in each end of the bore of the moveable face assembly (14).
6. Install the moveable face assembly (14) onto the shaft of the fixed face assembly (7).

⚠ CAUTION

- **To avoid damaging the spiral back-up rings, be very careful when installing the moveable face.**

6.1. Rotate the moveable face assembly clockwise while installing it onto the shaft.

6.2. Install the retaining ring (3) **(Figure 17-5, Page 17-6)**.

7. Install the primary weights on the mounting pins **(Figure 17-10, Page 17-8)**.
8. Install a wave washer on each mounting pin. Make sure that the concave side of the washer faces the side of the primary weight with the small guide pin protruding from it **(Figure 17-10, Page 17-8)**.
9. Install the secondary weights onto the mounting pins with the weight pins on the secondary weights pointing away from the primary weights. The wave washers should be between the primary and secondary weights **(Figure 17-11, Page 17-8)**.
10. Install white plastic flat washers on each end of the mounting pin and push them against the outside surfaces of the weights. Center the weights and washers on the mounting pin **(Figure 17-14, Page 17-10)**.
11. Install the weight assemblies into the slots in the hub casting **(Figure 17-9, Page 17-8)**. Make sure the mounting pin protrudes an equal amount on each side of the weights when the assemblies are in position **(Figure 17-14, Page 17-10)**.

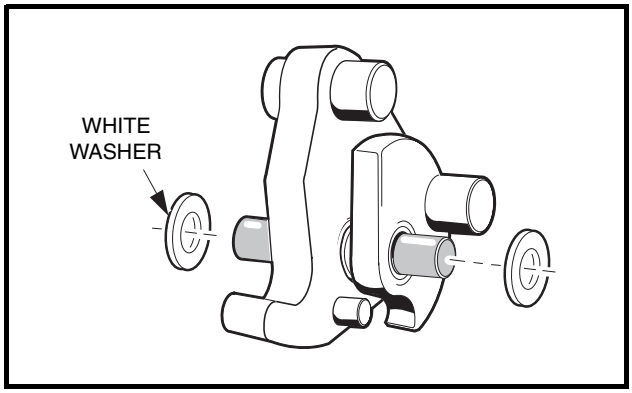


Figure 17-14 Install White Washers

12. Install the 1/4-20 bolts and washers (2) and tighten them to 10 ft-lb (13 N·m) **(Figure 17-5, Page 17-6)**. **See following NOTE.**

NOTE: *Make sure there is at least a (minimum) gap of 0.020 inch (0.51 mm) between each end of the mounting pin and the mounting bolt.*

13. Install three drive button take-up springs.

    13.1. Install each spring on right-hand side of the three button mounting posts (when looking into the interior of the clutch drive hub, and with the rib at a twelve o'clock position) as shown **(Figure 17-15, Page 17-11)**.

14. Compress each take-up spring and install the drive button over the rib and take-up spring **(Figure 17-8, Page 17-8)**.

15. Install a no. 10-24 button retaining screw with flat washer through each button and into the rib. Tighten the screws to 34 in-lb (3.8 N·m) **(Figure 17-9, Page 17-8)**.

16. Install the thrust washer (11) onto the moveable face assembly **(Figure 17-5, Page 17-6)**.

17. Install the hub assembly (8) on the moveable face assembly and align the match marks made before disassembling the clutch. Press the hub assembly on by hand.

18. Replace the three plastic plugs (22) into the hole protectors **(Figure 17-5, Page 17-6)**.

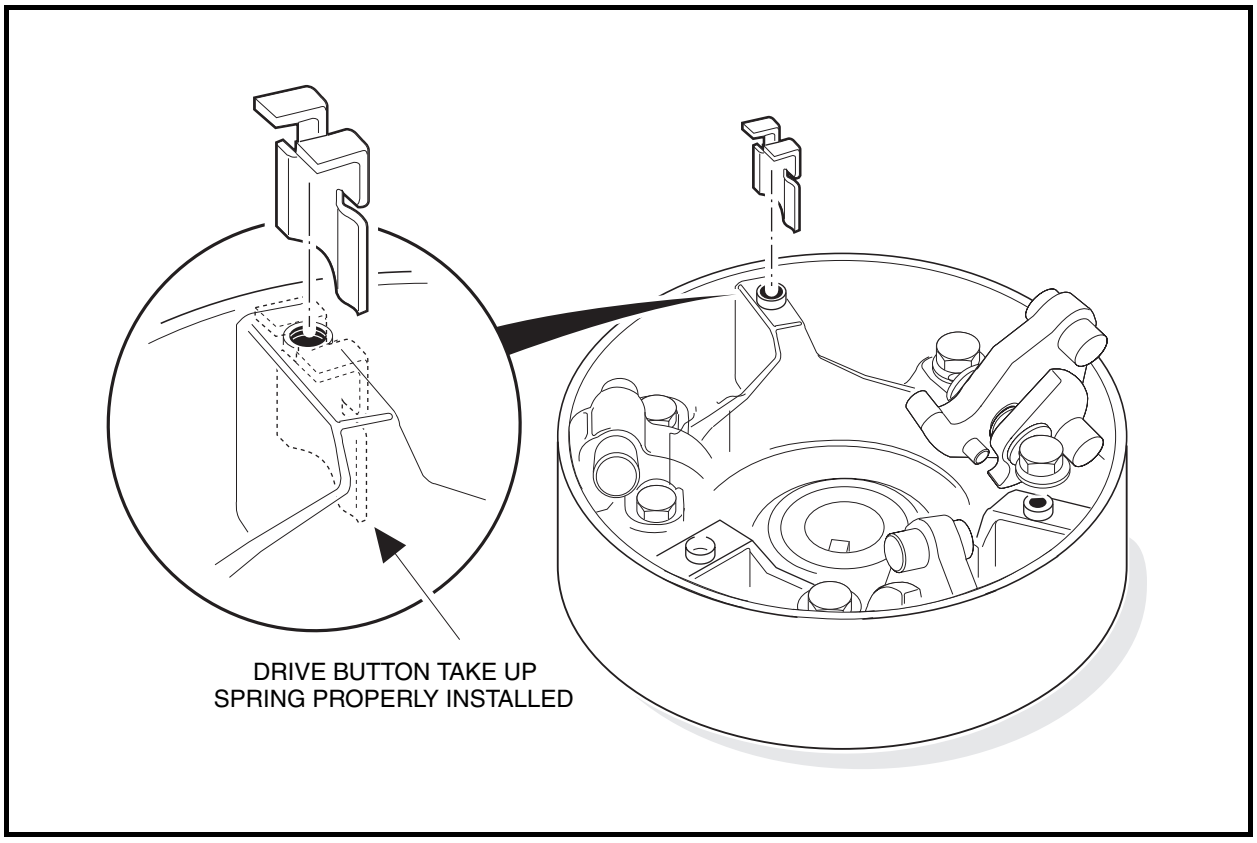


Figure 17-15 Correct Orientation of Drive Button Take-up Springs

DRIVE CLUTCH INSTALLATION

1. Place the drive clutch assembly on the crankshaft taper. Position the mounting washer (with the green side facing out) on the bolt (17) and start the bolt into the crankshaft **(Figure 17-5, Page 17-6)**. **See following NOTE.**

NOTE: *The drive clutch mounting bolt has left-hand threads.*

2. Tighten the drive clutch retaining bolt (17) to 25 ft-lb (33.9 N·m) **(Figure 17-5, Page 17-6)**.
3. Install the starter/generator belt and adjust belt tension as instructed. **See Belt Tension Adjustment, Section 12, Page 12-10.** Tighten the starter/generator mounting hardware to 23 ft-lb (31.2 N·m) and the adjusting hardware to 13 ft-lb (17.6 N·m).
4. Install the drive belt as instructed. **See Drive Belt Installation on page 17-3.**
5. Connect battery cables, positive (+) cable first, and tighten hardware to 12 ft-lb (16 N·m). **See Figure 10-1, Section 10, Page 10-1.** Coat terminals with Battery Terminal Protector Spray (CCI P/N 1014305) to minimize corrosion.
6. Connect the spark plug wire to the plug.
7. Drive the vehicle and check for proper operation.

DRIVEN CLUTCH

See General Warning, Section 1, Page 1-1.

DRIVEN CLUTCH REMOVAL

1. Remove the drive belt as instructed. **See Drive Belt Removal on page 17-2.**
2. Remove the bolt (11) and mounting washer (12) from the clutch shaft **(Figure 17-18, Page 17-14)**.
3. Grasp the driven clutch assembly and slide it off the shaft.
4. Leave the key (9) in the keyway.

DRIVEN CLUTCH DISASSEMBLY

1. Using external snap ring pliers, remove the retaining ring (4) **(Figure 17-16, Page 17-13)**. **See following WARNING.**

⚠ WARNING

- **Do not place fingers under the cam when removing the cam. The moveable face may spin when the cam buttons release from the cam ramps, resulting in severe personal injury.**

2. Insert a puller plug (CCI P/N 1014507) **(Figure 17-17, Page 17-13)** into the shaft bore and use a driven clutch cam puller (CCI P/N 1014508) to remove the cam (4) from the fixed face shaft (8) **(Figure 17-18, Page 17-14)**.
3. Remove the spring (5) **(Figure 17-18, Page 17-14)**.
4. Retain the key (3).
5. Slide the moveable face (7) off the fixed face shaft (8).

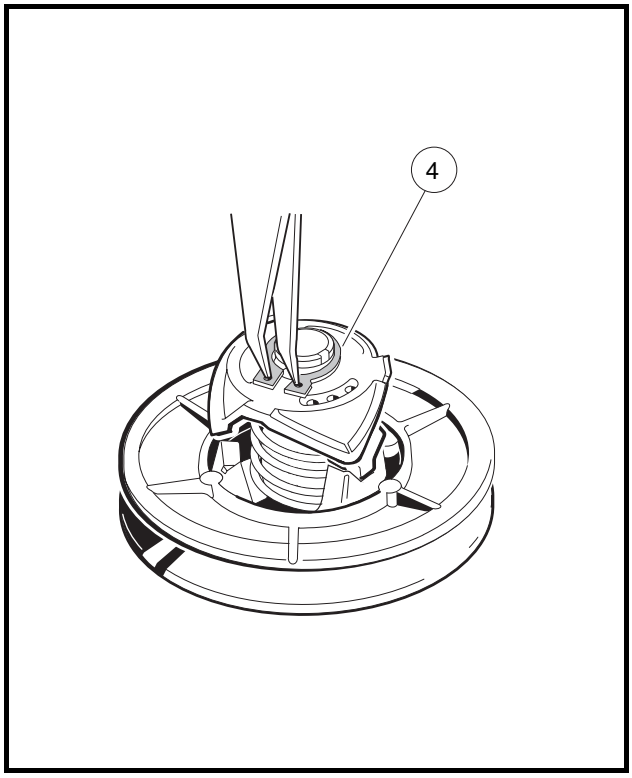


Figure 17-16 Remove Retaining Ring

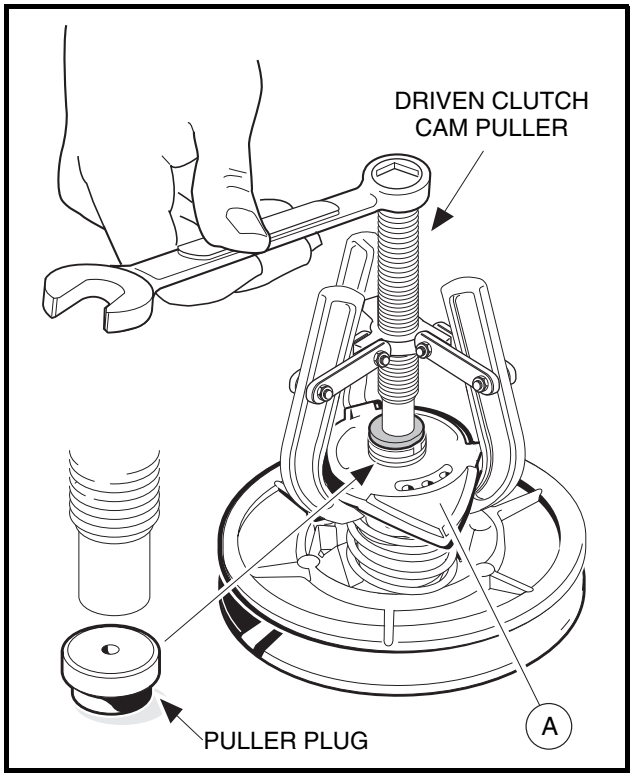


Figure 17-17 Driven Clutch Disassembly

DRIVEN CLUTCH INSPECTION

1. Inspect the cam (4) for excessive wear. Replace it if necessary **(Figure 17-18, Page 17-14)**.
2. Inspect the drive buttons (6) for excessive wear. Replace if necessary. To remove the drive buttons, remove the socket-head cap screws and then the buttons.
3. Inspect the smooth surface on the fixed and moveable face assemblies. Assemblies must be replaced if surfaces are worn more than 0.060 inch (1.5 mm).
4. Inspect the bronze bearing in the moveable face. If the bearing bore diameter is more than 1.384 inch (35.15 mm), the entire moveable face assembly must be replaced.
5. Inspect the shaft of the fixed face assembly. There should be no noticeable wear. Replace the shaft if it is worn, scratched or damaged.

DRIVEN CLUTCH ASSEMBLY

1. Place the three drive buttons (6) in position. Apply one drop of Loctite® 222 to each of the socket-head cap screws and then install and tighten them to 8 in-lb (0.9 N·m) **(Figure 17-18, Page 17-14)**.
2. Slide the moveable face assembly (7) onto the fixed face shaft (8).
3. Place the end of the spring (5) into the hole in the moveable face assembly.
4. Install the key (3) into the keyway of the fixed face assembly (8) shaft.

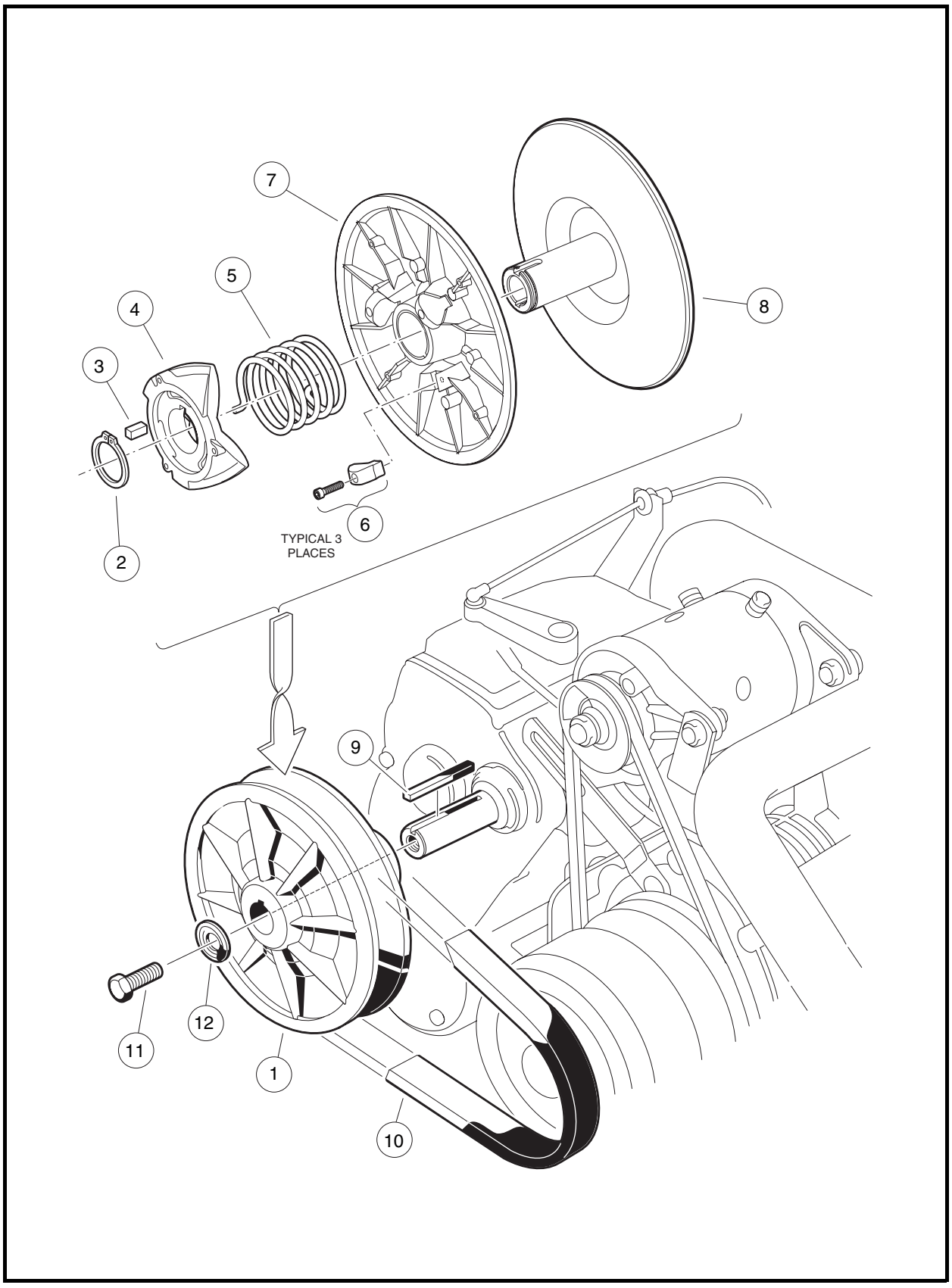


Figure 17-18 Driven Clutch Assembly

Driven Clutch Assembly, Continued:

5. Holding the cam (4) in position for assembly on the shaft, install the other end of the spring (5) into the center spring hole of the cam. Rotate the cam until the keyway is aligned with the key (3) on the fixed face assembly, and then start the cam onto the shaft approximately 1/4 to 3/8 inch (6.3 to 9.5 mm).

5.1. **Press Assembly Process:**

5.1.1. Place the clutch assembly in a press and position the cam press tool (CCI P/N 101809101) on the cam as shown **(Figure 17-19, Page 17-15).**

5.1.2. Hold the fixed face assembly (3) and rotate the moveable face assembly (1) one-third turn **clockwise**, then press the cam (2) onto the fixed face assembly **(Figure 17-19, Page 17-15)**.

5.1.3. Install the retaining ring (2) **(Figure 17-18, Page 17-14)**. **See following NOTE**.

NOTE: *The retaining ring can be reused if the O.D. does not exceed 1.607 inches (40.82 mm); otherwise, it must be replaced with a new ring (CCI P/N 1014080).*

5.1.4. While holding onto the cam, tap the end of the fixed face shaft lightly with a plastic mallet until the cam seats against the retaining ring. **See following CAUTION.**

⚠ CAUTION

- **Do not use a metal hammer to tap the fixed face hub. A metal hammer will damage the shaft.**

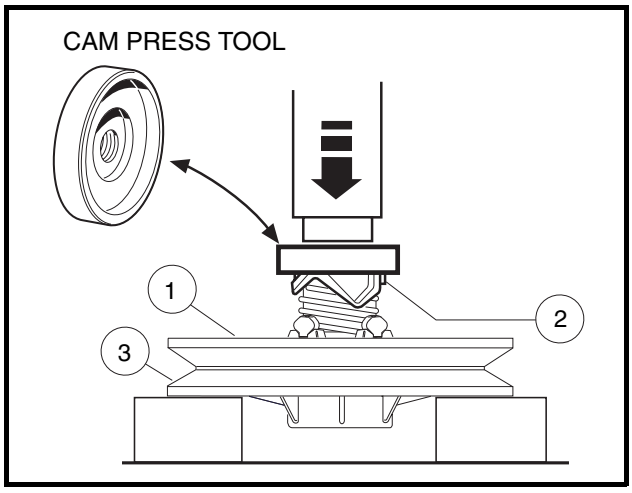


Figure 17-19 Cam Press Tool

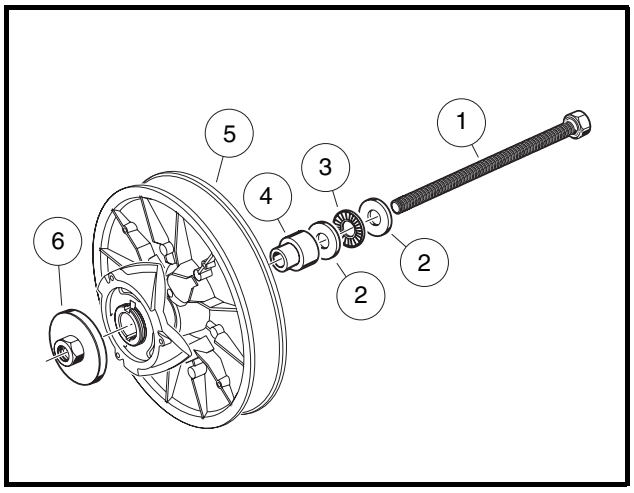


Figure 17-20 Cam Installation Tool

5.2. **Field Assembly Process:**

NOTE: *This process is for field assembly requirements where hydraulic and pneumatic press equipment is not available. Use the cam installation tool (CCI P/N 101808401) for this process.*

5.2.1. With the clutch loosely assembled, set the edge of the clutch body (5) on a clean, flat surface **(Figure 17-20, Page 17-15)**.

5.2.2. Assemble the threaded bolt (1) through the washer (2), the thrust bearing assembly (3), the second washer (2), and the hub guide (4).

NOTE: *It is very important that the bolt, washers, and thrust bearing assembly be assembled in the order described and shown.*

Driven Clutch Assembly, Continued:

5.2.3. Slide the bolt (1) through the clutch body (5) until the threaded bolt, washers, bearing, and hub guide are against the fixed face hub **(Figure 17-20, Page 17-15)**.

5.2.4. Hold the clutch assembly and cam installation tool together and place the fixed face down on spaced blocks **(Figure 17-19, Page 17-15)**.

5.2.5. Place the cam press hub (6) onto the cam installation bolt and thread it down onto the cam hub, centering the press hub onto the cam hub.

5.2.6. Hold the fixed face assembly of the clutch (5) and rotate the moveable face of the clutch one-third turn clockwise.

5.2.7. Use two wrenches, and hold the bolt head while tightening the cam press hub (6) pressing the cam onto the keyed shaft. Advance the press hub until it is firm against the shaft end.

5.2.8. Remove the cam press hub (6) and installation tool, and install the retaining ring.

NOTE: *The retaining ring can be reused if the O.D. does not exceed 1.607 inches (40.82 mm); otherwise, it must be replaced with a new ring (CCI P/N 1014080).*

DRIVEN CLUTCH INSTALLATION

1. To install the driven clutch, reverse the removal procedure. Make sure that the washer (12) is mounted with the flat portion of the washer against the driven clutch **(Figure 17-18, Page 17-14)**. Secure with a new bolt (11). **See following NOTE.**

NOTE: *The bolt (11) must be replaced with a new bolt (CCI P/N 102242101) containing a locking patch that will prevent the bolt from loosening.*

2. Tighten the bolt (11) to 14 ft-lb (19.0 N·m).
3. Connect the spark plug.
4. Connect battery cables, positive (+) cable first, and tighten hardware to 12 ft-lb (16 N·m). **See Figure 10-1, Section 10, Page 10-1.** Coat terminals with Battery Terminal Protector Spray (CCI P/N 14305) to minimize corrosion.

SECTION 18 – ELECTRICAL SYSTEM AND TESTING: ELECTRIC VEHICLE

⚠ DANGER

- **See General Warning, Section 1, Page 1-1.**

⚠ WARNING

- **See General Warning, Section 1, Page 1-1.**

GENERAL INFORMATION

The electric vehicle uses a 48-volt electrical system that is powered by four 12-volt lead-acid batteries and includes an onboard computer. The electric vehicle uses a shunt-wound 3.2 hp motor and includes several additional features.

- **Shunt-Wound Motor:** The shunt-wound motor, unlike a series motor, is designed so that the speed controller is able to vary the amount of current passing through the field coils independently from the current passing through the armature.
- **Motor Braking:** Under certain conditions a shunt-wound motor also has the ability to act as an electrical brake to slow the vehicle. There are three features of the electrical system which will activate the motor braking function: Zero Speed Detect, Pedal Down Motor Braking, and Pedal Up Motor Braking (adjustable with the Diagnostic and Programming handset).
- **Zero Speed Detect:** the Zero-Speed Detect function will prevent the vehicle from rolling at more than 1 or 3 mph (1.5 or 4.8 km/h) unless the accelerator is pressed. This prevents the possibility of a parked vehicle (with the park brake disengaged) rolling away too fast to be overtaken on foot. If the zero speed detect function remains engaged for two seconds or more, a warning buzzer will sound to alert the driver that motor braking has been activated.

⚠ WARNING

- **Zero speed detect will not limit vehicle speed to 1 mph (1.6 km/h) on very steep grades. Do not operate vehicle on slopes exceeding 20% grades.**

- **Pedal Down Motor Braking:** This feature helps to control vehicle downhill speed. Motor braking is activated when the vehicle reaches the programmed top speed and holds the vehicle at that speed. Motor braking is automatically disengaged when vehicle speed slows below the programmed top speed.
- **Pedal Up Motor Braking (adjustable):** When vehicle speed is above 11 mph (17.7 km/h), releasing the accelerator pedal will activate motor braking, which slows the vehicle speed. Once vehicle speed slows to below approximately 11 mph (17.7 km/h), with the accelerator pedal still released, motor braking will be deactivated and the vehicle will coast freely. This feature is adjustable. Contact your nearest distributor/dealer to inquire about this adjustable feature.
- **Regenerative Braking**: When motor braking is activated, the vehicle motor acts as a generator, slowing the vehicle as it creates energy that is used to charge the batteries.

WIRING DIAGRAM

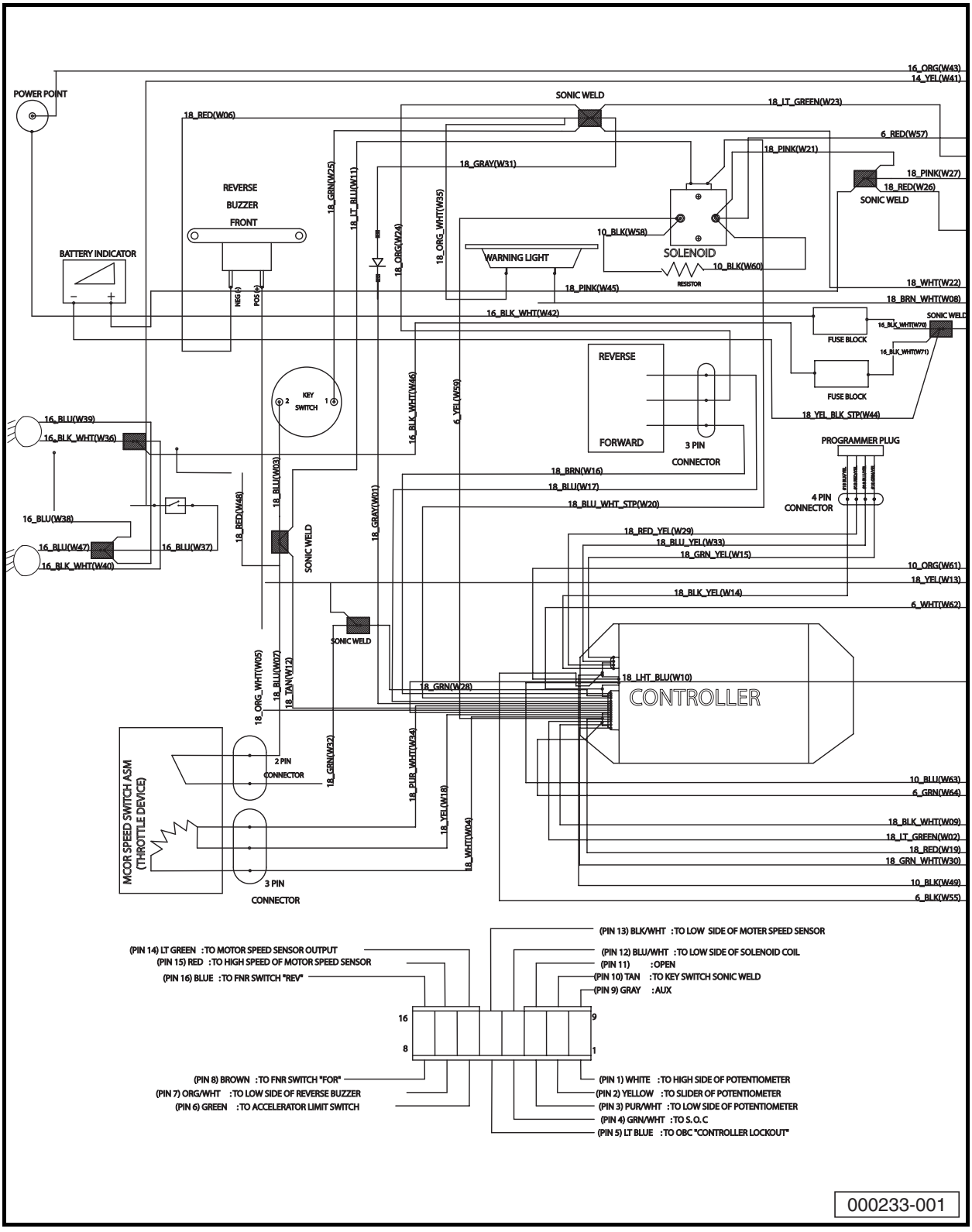


Figure 18-1 Wiring Diagram for Electric Vehicles

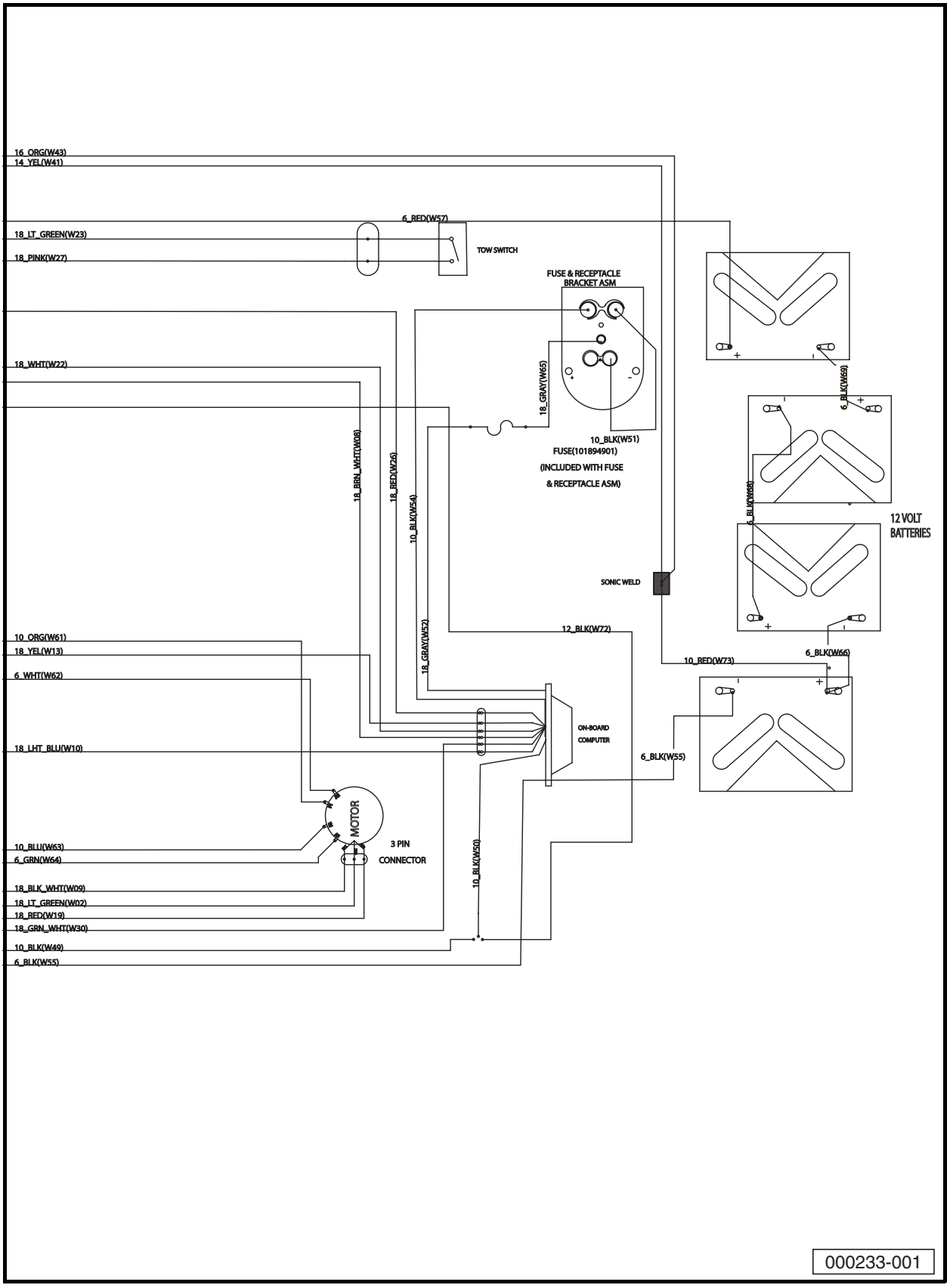


Figure 18-2 Wiring Diagram for Electric Vehicles

Wiring Diagram, Continued:

- **Tow/Run Switch:** When the Tow/Run switch is in the RUN position, the vehicle will function normally. When the switch is in the TOW position, power to the OBC and controller is shut off, disabling the vehicle operating circuit and zero speed detect, allowing the vehicle to be towed.
- **Motor Protection Circuit:** The operator should never attempt to hold the vehicle on an incline by pressing the accelerator pedal instead of the brake pedal, as motor overheating could result. By reducing the current to the motor during such an occurrence, the motor protection circuit reduces the possibility of motor damage. When this situation arises, a *motor stall fault* is recorded by the speed controller and will be displayed on the diagnostic handset in the Diagnostic History menu. **See the Diagnostic Handset Owner's Manual.**
- **High Pedal Detect:** This function prevents unexpected vehicle movement if the key switch is turned ON after the accelerator is pressed, or the accelerator pedal is pressed when Forward/Reverse switch is used to change the direction of travel. The vehicle will not move until the accelerator is released and pressed again. When this situation arises, a *HPD fault* is recorded by the speed controller and will be displayed on a diagnostic and programming handset in the Diagnostic History menu. **See the Diagnostic Handset Owner's Manual.**
- **Onboard Computer (OBC):** The OBC, 1) monitors battery condition, 2) monitors the number of energy units used by the vehicle, 3) determines the number of energy units required to recharge the batteries and shuts the charger off when this number is reached, 4) determines when to activate regenerative motor braking, 5) locks out vehicle movement while the charger is plugged into the vehicle charger receptacle, 6) stores operating data, which can be read by the Communication Display Module (CDM). **See Communication Display Module (CDM) on page 18-35.**

TROUBLESHOOTING

The following troubleshooting guides will be helpful in identifying operating difficulties should they occur. The guides include the symptom, probable cause(s) and suggested checks. The procedures used in making these checks can be found in the referenced sections of this maintenance and service supplement.

TROUBLESHOOTING THE VEHICLE WITH THE DIAGNOSTIC HANDSET

We recommend the use of the diagnostic handset for troubleshooting vehicles equipped with the electrical system. Troubleshooting Guide 1 is to be used in conjunction with the handset. Refer to the Diagnostic Handset Owner's Manual for operating instructions. **See following WARNING.**

⚠ WARNING

- **The vehicle operator should not monitor the diagnostic handset while the vehicle is in motion. A technician can monitor the diagnostic handset while traveling as a passenger in the vehicle. Failure to heed this warning could result in severe personal injury or death.**

In the event that the vehicle is not functioning properly after completing Troubleshooting Guide 1, the technician should proceed to Troubleshooting Guide 2.

If a diagnostic handset is unavailable, the technician should proceed to Troubleshooting Guide 2.

TROUBLESHOOTING GUIDE 1

The following troubleshooting guide is intended for use with a diagnostic handset. For handset operating instructions, refer to the Diagnostic Handset Owner's Manual. **See following NOTE.**

NOTE: *Before troubleshooting the vehicle, check the diagnostic history from the Special Diagnostics Menu. Note any fault codes.*

TROUBLESHOOTING GUIDE 1

SYMPTOM	POSSIBLE CAUSES	CORRECTIVE ACTION
Test Menu – THROTTLE % value does not increase as the accelerator pedal is pressed **or** **Diagnostic Menu – THROTTLE FAULT 1 fault code**	Loose or disconnected three-pin connector at the MCOR or broken wire	Repair and/or connect the three-pin connector to the MCOR
	Loose or disconnected 16-pin connector at speed controller or broken wire	Repair and/or connect the 16-pin connector to the speed controller
	Failed MCOR	Test Procedure 4 – MCOR Voltage on page 18-14
Test Menu – HEATSINK °C indicates that temperature is above 85 °C (145 °F) **or** **Diagnostic Menu – THERMAL CUTBACK fault code**	Over-adjusted brakes	**See Brake Adjustment, Section 6, Page 6-8.**
	Vehicle is over-loaded	Ensure that vehicle is not over-loaded before returning to operation
Test Menu – ARM PWM value does not reach 100% when vehicle is at full speed	Failed MCOR	Test Procedure 4 – MCOR Voltage on page 18-14
	Improper pedal group adjustment	**See Pedal Group Adjustment – Electric Vehicles, Section 5, Page 5-16.**
Test Menu – SPEED PULSES menu item indicates that speed pulses are OFF when the vehicle is in motion **or** **Diagnostic Menu – SPEED SENSOR fault code**	Loose or disconnected motor speed sensor or broken wire	Repair and/or connect the three-pin connector to the motor speed sensor
	Loose or disconnected 16-pin connector at speed controller or broken wire	Repair and/or connect the 16-pin connector to the speed controller
	Failed motor speed sensor	Test Procedure 13 – Motor Speed Sensor on page 18-30
Test Menu – FOOT INPUT menu item indicates that the MCOR internal limit switch is always ON or always OFF.	Loose or disconnected two-pin connector at the MCOR or broken wire	Repair and/or connect the two-pin connector to the MCOR
	Loose or disconnected 16-pin connector at speed controller or broken wire	Repair and/or connect the 16-pin connector to the speed controller
	Failed MCOR	Test Procedure 8 – Key Switch and MCOR Limit Switch Circuit on page 18-17
Test Menu – FORWARD INPUT and/or REVERSE INPUT does not indicate the correct reading **or** **Diagnostic Menu – PROC/WIRING fault code**	Loose or disconnected Forward/Reverse rocker switch (quick disconnect terminals) or broken wire	Repair and/or connect the quick disconnect terminals to the Forward/ Reverse switch
	Loose or disconnected Forward/Reverse rocker switch (three-pin connector) or broken wire	Repair and/or connect the three-pin connector from the Forward/Reverse switch to the wire harness
	Loose or disconnected 16-pin connector at speed controller or broken wire	Repair and/or connect the 16-pin connector to the speed controller
	Failed Forward/Reverse rocker switch	Test Procedure 15 – Forward/Reverse Rocker Switch on page 18-32

Troubleshooting Guide continued on next page...

TROUBLESHOOTING GUIDE 1

SYMPTOM	POSSIBLE CAUSES	CORRECTIVE ACTION
Test Menu – MAIN CONT (solenoid) does not indicate ON when the solenoid should be activated. **or** **Diagnostic Menu – MAIN CONT DNC (main contactor (solenoid) did not close) fault code**	Speed controller logic malfunction	Disconnect the batteries and allow the speed controller capacitors to discharge. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.** Reconnect the batteries and see if the symptom returns.
	Loose, broken, or disconnected wire(s) at solenoid or B+ speed controller terminal	Repair and/or connect the loose or disconnected wire(s)
	Loose or disconnected 16-pin connector at speed controller or broken wire	Repair and/or connect the 16-pin connector to the speed controller
	Failed solenoid	Replace solenoid. **See Solenoid Removal, Section 19, Page 19-6.**
Test Menu – KEY INPUT does not indicate ON when key switch is in the ON position	Loose or disconnected wires at key switch terminals or broken wire	Repair and/or connect the quick disconnect terminals to the Forward/ Reverse switch
	Loose or disconnected 16-pin connector at speed controller or broken wire	Repair and/or connect the 16-pin connector to the speed controller
	Failed key switch	Test Procedure 8 – Key Switch and MCOR Limit Switch Circuit on page 18-17
Diagnostic Menu – THROTTLE FAULT 1 fault code	Loose or disconnected three-pin connector at the MCOR or broken wire	Repair and/or connect the three-pin connector to the MCOR
	Loose or disconnected 16-pin connector at speed controller or broken wire	Repair and/or connect the 16-pin connector to the speed controller
	Failed MCOR	Test Procedure 4 – MCOR Voltage on page 18-14
Diagnostic Menu – HW FAILSAFE (Hardware Failsafe) fault code	Armature drive FET's (field-effect transistors) inside speed controller have failed	Replace the speed controller. **See Speed Controller Removal, Section 19, Page 19-9.**
	Speed controller logic malfunction	Disconnect the batteries and allow the speed controller capacitors to discharge. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.** Reconnect the batteries and see if the symptom returns.
Diagnostic Menu – MAIN WELDED (main solenoid contacts welded) fault code	solenoid contacts have failed closed	Replace solenoid. **See Solenoid Removal, Section 19, Page 19-6.**
Diagnostic Menu – MAIN DRIVER ON or MAIN DRIVER OFF fault code	Speed controller logic malfunction	Disconnect the batteries and allow the speed controller capacitors to discharge. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.** Reconnect the batteries and see if the symptom returns.
	Failure of the FET that controls the solenoid coil	Replace the speed controller. **See Speed Controller Removal, Section 19, Page 19-9.**

Troubleshooting Guide continued on next page...

TROUBLESHOOTING GUIDE 1

SYMPTOM	POSSIBLE CAUSES	CORRECTIVE ACTION
Diagnostic Menu – MAIN COIL FAULT fault code **or** **Diagnostic Menu – MAIN DROPOUT fault code**	Solenoid coil has failed in an open condition	Replace solenoid. **See Solenoid Removal, Section 19, Page 19-6.**
Diagnostic Menu – FIELD MISSING fault code	Loose or disconnected motor field coil wires at motor or speed controller or broken wire	Repair and/or connect the field coil wires
	Failure of the motor field windings	Section 22a – Motor (Model 5BC59JBS6365) or Section 22b – Motor (Model EJ4-4001)
	Failure of the FET's that control field current	Replace the speed controller. **See Speed Controller Removal, Section 19, Page 19-9.**
Diagnostic Menu – HPD (high pedal detect) fault code	Operator error	Train operators to fully remove foot from accelerator pedal before turning key switch to the ON position or changing the selected direction with the Forward/ Reverse switch
Diagnostic Menu – LOW BATTERY fault code	Batteries require charging	Place batteries on battery charger and allow them to fully charge
	Improperly maintained or failed batteries	Section 20 – Batteries: Electric VEhicles
Diagnostic Menu – OPEN ARMATURE fault code	Loose or disconnected motor armature wires at motor or speed controller or broken wire	Repair and/or connect the motor armature wires
	Failure of the motor armature or brushes	Section 22a – Motor (Model 5BC59JBS6365) or Section 22b – Motor (Model EJ4-4001)
	Failure of the FET's that control armature current	Replace the speed controller. **See Speed Controller Removal, Section 19, Page 19-9.**

Troubleshooting Guide continued on next page...

TROUBLESHOOTING GUIDE 2

TROUBLESHOOTING GUIDE 2

SYMPTOM	POSSIBLE CAUSES	CORRECTIVE ACTION
Vehicle does not operate	Batteries discharged	Charge batteries
	Improper or poor battery connections	Check vehicle wiring. **See Wiring Diagram on page 18-2.**
	Battery charger is connected to the vehicle – Solenoid lockout feature has disabled the vehicle	Disconnect the battery charger from the vehicle
	Onboard computer failure	Test Procedure 2 – Onboard Computer Solenoid Lockout Circuit on page 18-11
	Key switch and MCOR limit switch circuit	Check for loose or disconnected wires at key switch and MCOR
	Failed key switch	Test Procedure 8 – Key Switch and MCOR Limit Switch Circuit on page 18-17
	Failed MCOR	Test Procedure 8 – Key Switch and MCOR Limit Switch Circuit on page 18-17. See also Test Procedure 4 – MCOR Voltage on page 18-14.
	Forward/Reverse rocker switch	Test Procedure 15 – Forward/Reverse Rocker Switch on page 18-32
	Solenoid – loose wires	Test Procedure 3 – Solenoid Activating Coil and Diode on page 18-12
	Solenoid – failed coil	Test Procedure 3 – Solenoid Activating Coil and Diode on page 18-12
	Solenoid – failed solenoid diode	Test Procedure 3 – Solenoid Activating Coil and Diode on page 18-12
	Speed controller thermal cutback	Allow controller to cool and ensure that vehicle is not over-loaded before returning to operation
	16-pin connector at speed controller	Check for loose or disconnected wires at the 16-pin connector. **See also Test Procedure 9 – 16-Pin Connector on page 18-19.**
	High pedal detect	Cycle accelerator pedal
	Motor stall	Cycle accelerator pedal
	Motor failure	Section 22a – Motor (Model 5BC59JBS6365) or Section 22b – Motor (Model EJ4-4001)
	Failed Tow/Run switch	Test Procedure 6 – Tow/Run Switch on page 18-16
	Failed (open) diode	Test Procedure 9F – Pin 9 on page 18-25
	Speed controller failure	Replace speed controller. **See Speed Controller Removal, Section 19, Page 19-9.**

Troubleshooting Guide continued on next page...

TROUBLESHOOTING GUIDE 2

SYMPTOM	POSSIBLE CAUSES	CORRECTIVE ACTION
Vehicle runs slowly	Speed sensor disconnected or failed	Test Procedure 13 – Motor Speed Sensor on page 18-30
	Incorrect speed setting	To change the programmed top speed of the vehicle, a diagnostic and programming handset must be used
	Wiring – improperly wired	Check vehicle wiring. **See Wiring Diagram on page 18-2.**
	Batteries discharged	Charge batteries
	MCOR malfunction	Test Procedure 4 – MCOR Voltage on page 18-14
	Motor – loose wires	Inspect and tighten all wire connections at the motor
	Failed motor	Replace motor. **See Motor Removal, Section 22a, Page 22a-2 or Section 22b, page 22b-2.**
	Vehicle is over-loaded	Ensure that vehicle is not over-loaded before returning to operation
	Speed controller failure	Replace speed controller. **See Speed Controller Removal, Section 19, Page 19-9.**
	Brakes – improperly adjusted	**See Brake Adjustment, Section 6, Page 6-8.**
	Tires – under-inflated or flat tires	**See Section 8 – Wheels and Tires.**
Vehicle operates, but motor braking function does not	Wiring – improperly wired	Check vehicle wiring. **See Wiring Diagram on page 18-2.**
	Speed sensor disconnected or failed	Test Procedure 13 – Motor Speed Sensor on page 18-30
Vehicle will run in forward, but not in reverse or will run in reverse but not forward	Forward/Reverse rocker switch – improperly wired	Test Procedure 15 – Forward/Reverse Rocker Switch on page 18-32
	Motor – improperly wired	Check motor wiring. **See Wiring Diagram on page 18-2.**
	Speed controller – improperly wired or failed speed controller FET	Check vehicle wiring. **See Wiring Diagram on page 18-2.**
Vehicle operates, but battery charger does not charge batteries	Onboard computer – gray wire or fuse	Test Procedure 11 – Onboard Computer Gray Wire and Fuse on page 18-29
	Battery charger connections – loose wires at receptacle or batteries	Check wire connections and tighten if necessary.
	Battery charger	Refer to the appropriate battery charger maintenance and service manual

TEST PROCEDURES

Using the following procedures, the entire electrical system can be tested without major disassembly of the vehicle. **See following WARNING.**

⚠ WARNING

- **If wires are removed or replaced, make sure wiring and wire harness are properly routed and secured. Failure to properly route and secure wiring could result in vehicle malfunction, property damage, personal injury, or death.**

INDEX OF TEST PROCEDURES

TEST PROCEDURE 1 – BATTERIES / VOLTAGE CHECK

See General Warning, Section 1, Page 1-1.

NOTE: *The batteries must be properly maintained and fully charged in order to perform the following test procedures. Battery maintenance procedures, including watering information and allowable mineral content, can be found in Section 20 of this manual.* ***See Battery Care, Section 20, Page 20-2.***

The battery voltage can be displayed with the Diagnostic Handset. If a handset is not available, proceed to Batteries / Voltage Check without the Diagnostic Handset on page 18-11.

Batteries / Voltage Check with the Diagnostic Handset

1. Connect the handset to the vehicle as described in the handset Owner's Manual.

2. Access the Test menu and select BATT VOLTAGE by using the SCROLL DISPLAY buttons. The handset should indicate at least 48 volts with the batteries fully charged. If not, check for loose battery connections or a battery installed in reverse polarity. Refer to Section 20 – Batteries: Electric VEhicles, for further details on battery testing.

Batteries / Voltage Check without the Diagnostic Handset

1. With batteries connected and using a multimeter set to 200 volts DC, place red (+) probe on the positive (+) post of battery no. 1 and the black (–) probe on the negative (–) post of battery no. 4 **(Figure 18-3, Page 18-11)**. The multimeter should indicate at least 48 volts with the batteries fully charged. If not, check for loose battery connections or a battery installed in reverse polarity. Refer to Section 20 – Batteries: Electric VEhicles, for further details on battery testing.

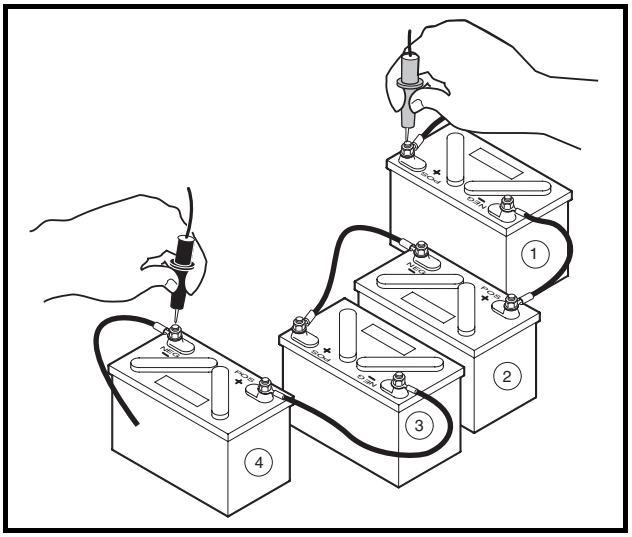


Figure 18-3 Battery Voltage Test

TEST PROCEDURE 2 – ONBOARD COMPUTER SOLENOID LOCKOUT CIRCUIT

See General Warning, Section 1, Page 1-1.

The solenoid lockout circuit disables the vehicle when the battery charger is plugged into the vehicle. Use the following procedure to test the solenoid lockout circuit:

1. With batteries connected, place the Tow/Run switch in the RUN position.

2. Set a multimeter to 200 volts DC. Place black (–) probe on battery no. 4 negative post and red (+) probe (with insulation-piercing probe) on the blue onboard computer wire (at a point between the OBC and the six-pin connector). The reading should be approximately 48-50 volts (full battery voltage). If the reading is not 48-50 volts, proceed to step 3. If the reading is 48-50 volts, proceed to Test Procedure 3 – Solenoid Activating Coil and Diode on page 18-12.

3. Place insulation-piercing probe on the light blue 18-gauge wire at a point between OBC six-pin connector and main wire harness. If reading is 48-50 volts, check the wire terminal connectors inside six-pin connector at OBC six-pin connector. Make sure pins are properly aligned inside housing. Make sure wire colors match and are connected to the correct terminals.

Batteries / Voltage Check without the Diagnostic Handset, Continued:

4. If reading is zero volts, plug the charger DC cord into the vehicle charger receptacle. If the dash light illuminates for 10 seconds, the OBC is now powered-up. Unplug the DC cord; the reading at the OBC blue wire should be approximately 48-50 volts. If the vehicle now operates normally, the DC cord has powered up the electrical system. The electrical system should also power-up when the accelerator pedal is pressed. To check the accelerator pedal function, see Test Procedure 4 – MCOR Voltage on page 18-14.
5. If the dash light illuminates for 10 seconds and the vehicle does not operate:
   5.1. Set a multimeter to 200 volts DC. Place black (–) probe on battery number 4 and place red (+) probe (with insulation-piercing probe) on blue 18-gauge wire at OBC six-pin connector.
   5.2. With Tow/Run switch in the RUN position, the voltage reading should be approximately 48 volts.
6. If the dash light does not illuminate and the vehicle does not operate, check the OBC activation circuit.
   6.1. Set a multimeter to 200 volts DC. Place the black (–) probe on the battery no. 4 negative post and place the red (+) probe (with insulation-piercing probe) on the red 18-gauge wire located on the OBC side of the six-pin connector. The reading should be approximately 48 volts. If the reading is incorrect, test the Tow/Run switch and connecting wires. **See Test Procedure 6 – Tow/Run Switch on page 18-16.**
   6.2. Set a multimeter to 200 volts DC. Place the black (–) probe on the battery no. 4 negative post and place the red (+) probe (with insulation-piercing probe) on the red 18-gauge wire (harness side of six-pin connector). Multimeter should indicate 48 volts. If voltage is correct, check connections in the six-pin connector. If connections are correct, OBC activation circuit has failed. Replace OBC.

TEST PROCEDURE 3 – SOLENOID ACTIVATING COIL AND DIODE

See General Warning, Section 1, Page 1-1.

1. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.**
2. Remove the two small wire terminals from the solenoid. **See following NOTE.**

NOTE: *Some solenoids are not equipped with a diode. If there is no diode present on the small solenoid terminals, proceed to step 5.*

3. The diode must be checked and found to be functioning correctly before the activating coil resistance can be accurately measured. The diode can only be tested using a continuity test light (CCI P/N 1011273).
   3.1. Place the probe end of the tester on the small terminal of the solenoid marked positive (+) and place the alligator clip of the tester on the wire on the other small activating coil terminal **(Figure 18-4, Page 18-13)**. The tester should illuminate, indicating continuity.
   3.2. Reverse the positions of the probe and the alligator clip **(Figure 18-5, Page 18-13)**. The tester should not illuminate. If any other reading is obtained, the diode must be replaced. If the diode is functioning correctly, proceed to step 5.

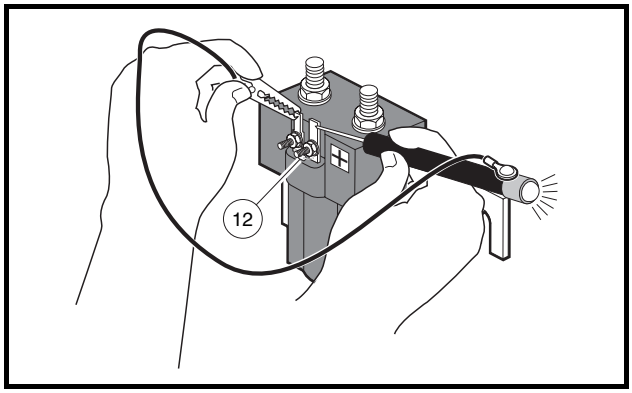


Figure 18-4 Diode Test – Probe Position One

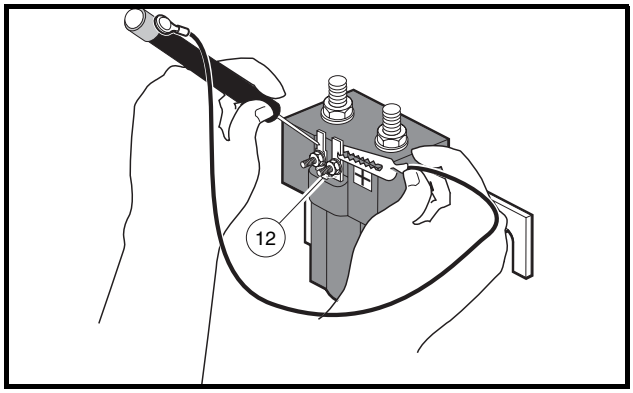


Figure 18-5 Diode Test – Probe Position Two

4. To remove the diode, carefully clip the two leads where they attach to the solenoid terminals **(Figure 18-6, Page 18-13 and Figure 18-7, Page 18-13)**. **See following NOTE.**

NOTE: *The diode must be functioning correctly before checking the resistance of the activating coil. In the case of a failed diode, the diode must be removed before the coil resistance can be checked.*

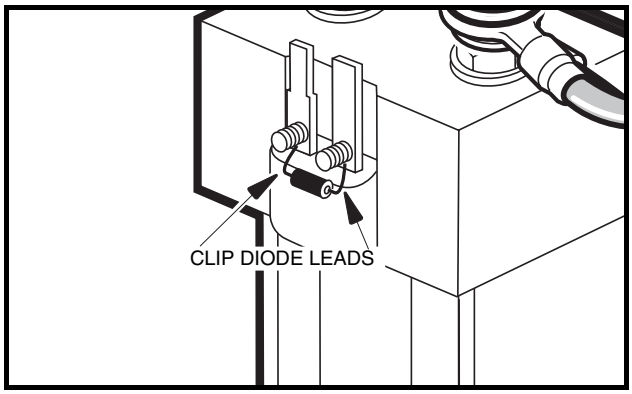


Figure 18-6 Diode Removal

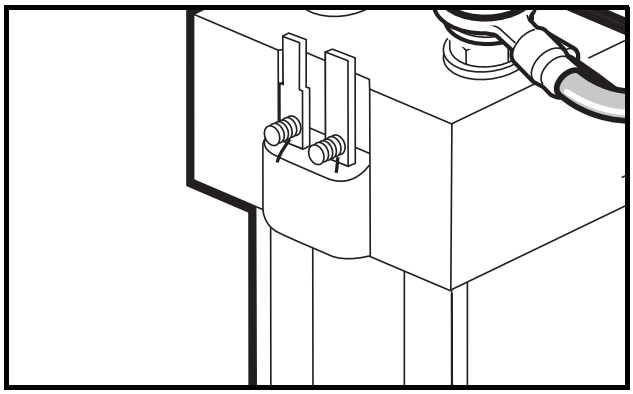


Figure 18-7 Solenoid with Diode Removed

5. Place red (+) probe of the multimeter on the positive (+) solenoid terminal. Place the black (–) probe on the other small solenoid terminal. A reading of 180 to 190 ohms should be obtained **(Figure 18-8, Page 18-13)**. If not, replace the solenoid.

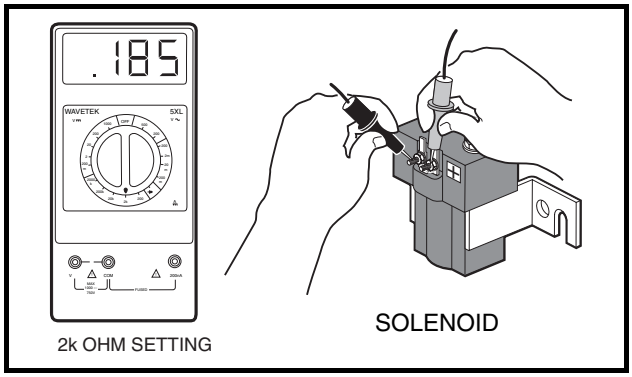


Figure 18-8 Activating Coil Test

6. If a failed diode was removed, replacement of the diode is not necessary because a diode that serves the same function is located within the speed controller.

TEST PROCEDURE 4 – MCOR VOLTAGE

See General Warning, Section 1, Page 1-1.

The accelerator position, which is proportional to the MCOR voltage, can be displayed with the diagnostic handset. If a handset is not available, proceed to MCOR Voltage Test without the Diagnostic Handset on page 18-14.

MCOR Voltage Test with the Diagnostic Handset

1. Place chocks at the front wheels and lift the rear of the vehicle with a chain hoist or floor jack. Position jack stands under the frame crossmember between the spring mount and side stringer, just forward of each rear wheel. **See WARNING "Lift only one end..." in General Warning, Section 1, Page 1-1. See following NOTE.**

NOTE: *The key switch should be placed in the OFF position and left in the OFF position for the duration of this test.*

2. Connect the handset to the vehicle as described in the Diagnostic Handset Owner's Manual.
3. Access the Test menu and select THROTTLE % by using the SCROLL DISPLAY buttons.
4. The handset should indicate 0 % with the pedal not pressed. While monitoring the handset display screen, slowly press the accelerator pedal. As the pedal is pressed, the handset should indicate a rise from 0 % (pedal not pressed) to 100 % (pedal fully pressed).
5. If the MCOR does not operate as described in step 4, proceed to MCOR Voltage Test without the Diagnostic Handset on page 18-14.

MCOR Voltage Test without the Diagnostic Handset

1. Place chocks at the front wheels and lift the rear of the vehicle with a chain hoist or floor jack. Position jack stands under the frame crossmember between the spring mount and side stringer, just forward of each rear wheel. **See WARNING "Lift only one end..." in General Warning, Section 1, Page 1-1. See following NOTE.**

NOTE: *The key switch should be placed in the OFF position and left in the OFF position for the duration of this test.*

2. With the batteries connected, place Tow/Run switch in RUN. Using a multimeter set to 200 volts DC, place red (+) probe on battery no. 1 positive post and place black (–) probe (with insulation-piercing probe) on the purple/white wire at a point close to the three-pin connector at the MCOR. The reading should be approximately 48-50 volts (full battery voltage).
3. If reading is zero volts, check the purple/white wire continuity from the three-pin connector at the MCOR to the 16-pin connector at the speed controller. Check terminal positions in three-pin connector at the MCOR and the 16-pin connector. If all of the continuity readings are correct and the connectors are wired correctly, replace the speed controller.
4. With multimeter set to 20 volts DC, place the black (–) probe on battery no. 4 negative post and the red (+) probe (with insulation-piercing probe) on the white wire at a point close to the three-pin connector at the MCOR. The reading should be approximately 4.65 volts.
5. If reading is zero volts, check the white wire continuity from the three-pin connector at the MCOR to the 16-pin connector at the speed controller. Check terminal positions in three-pin connector at the MCOR and the 16-pin connector. If all of the continuity readings are correct and the connectors are wired correctly, replace the speed controller.

6. With multimeter set to 20 volts DC, place the black (–) probe on battery no. 4 negative post and the red (+) probe (with insulation-piercing probe) on the no. 18 yellow wire at a point close to three-pin connector at the MCOR. The reading should be approximately 0.32 volts with the pedal up. Slowly press the accelerator pedal and note the readings on the multimeter. As the pedal is pressed, the reading should increase until it reaches 4.65 volts when the pedal is fully pressed.
7. If reading does not increase as the pedal is pressed, replace the MCOR.
8. If the reading is not approximately 4.60 volts with the pedal fully pressed, the vehicle will not operate at rated top speed. Check the MCOR resistance.
   8.1. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.**
   8.2. Disconnect the 16-pin connector at the speed controller.
   8.3. Set a multimeter to 20k ohms. Connect the red (+) probe of the multimeter to the yellow wire at the MCOR three-pin connector with an insulation piercing probe. Connect black (–) probe to the purple/white wire with an insulation-piercing probe.
   8.4. With the accelerator pedal fully up (not pressed), the multimeter should read approximately 1k ohms.
   8.5. Slowly press the accelerator pedal while monitoring the multimeter. The resistance should rise as the pedal is pressed. When the pedal is all the way to the floor, the multimeter should indicate between 5.67k ohms and 7.43k ohms.
   8.6. Using a multimeter set for 20k ohms, connect the red (+) probe of the multimeter to the yellow wire at the MCOR three-pin connector with an insulation piercing probe. Connect black (–) probe to the white wire with an insulation-piercing probe.
   8.7. With the accelerator pedal fully up (not pressed), the multimeter should indicate between 5.67k ohms and 7.43k ohms.
   8.8. Slowly press the accelerator pedal while monitoring the multimeter. The resistance should drop as the pedal is pressed. When the pedal is all the way to the floor, the multimeter should indicate approximately 1k ohms.
   8.9. If the MCOR does not operate as described, replace the MCOR.

TEST PROCEDURE 5 – A1 AND A2 MOTOR VOLTAGE

See General Warning, Section 1, Page 1-1.

1. Place chocks at the front wheels and lift the rear of the vehicle with a chain hoist or floor jack. Position jack stands under the frame crossmember between the spring mount and side stringer, just forward of each rear wheel. **See WARNING "Lift only one end..." in General Warning, Section 1, Page 1-1.**
2. With the batteries connected and using a multimeter set to 200 volts DC, place the black (–) probe on the A2 motor terminal (white wire) and connect the red (+) probe to the A1 (green wire) motor terminal.
3. With Tow/Run switch in the RUN position, place the Forward/Reverse switch in the FORWARD position, turn key switch to the ON position and slowly press accelerator pedal.
4. As the accelerator pedal is pressed, the voltage reading should increase from approximately 5 volts RMS when the MCOR limit switch closes, to approximately 48 volts RMS with the accelerator pedal fully pressed.
   4.1. If there is no voltage reading, check the MCOR. **See Test Procedure 4 – MCOR Voltage on page 18-14.** Also check the continuity of the large posts of the solenoid. **See Test Procedure 14 – Solenoid Continuity on page 18-31.**
   4.2. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.**
   4.3. Check continuity on A1 and A2 motor terminal posts and continuity of the F1 and F2 motor terminal posts. Also, check continuity of all motor wires. **See Section 22a – Motor (Model 5BC59JBS6365) or Section 22b – Motor (Model EJ4-4001).**

TEST PROCEDURE 6 – TOW/RUN SWITCH

See General Warning, Section 1, Page 1-1.

Tow/Run Switch Test with the Diagnostic Handset

1. With the Tow/Run switch in the RUN position, connect the handset to the vehicle as described in the Diagnostic Handset Owner's Manual.
2. Immediately after the handset is connected to the vehicle, the screen should display a copyright notice and the Diagnostic Handset model number.
3. If the handset display screen is blank, drive the vehicle a short distance to activate the onboard computer.
4. If the vehicle will not operate, proceed to Tow/Run Switch Test without the Diagnostic Handset.
5. If the handset display screen begins to work after the vehicle has been driven, turn the key switch to the OFF position and proceed to step 6; otherwise, perform the following procedure, Tow/Run Switch Test without the Diagnostic Handset.
6. With the handset still connected to the vehicle, place the Tow/Run Switch in the TOW position and wait 90 seconds.
7. If the handset display screen goes blank after 90 seconds, the Tow/Run switch and connecting wires are operating correctly.
8. If the handset display screen is still active after 90 seconds, the switch has failed closed. Replace the Tow/Run switch. **See Tow/Run Switch Removal, Section 19, Page 19-3.**

Tow/Run Switch Test without the Diagnostic Handset

1. Set a multimeter to 200 volts DC and with the batteries connected, connect the black (–) probe to the negative post of battery no. 4 and connect red (+) probe (with insulation-piercing probe) on the light green wire close to the two-pin connector on the Tow/Run switch.
2. With the Tow/Run switch in the RUN position, the reading should be approximately 48-50 volts. With the switch in the TOW position, the reading should be below approximately 5 volts.
3. If the reading is above 5 volts with the switch in the TOW position, replace the switch.
4. If the reading is below 5 volts with switch in the RUN position, check continuity of the two-pin connector and the pink 18-gauge wire from the large post of the solenoid to the two-pin connector at the Tow/Run switch.
5. If the two-pin connector and pink wire continuity readings are correct, replace the Tow/Run switch.
6. If replacement of the Tow/Run switch does not correct the problem, check the diode on Pin 9. **See Test Procedure 9F – Pin 9 on page 18-25.**

TEST PROCEDURE 7 – BATTERY PACK VOLTAGE (UNDER LOAD)

See General Warning, Section 1, Page 1-1.

1. Before proceeding with this test procedure, the batteries must be connected and fully charged. Connect the positive (+) lead of a 36 to 48-volt battery discharge machine (CCI P/N 101831901), to battery no. 1 positive post and connect the negative (–) lead to battery no. 4 negative post. Record the voltage reading from discharge machine.
2. Turn the discharge machine on and record the voltage reading of battery pack while under load.
3. A fully charged set of batteries in good condition should read between 46-49 volts while under load.
4. A reading of 32-46 volts indicates discharged or failed batteries. Each battery should be checked with a multimeter while under load.

5. A reading of 32 volts or less will not activate discharge machine. If the voltage of the batteries is below 32 volts, the batteries are deeply discharged or have failed.
6. Recording the battery pack voltage reading while under load provides a more accurate diagnosis of the condition of the batteries. When the discharge machine is ON, it places the battery pack under load and many times can help determine if one or more batteries in the set have failed. Testing battery voltage while the batteries are not under load will not always indicate the true condition of the batteries. For more information about the batteries, refer to Section 20 – Batteries: Electric VEhicles.

TEST PROCEDURE 8 – KEY SWITCH AND MCOR LIMIT SWITCH CIRCUIT

See General Warning, Section 1, Page 1-1.

Key Switch and MCOR Limit Switch Circuit Test with the Diagnostic Handset

1. Place chocks at the front wheels and lift the rear of the vehicle with a chain hoist or floor jack. Position jack stands under the frame crossmember between the spring mount and side stringer, just forward of each rear wheel. **See WARNING "Lift only one end..." in General Warning, Section 1, Page 1-1.**
2. Turn the key switch to the OFF position and place the Forward/Reverse switch in the NEUTRAL position.
3. Connect the handset to the vehicle as described in the Diagnostic Handset Owner's Manual.
4. Test the key switch.
   4.1. Access the Test menu, and select KEY INPUT by using the SCROLL DISPLAY buttons. The handset should indicate OFF when the key switch is in the OFF position.
   4.2. While monitoring the handset display screen, turn the key switch to the ON position. The handset should indicate ON.
   4.3. If the handset does not indicate that KEY INPUT is ON when the key switch is in the ON position, proceed to the following procedure, Key Switch and MCOR Limit Switch Circuit Test without the Diagnostic Handset. If the key switch functions as described, proceed to the following step. **See following NOTE.**

NOTE: *The key switch MUST function properly in order to test the MCOR limit switch with the diagnostic handset.*

5. Test the MCOR limit switch.
   5.1. Select FOOT INPUT on the Test menu by using the SCROLL DISPLAY buttons on the handset.
   5.2. The handset should indicate that FOOT INPUT is OFF when the accelerator pedal is not pressed, regardless of the key switch position.
   5.3. With the key switch in the ON position, press the accelerator pedal. The handset should indicate that FOOT INPUT is ON when the accelerator pedal is pressed.
6. If any reading is obtained that is not described in steps 4 and 5, perform the following steps:
   6.1. Check the pedal group for proper adjustment. **See Section 5 – Pedal Group Adjustment – Electric Vehicles.**
   6.2. Check the wiring of the key switch and MCOR. **See Wiring Diagram on page 18-2.**
   6.3. Check the continuity of the key switch wires and the MCOR limit switch wires.
7. If the problem was not found, proceed to the following procedure, Key Switch and MCOR Limit Switch Circuit Test without the Diagnostic Handset on page 18-18.

Key Switch and MCOR Limit Switch Circuit Test without the Diagnostic Handset

1. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.**
2. Place chocks at the front wheels and lift the rear of the vehicle with a chain hoist or floor jack. Position jack stands under the frame crossmember between the spring mount and side stringer, just forward of each rear wheel.
3. Turn the key switch to the OFF position and place the Forward/Reverse switch in the NEUTRAL position.
4. Test the key switch.
   - 4.1. Remove the instrument panel. **See step 2 of Key Switch Removal, Section 19, Page 19-1.**
   - 4.2. Set a multimeter to 200 ohms. Place the red (+) probe on the key switch terminal with the blue wire. Place the black (–) probe on the other key switch terminal.
   - 4.3. With the key switch in the OFF position, the multimeter should indicate that continuity is not present.
   - 4.4. With the key switch in the ON position, the multimeter should indicate that continuity is present.
   - 4.5. If any other reading is obtained, replace the key switch. **See Key Switch Removal, Section 19, Page 19-1.**
   - 4.6. If the key switch operates as described in the previous steps, install the dash panel in the reverse order of removal and proceed to the following step.
5. Test the MCOR limit switch. **See following NOTE.**

NOTE: *Make sure that the key switch is operating correctly and that the key switch and dash panel are properly installed before proceeding.*

- 5.1. With batteries connected and using a multimeter set to 200 volts DC, place the black (–) probe on the battery no. 4 negative post and place the red (+) probe (with insulation-piercing probe) on the green wire close to the two-pin connector on the MCOR.
- 5.2. With Tow/Run switch in the RUN position, key switch in the ON position, and Forward/Reverse rocker switch in the NEUTRAL position, the voltage reading should be zero volts. When the accelerator pedal is pressed, the voltage reading should be approximately 48 volts (full battery voltage).
- 5.3. If the voltage reading is 48 volts when the accelerator pedal is not pressed, check the pedal group for proper adjustment. **See Section 5 – Pedal Group Adjustment – Electric Vehicles.**
- 5.4. If the voltage reading is zero volts when the accelerator pedal is pressed, check the limit switch circuit using the following test procedures.
  - 5.4.1. Set a multimeter to 200 volts DC. Place black (–) probe on battery no. 4 negative post and the place red (+) probe (with insulation-piercing probe) on the blue wire where it connects to the MCOR. With the key switch ON, the reading should be approximately 48 volts (full battery voltage).
  - 5.4.2. If the reading is zero volts, check the continuity of the blue wire that goes from the key switch to the MCOR.
  - 5.4.3. If the reading is approximately 48 volts, proceed to the following step.
  - 5.4.4. Set a multimeter to 200 volts DC. Place the black (–) probe on the battery no. 4 negative post and place the red (+) probe (with insulation-piercing probe) on the green wire where it connects to the MCOR. With the Tow/Run switch in the RUN position, the key switch ON, the Forward/Reverse rocker switch in NEUTRAL and the accelerator pedal pressed, the reading should be approximately 48 volts (full battery voltage).
  - 5.4.5. If the reading is zero volts, test the continuity of the MCOR limit switch and the green wire. If the limit switch does not pass the continuity test, replace the MCOR. **See MCOR Removal, Section 19, Page 19-5.**

TEST PROCEDURE 9 – 16-PIN CONNECTOR

See General Warning, Section 1, Page 1-1.

1. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.**
2. Disconnect the 16-pin connector from the speed controller. Inspect terminal ends inside plug to ensure they are in position and seated in plug housing. If any terminals look like they are not pushed all the way into the connector, gently push the terminals until they are firmly seated in the 16-pin connector. After each terminal has been pushed into the housing, gently pull on the wire to ensure it is locked into place.
3. Check wires in the plug to make sure none are broken at the terminal pin crimp. Repair or replace as required.
4. Check the wire colors of each wire and make sure that the colors for each pin position match the wire colors in the wiring diagram. **See Wiring Diagram on page 18-2.**
5. When connecting the 16-pin connector to the controller, push plug into controller receptacle with enough force to lock plug into place. An audible click will be heard when plug is properly seated to the controller.

A procedure is provided for testing each of the wires in the 16-pin connector. Refer to the following chart for the appropriate procedure for each pin in the 16-pin connector.

If the results of any of the referenced procedures are different from those described in the procedure, check the continuity of the wires in the wire harness and test the connected components with the appropriate test procedures. **See Index of Test Procedures on page 18-10.**

SPEED CONTROLLER 16-PIN CONNECTOR WIRE	TEST PROCEDURE
Pin 1 – White (18-gauge)	Test Procedure 9A – Pins 1, 2, and 3 on page 18-20
Pin 2 – Yellow (18-gauge)	
Pin 3 – Purple/White (18-gauge)	
Pin 4 – Green/White (18-gauge)	Reserved for future use. Wire serves no function at this time
Pin 5 – Light Blue (18-gauge)	Test Procedure 9B – Pin 5 on page 18-21
Pin 6 – Green (18-gauge)	Test Procedure 9C – Pin 6 on page 18-22
Pin 7 – Orange/White (18-gauge)	Test Procedure 9D – Pin 7 on page 18-23
Pin 8 – Brown (18-gauge)	Test Procedure 9E – Pins 8 and 16 on page 18-24
Pin 9 – Gray (18-gauge) with diode	Test Procedure 9F – Pin 9 on page 18-25
Pin 10 – Tan (18-gauge)	Test Procedure 9G – Pin 10 on page 18-27
Pin 11 – Open (no wire)	
Pin 12 – Blue/White (18-gauge)	Test Procedure 9H – Pin 12 on page 18-28
Pin 13 – Black/White (18-gauge)	Test continuity of each wire and perform Test Procedure 13 – Motor Speed Sensor on page 18-30
Pin 14 – Light Green (18-gauge)	
Pin 15 – Red (18-gauge)	
Pin 16 – Blue (18-gauge)	Test Procedure 9E – Pins 8 and 16 on page 18-24

Test Procedure 9A – Pins 1, 2, and 3

See General Warning, Section 1, Page 1-1.

Pins 1, 2, and 3 in the 16-pin connector provide a connection point from the MCOR potentiometer to the speed controller.

1. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.**
2. Place chocks at the front wheels and lift the rear of the vehicle with a chain hoist or floor jack. Position jack stands under the frame crossmember between the spring mount and side stringer, just forward of each rear wheel. **See WARNING "Lift only one end..." in General Warning, Section 1, Page 1-1.**
3. Disconnect the 16-pin connector at the speed controller.
4. Set a multimeter to 20k ohms. Insert the red (+) probe of the multimeter into pin 2 (yellow wire) of the 16-pin connector. **See following CAUTION.** Insert the black (–) probe into pin 3 (purple/white wire) of the 16-pin connector **(Figure 18-9, Page 18-20)**.

CAUTION

- **Do not fully insert probes into the 16-pin plug. Doing so can result in a poor connection.**

5. With the accelerator pedal fully up (not pressed), the multimeter should read approximately 1k ohms.
6. Slowly press the accelerator pedal while monitoring the multimeter. The resistance should rise as the pedal is pressed. When the pedal is all the way to the floor, the multimeter should indicate between 5.67k ohms and 7.43k ohms.
7. Set a multimeter to 20k ohms. Insert the red (+) probe of the multimeter into pin 2 (yellow wire) at the 16-pin connector. Connect the black (–) probe into pin 1 (white wire). **See previous CAUTION.**
8. With the accelerator pedal fully up (not pressed), the multimeter should indicate between 5.67k ohms and 7.43k ohms.
9. Slowly press the accelerator pedal while monitoring the multimeter. The resistance should drop as the pedal is pressed. When the pedal is all the way to the floor, the multimeter should indicate approximately 1k ohms.
10. If any other reading is observed, check the continuity of the wires in the wire harness.

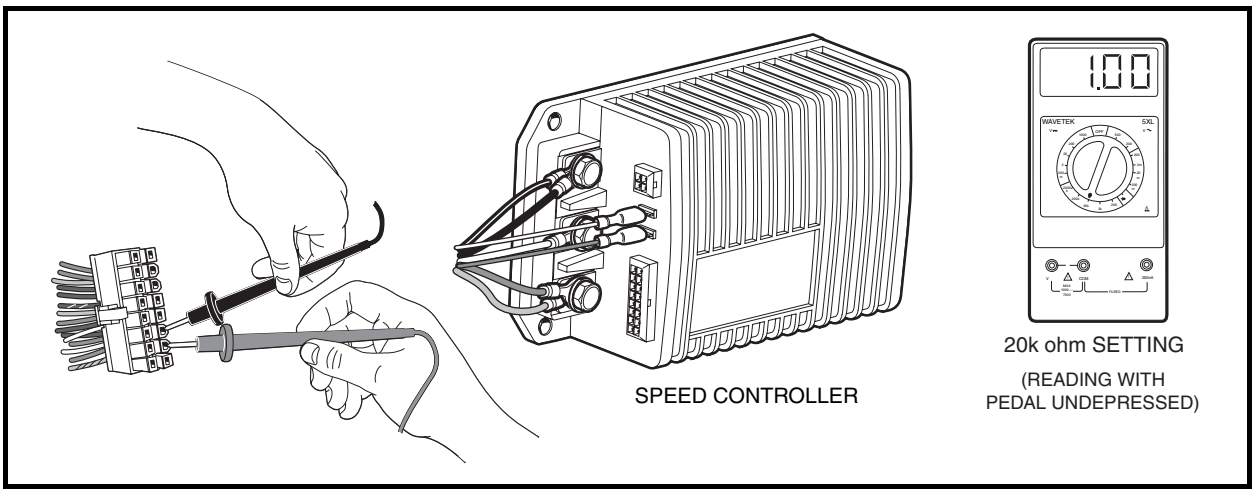


Figure 18-9 Pins 1, 2, and 3 Test

Test Procedure 9B – Pin 5

See General Warning, Section 1, Page 1-1.

Pin 5 in the 16-pin connector provides a connection point for the solenoid lockout circuit from the onboard computer to the speed controller.

1. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.**
2. Place chocks at the front wheels and lift the rear of the vehicle with a chain hoist or floor jack. Position jack stands under the frame crossmember between the spring mount and side stringer, just forward of each rear wheel. **See WARNING "Lift only one end..." in General Warning, Section 1, Page 1-1.**
3. Disconnect the 16-pin connector at the speed controller.
4. Set a multimeter to 200 volts DC. Insert the red (+) probe of the multimeter into pin 5 (light blue wire) of the 16-pin connector. **See following CAUTION.** Using an alligator clip, connect the black (–) probe to the B– terminal of the speed controller **(Figure 18-10, Page 18-21)**.

CAUTION

- **Do not fully insert probes into the 16-pin plug. Doing so can result in a poor connection.**

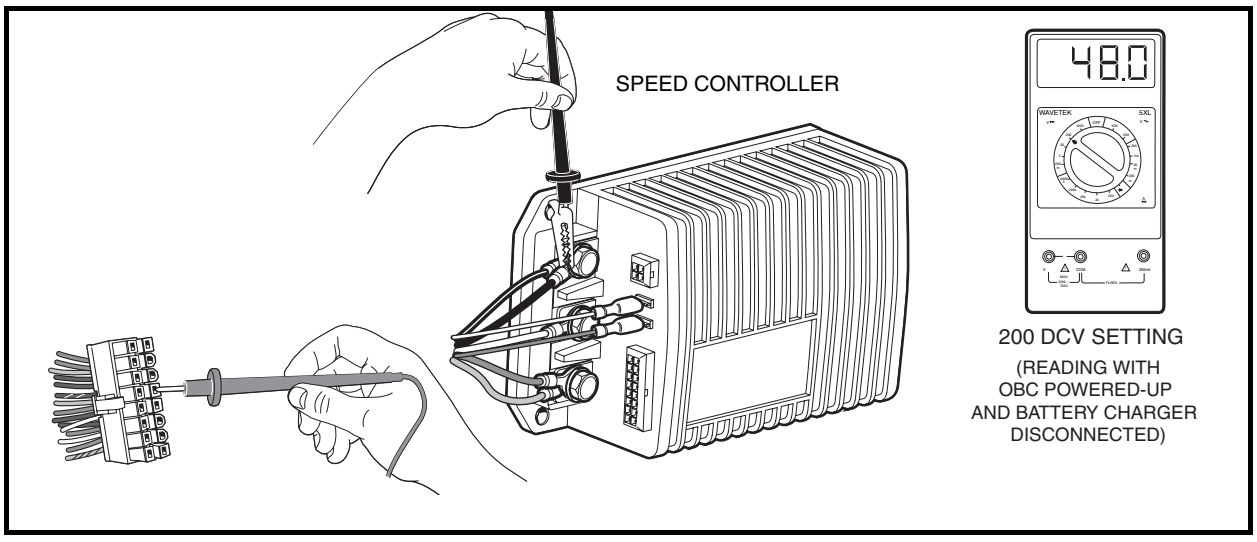


Figure 18-10 Pin 5 Test

5. Place the Tow/Run switch in the TOW position and connect the battery cables, positive (+) cable first. Tighten battery terminals to 110 in-lb (12.4 N·m).
6. Place the Tow/Run switch in the RUN position.
7. The multimeter should indicate zero volts DC at this time.
8. While monitoring the multimeter, plug the battery charger into the vehicle charger receptacle.
9. After a short delay, the onboard computer should power-up (come out of sleep mode), charger relay should click, and the ammeter on the charger should indicate that the vehicle batteries are being charged.
10. The multimeter should indicate zero volts DC while the charger is connected to the vehicle.

Test Procedure 9B – Pin 5, Continued:

11. While observing the multimeter, disconnect the DC plug from the vehicle charger receptacle.
12. The multimeter should indicate full battery voltage when the charger is not connected to the vehicle.
13. If any other reading is obtained, check the following items:
    - Continuity of the wires in the wire harness
    - Onboard computer for proper operation. **See Test Procedure 11 – Onboard Computer Gray Wire and Fuse on page 18-29.**
    - Tow/Run switch for proper operation. **See Test Procedure 6 – Tow/Run Switch on page 18-16.**

Test Procedure 9C – Pin 6

See General Warning, Section 1, Page 1-1.

Pin 6 in the 16-pin connector provides a connection point for the MCOR limit switch to the speed controller.

1. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.**
2. Place chocks at the front wheels and lift the rear of the vehicle with a chain hoist or floor jack. Position jack stands under the frame crossmember between the spring mount and side stringer, just forward of each rear wheel. **See WARNING "Lift only one end..." in General Warning, Section 1, Page 1-1.**
3. Disconnect the 16-pin connector at the speed controller.
4. Set a multimeter to 200 volts DC, insert the red (+) probe of the multimeter into pin 6 (green wire) of the 16-pin connector. **See following CAUTION.** Using an alligator clip, connect the black (–) probe to the B– terminal of the speed controller **(Figure 18-11, Page 18-22)**.

CAUTION

- **Do not fully insert probes into the 16-pin plug. Doing so can result in a poor connection.**

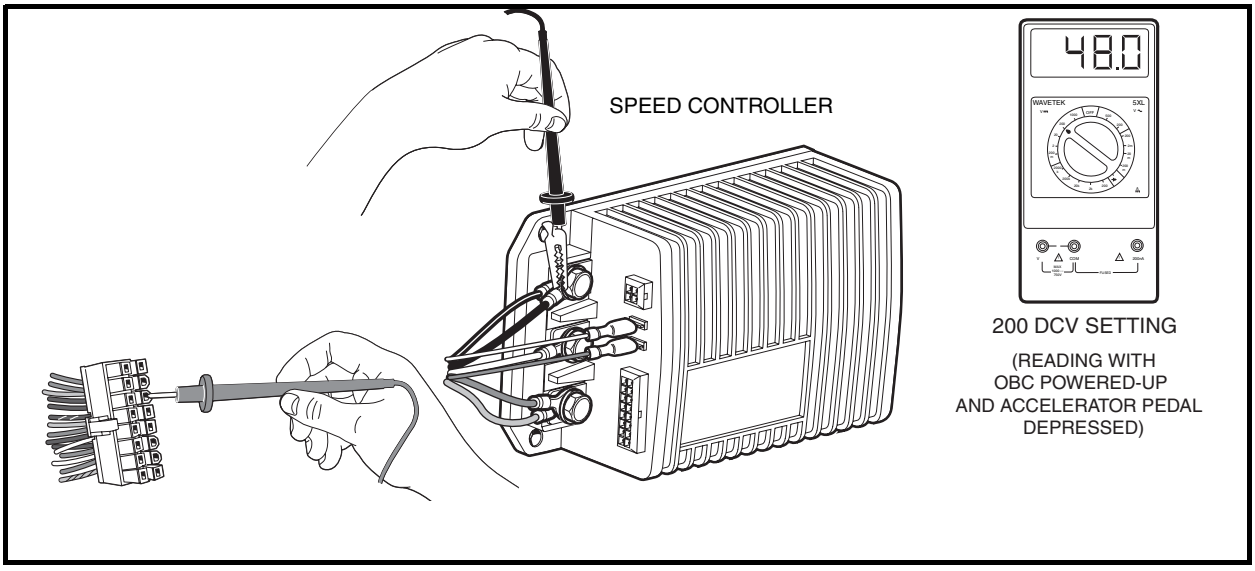


Figure 18-11 Pin 6 Test

5. Place the Tow/Run switch in the TOW position and connect the battery cables, positive (+) cable first. Tighten battery terminals to 110 in-lb (12.4 N·m).
6. Place the Tow/Run switch in the RUN position, key switch in the ON position, and Forward/Reverse switch in the FORWARD position.
7. The multimeter should indicate zero volts DC at this time.
8. While monitoring the multimeter, slowly press the accelerator pedal and hold the pedal at approximately 20% of full travel.
9. After a short delay, the onboard computer should power-up (come out of sleep mode).
10. The multimeter should indicate full battery voltage (approximately 48 volts) when the accelerator pedal is pressed.
11. While observing the multimeter, release the accelerator pedal.
12. The multimeter should indicate zero volts when the accelerator pedal is not pressed.
13. If any other reading is obtained, check the following items:
    - Continuity of the wires in the wire harness
    - Onboard computer for proper operation. **See Test Procedure 11 – Onboard Computer Gray Wire and Fuse on page 18-29.**
    - Tow/Run switch for proper operation. **See Test Procedure 6 – Tow/Run Switch on page 18-16.**
    - Key switch and MCOR limit switch for proper operation. **See Test Procedure 8 – Key Switch and MCOR Limit Switch Circuit on page 18-17.**
    - Ensure that the pedal group is adjusted correctly. **See Pedal Group Adjustment – Electric Vehicles, Section 5, Page 5-16.**

Test Procedure 9D – Pin 7

See General Warning, Section 1, Page 1-1.

Pin 7 in the 16-pin connector provides a connection point for the reverse buzzer to the speed controller.

1. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.**
2. Place chocks at the front wheels and lift the rear of the vehicle with a chain hoist or floor jack. Position jack stands under the frame crossmember between the spring mount and side stringer, just forward of each rear wheel. **See WARNING "Lift only one end..." in General Warning, Section 1, Page 1-1.**
3. Disconnect the 16-pin connector at the speed controller.
4. Place a jumper wire with an alligator clip between the B– terminal of the speed controller (use alligator clip for this connection) and pin 7 (orange/white wire) of the 16-pin connector **(Figure 18-12, Page 18-24)**. **See following CAUTION.**

CAUTION

- **Do not fully insert probes into the 16-pin plug. Doing so can result in a poor connection.**

5. Place the Tow/Run switch in the TOW position and connect the battery cables, positive (+) cable first. Tighten battery terminals to 110 in-lb (12.4 N·m).
6. Place the Tow/Run switch in the RUN position.
7. The reverse buzzer should sound when the Tow/Run switch is in the RUN position.

Key Switch and MCOR Limit Switch Circuit Test without the Diagnostic Handset, Continued:

8. If any other activity is observed, check the following items:
   - Continuity of the wires in the wire harness
   - Reverse buzzer for proper operation. **See Test Procedure 16 – Reverse Buzzer on page 18-33.**
   - Tow/Run switch for proper operation. **See Test Procedure 6 – Tow/Run Switch on page 18-16.**

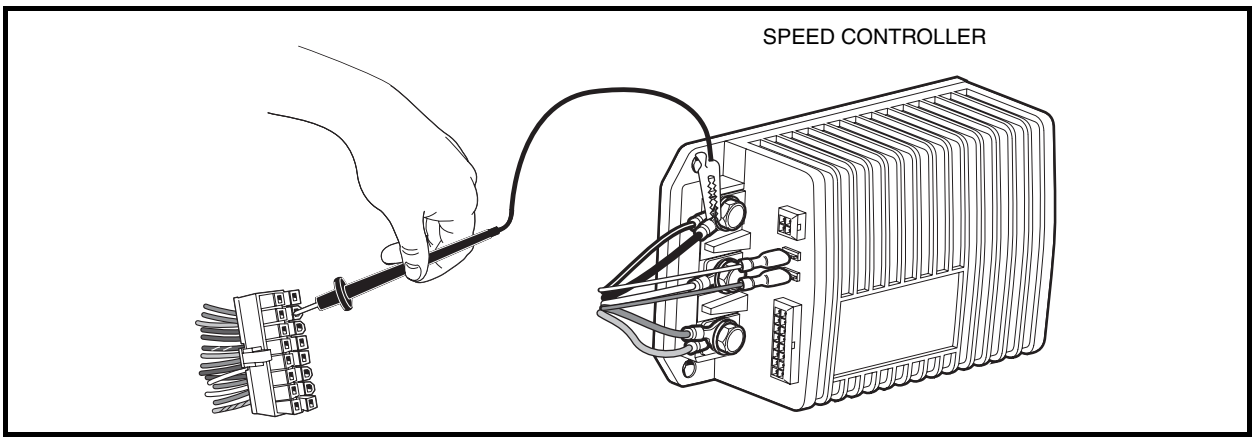


Figure 18-12 Pin 7 Test

Test Procedure 9E – Pins 8 and 16

See General Warning, Section 1, Page 1-1.

Pins 8 and 16 in the 16-pin connector provide a connection point for the Forward/Reverse rocker switch to the speed controller. The switch provides a +48 volt signal to the speed controller through pin 8 when the Forward/Reverse switch is in the FORWARD position and provides a +48 volt signal on pin 16 when the Forward/Reverse switch is in the REVERSE position.

1. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.**
2. Place chocks at the front wheels and lift the rear of the vehicle with a chain hoist or floor jack. Position jack stands under the frame crossmember between the spring mount and side stringer, just forward of each rear wheel.
3. Disconnect the 16-pin connector at the speed controller.
4. Set a multimeter to 200 volts DC, insert the red (+) probe of the multimeter into pin 8 (brown wire) of the 16-pin connector. **See following CAUTION.** Using an alligator clip, connect the black (–) probe to the B– terminal of the speed controller **(Figure 18-13, Page 18-25)**.

CAUTION

- **Do not fully insert probes into the 16-pin plug. Doing so can result in a poor connection.**

5. Place the Tow/Run switch in the TOW position and connect the battery cables, positive (+) cable first. Tighten battery terminals to 110 in-lb (12.4 N·m).
6. Place the Tow/Run switch in the RUN position and the Forward/Reverse switch in the NEUTRAL position. The multimeter should indicate zero volts DC at this time.

7. While monitoring the multimeter, place the Forward/Reverse switch in the REVERSE position. The multimeter should still indicate zero volts.
8. Place the Forward/Reverse switch in the FORWARD position. The multimeter should indicate full battery voltage (approximately 48 volts).
9. Insert the red (+) probe of the multimeter into pin 16 (blue wire) of the 16-pin connector. Leave the black (–) probe (alligator clip) connected to the B– terminal of the speed controller. **See previous CAUTION.**
10. Place the Forward/Reverse switch in the NEUTRAL position. The multimeter should indicate zero volts DC at this time.
11. While monitoring the multimeter, place the Forward/Reverse switch in the FORWARD position. The multimeter should still indicate zero volts.
12. Place the Forward/Reverse switch in the REVERSE position. The multimeter should indicate full battery voltage (approximately 48 volts).
13. If any other reading is obtained, check the following items:
    - Continuity of the wires in the wire harness
    - Forward/Reverse switch for proper operation. **See Test Procedure 15 – Forward/Reverse Rocker Switch on page 18-32.**
    - Tow/Run switch for proper operation. **See Test Procedure 6 – Tow/Run Switch on page 18-16.**

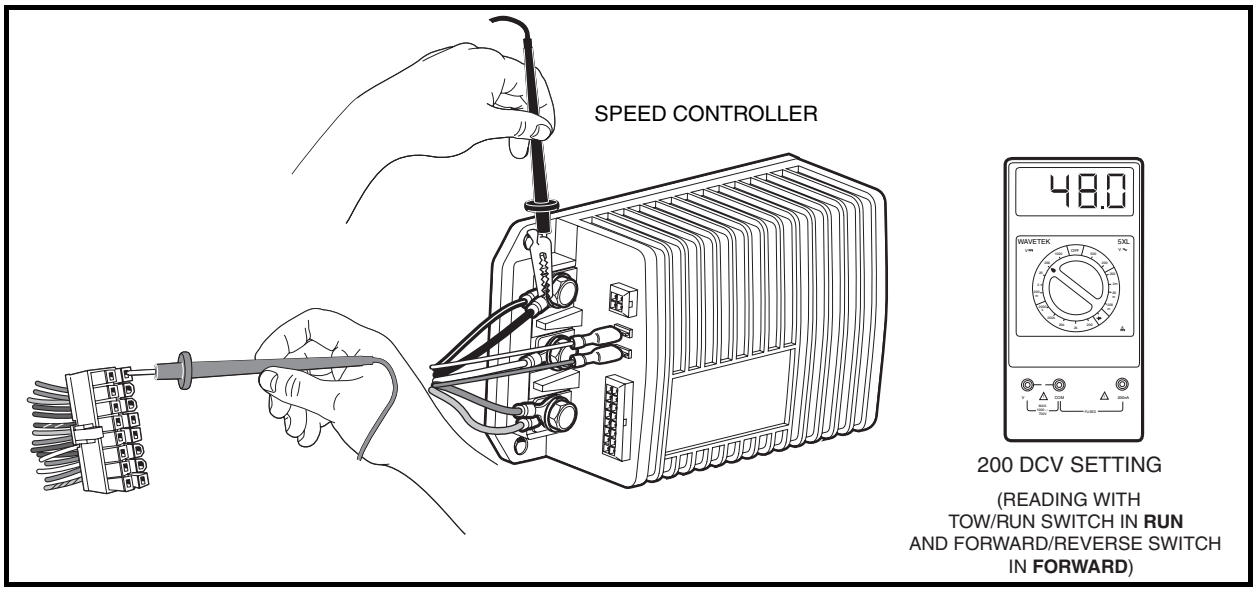


Figure 18-13 Pins 8 and 16 Test

Test Procedure 9F – Pin 9

See General Warning, Section 1, Page 1-1.

Pin 9 in the 16-pin connector provides a connection point for the Tow/Run switch to the speed controller. The switch provides a +48 volt signal to the speed controller through pin 9 when the Tow/Run switch is in the RUN position.

NOTE: *There is a diode in the wire connected at Pin 9.*

Test Procedure 9F – Pin 9, Continued:

1. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.**
2. Place chocks at the front wheels and lift the rear of the vehicle with a chain hoist or floor jack. Position jack stands under the frame crossmember between the spring mount and side stringer, just forward of each rear wheel. **See WARNING "Lift only one end..." in General Warning, Section 1, Page 1-1.**
3. Disconnect the 16-pin connector at the speed controller.
4. With the multimeter set to the diode test function (→|←), connect the black (–) probe of the multimeter to the light green wire terminal of the two-pin connector at the Tow/Run switch and the red (+) probe of the multimeter to the pin 9 terminal **(Figure 18-14, Page 18-26)**. **See following CAUTION**. The reading should indicate an overload (no continuity). A diode is designed to conduct current in one direction only. If a diode conducts current (shows continuity) with the meter probes as described, the diode has failed and must be removed from the wire harness. **See Pin 9 Diode Removal, Section 19, Page 19-13.**

CAUTION

- **Do not fully insert probes into the 16-pin plug. Doing so can result in a poor connection.**

5. Reverse the multimeter probes and note the reading. With the black (–) probe of the multimeter on the pin 9 terminal of the multi-pin connector and the red (+) probe of the multimeter on the light green wire at the Tow/Run switch, the meter should read approximately 500 mV, however, a range of 400-600 mV is acceptable **(Figure 18-15, Page 18-26)**.

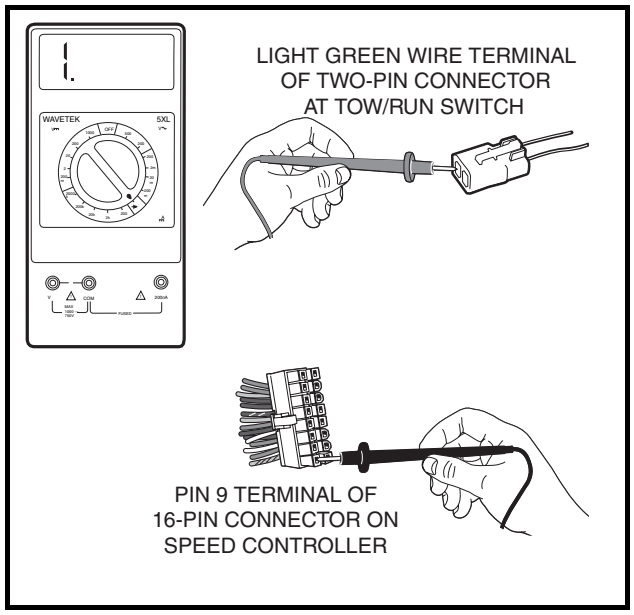


Figure 18-14 Diode Test

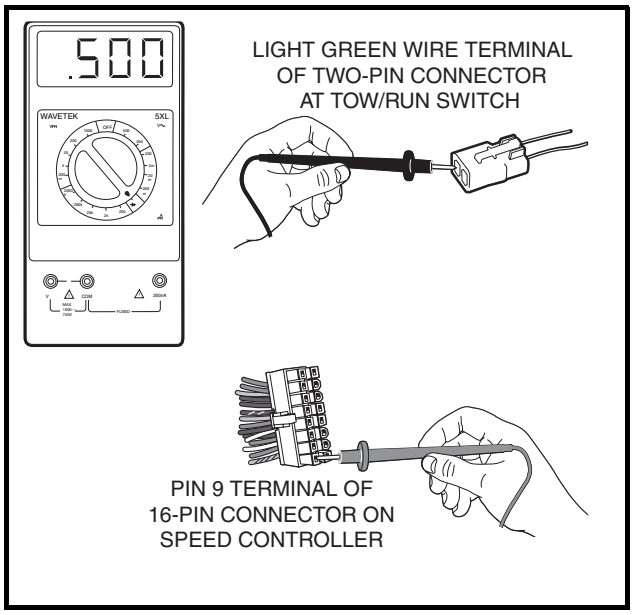


Figure 18-15 Diode Test – Probes Reversed

6. If any other reading is obtained, check the following items:
   - Continuity of the wires in the wire harness
   - Tow/Run switch for proper operation. **See Test Procedure 6 – Tow/Run Switch on page 18-16.**
7. If items in step 6 test out okay, the diode has failed open and should be removed from the harness. **See Pin 9 Diode Removal, Section 19, Page 19-13.**

Test Procedure 9G – Pin 10

See General Warning, Section 1, Page 1-1.

Pin 10 in the 16-pin connector provides a connection point for the key switch to the speed controller. The key switch provides a +48 volt signal to the speed controller through pin 10 when the key switch is in the ON position.

1. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.**
2. Place chocks at the front wheels and lift the rear of the vehicle with a chain hoist or floor jack. Position jack stands under the frame crossmember between the spring mount and side stringer, just forward of each rear wheel. **See WARNING "Lift only one end..." in General Warning, Section 1, Page 1-1.**
3. Disconnect the 16-pin connector at the speed controller.
4. With a multimeter set for 200 volts DC, insert the red (+) probe of the multimeter into pin 10 (tan wire) of the 16-pin connector. **See following CAUTION.** With an alligator clip, connect the black (–) probe to the B– terminal of the speed controller **(Figure 18-16, Page 18-27)**.

CAUTION

- **Do not fully insert probes into the 16-pin plug. Doing so can result in a poor connection.**

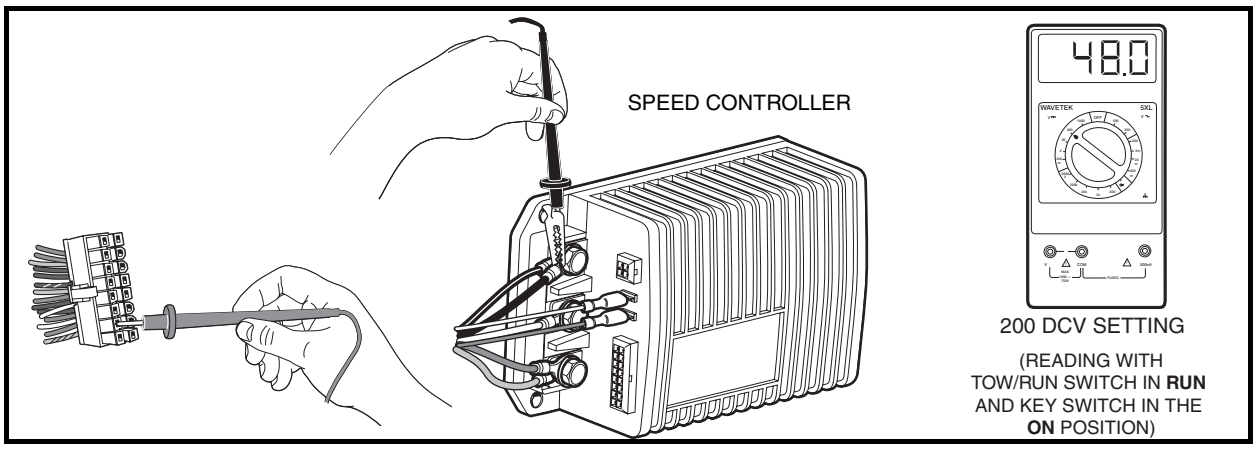


Figure 18-16 Pin 10 Test

5. Place the Tow/Run switch in the TOW position and connect the battery cables, positive (+) cable first. Tighten battery terminals to 110 in-lb (12.4 N·m).
6. With the Tow/Run switch in the TOW position, the multimeter should indicate zero volts.
7. Place the Tow/Run switch in the RUN position and the key switch in the ON position.
8. With the key switch in the ON position, the multimeter should indicate full battery voltage (approximately 48 volts). With the key switch in the OFF position, the reading should be zero volts.
9. If any other reading is obtained, check the following items:
   - Continuity of the wires in the wire harness
   - Tow/Run switch for proper operation. **See Test Procedure 6 – Tow/Run Switch on page 18-16.**
   - Key switch for proper operation. **See Test Procedure 8 – Key Switch and MCOR Limit Switch Circuit on page 18-17.**

Test Procedure 9H – Pin 12

See General Warning, Section 1, Page 1-1.

Pin 12 in the 16-pin connector provides a connection point for the solenoid coil to the speed controller. The speed controller activates the solenoid coil by providing a ground to the solenoid coil at the appropriate time.

1. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.**
2. Place chocks at the front wheels and lift the rear of the vehicle with a chain hoist or floor jack. Position jack stands under the frame crossmember between the spring mount and side stringer, just forward of each rear wheel. **See WARNING "Lift only one end..." in General Warning, Section 1, Page 1-1.**
3. Disconnect the 16-pin connector at the speed controller.
4. Place a jumper wire with an alligator clip between the B– terminal of the speed controller (use alligator clip for this connection) and pin 12 (blue/white wire) of the 16-pin connector **(Figure 18-17, Page 18-28)**. **See following CAUTION.**

CAUTION

- **Do not fully insert probes into the 16-pin plug. Doing so can result in a poor connection.**

5. Place the Tow/Run switch in the TOW position and connect the battery cables, positive (+) cable first. Tighten battery terminals to 110 in-lb (12.4 N·m).
6. Place the Tow/Run switch in the RUN position and the key switch in the ON position.
7. The solenoid should click when the key switch is placed in the ON position.
8. If any other activity is observed, check the following items:

- Continuity of the wires in the wire harness.
- Reverse buzzer for proper operation. **See Test Procedure 16 – Reverse Buzzer on page 18-33.**
- Tow/Run switch for proper operation. **See Test Procedure 6 – Tow/Run Switch on page 18-16.**
- Key switch for proper operation. **See Test Procedure 8 – Key Switch and MCOR Limit Switch Circuit on page 18-17.**
- Solenoid for proper operation. **See Test Procedure 14 – Solenoid Continuity on page 18-31.**

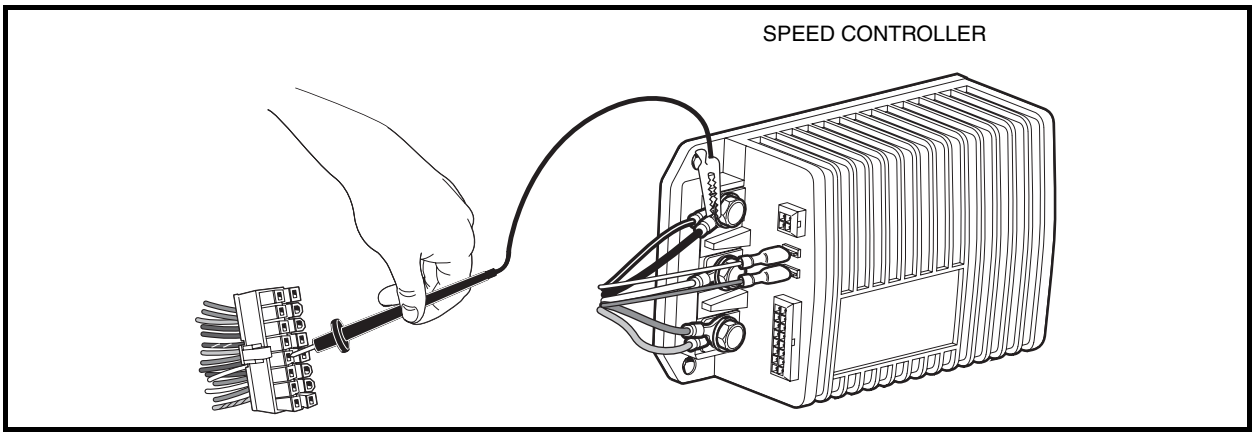


Figure 18-17 Pin 12 Test

TEST PROCEDURE 10 – ONBOARD COMPUTER SILICON-CONTROLLED RECTIFIER (SCR) CIRCUIT

See General Warning, Section 1, Page 1-1.

The silicon controlled rectifier (SCR), located inside the onboard computer, acts as a switch on the negative side of the circuit.

This allows the onboard computer (OBC) to control the battery charging current.

Use the following procedure to test the SCR:

1. With batteries connected and a multimeter set to 200 volts DC, place the red (+) probe on the positive post of battery no. 1 and place the black (–) probe on the charger receptacle fuse terminal that has the black 10-gauge OBC wire attached to it. The reading should be approximately 36-42 volts.
2. If the reading is zero volts, check the black 10-gauge wire connections at the controller and receptacle. Check the continuity of the black 10-gauge wires. If the wires and connections are okay, the SCR has failed. Replace the OBC. If the reading is correct, proceed to the following step.
3. Plug in AC and DC cords. When the battery charger relay clicks on, reading should be approximately 48 volts (full battery voltage). If the reading does not rise from approximately 40 volts to full battery voltage when the DC cord is plugged in and the relay clicks on, check the following items:
   - Charger receptacle fuse and black wire terminal socket in the charger receptacle.
   - Onboard computer gray wire and fuse. **See Test Procedure 11 – Onboard Computer Gray Wire and Fuse on page 18-29.**
   - Red wire at the charger receptacle. **See Test Procedure 12 – Voltage at Charger Receptacle Red Wire Socket on page 18-29.**

TEST PROCEDURE 11 – ONBOARD COMPUTER GRAY WIRE AND FUSE

See General Warning, Section 1, Page 1-1.

1. With batteries connected and a multimeter set to 200 volts DC, connect the red (+) probe to the positive post of battery no. 1 and black (–) probe (with insulation-piercing probe) to gray 16-gauge wire at a point between fuse and receptacle. Reading should be approximately 48 volts. If reading is zero volts, check gray wire fuse and fuse holder for continuity.
2. If the reading in step 1 is 48 volts, plug the DC cord into the vehicle's charger receptacle. The voltage reading should drop to approximately 4.0 volts before the charger relay clicks on.
3. When the charger relay is activated, the reading should rise to approximately 48 volts.
4. If voltage does not drop to approximately 4.0 volts when the DC cord is plugged in and then rise to approximately 48 volts when the charger relay clicks on, the gray wire circuit in the OBC has failed. Replace the OBC.

TEST PROCEDURE 12 – VOLTAGE AT CHARGER RECEPTACLE RED WIRE SOCKET

See General Warning, Section 1, Page 1-1.

1. With batteries connected and a multimeter set to 200 volts DC, place the black (–) probe on the negative post of battery no. 4 and place the red (+) probe on the charger receptacle socket connected to the red 10-gauge wire. The reading should be 48-50 volts (full battery voltage).
2. If the reading is zero volts, check the continuity of the 10-gauge red wire from the positive post of battery no. 1 to the receptacle socket.

TEST PROCEDURE 13 – MOTOR SPEED SENSOR

See General Warning, Section 1, Page 1-1.

Motor Speed Sensor Test with the Diagnostic Handset

⚠ CAUTION

- **Perform the following procedure only on a level surface. To avoid injury or property damage, ensure that the path of the vehicle is clear before pushing vehicle.**

1. Turn the key switch to the OFF position and place the Forward/Reverse switch in the NEUTRAL position.
2. Connect the handset to the vehicle as described in the Diagnostic Handset Owner's Manual.
3. Access the Test menu and select SPEED PULSES by using the SCROLL DISPLAY buttons. The handset should indicate OFF when the vehicle is at rest.
4. While monitoring the handset display screen, slowly push the vehicle a short distance (about 3 feet (1 meter)). The handset should indicate ON for speed sensor pulses while the wheels are in motion.
5. If the handset does not indicate ON while the wheels are in motion, proceed to the following procedure, Motor Speed Sensor Test without the Diagnostic Handset.

Motor Speed Sensor Test without the Diagnostic Handset

1. Turn the key switch to the OFF position and place the Forward/Reverse switch in the NEUTRAL position.
2. With batteries connected, disconnect the three-pin connector at the motor speed sensor.
3. Check voltage at black/white wire:
   - 3.1. Set a multimeter to 200 volts DC. Place the red (+) probe on the battery no. 1 positive post and place the black (–) probe on the black/white wire terminal socket in the three-pin connector. The voltage reading should be 48 to 50 volts (full battery voltage).
   - 3.2. If the reading is zero volts, check the continuity of the black/white wire from the 16-pin connector at the speed controller to the three-pin connector at the motor speed sensor. If the continuity is correct, replace the speed controller.
4. Check voltage at the red motor speed sensor wire:
   - 4.1. With Tow/Run switch in the RUN position and using a multimeter set to 20 volts DC, place the black (–) probe on the battery no. 4 negative post and place red (+) probe on red wire terminal socket in three-pin connector. The voltage reading should be approximately 15-16 volts.
   - 4.2. If the voltage reading is zero volts, check the continuity of the red wire from the 16-pin connector at the speed controller to the three-pin connector at the motor speed sensor. If the wire continuity is correct, replace the speed controller.
   - 4.3. If the reading is below 14 volts, replace the speed controller.
   - 4.4. If the voltage reading is correct, proceed to the following step.
5. Check voltage at the light green wire:
   - 5.1. Set a multimeter to 20 volts DC. Place the black (–) probe on the battery no. 4 negative post and place the red (+) probe on the light green wire female terminal in the three-pin connector at the motor speed sensor. The voltage reading should be from 4.60 to 4.90 volts.
   - 5.2. If the voltage is zero volts, check the continuity of the light green wire from the 16-pin connector at the speed controller to the three-pin connector at the motor speed sensor. If the continuity is correct, replace the speed controller.
   - 5.3. If reading is below 3.50 volts, check the continuity of the wires and plug and replace the speed controller if necessary.

6. Reconnect the three-pin connector at the motor speed sensor. Using a multimeter set to 20 volts DC, place the black (–) probe on the battery no. 4 negative post and place the red (+) probe (with insulation-piercing probe) on the green wire between the three-pin connector and the motor speed sensor.

   6.1. Raise one rear wheel off ground. Slowly turn the rear wheel to rotate the motor armature. As the armature rotates, the voltage reading should alternate from zero to approximately 4.85 volts. The voltage reading will fluctuate from zero to 4.85 volts and back to zero four times for each revolution of the motor armature. **See following NOTE.**

NOTE: *The voltage reading of 4.85 is an approximate reading. The actual reading may vary from 4.50 to 5.00 volts.*

   6.2. Replace the speed sensor if

- there is no voltage reading.
- the voltage reading is not above 3.50.
- the voltage reading does not fluctuate as the motor is turned.

TEST PROCEDURE 14 – SOLENOID CONTINUITY

See General Warning, Section 1, Page 1-1.

1. Place chocks at the front wheels and lift the rear of the vehicle with a chain hoist or floor jack. Position jack stands under the frame crossmember between the spring mount and side stringer, just forward of each rear wheel. **See WARNING "Lift only one end..." in General Warning, Section 1, Page 1-1.**
2. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.**
3. Disconnect the yellow wire from the large post of the solenoid.
4. Disconnect the resistor terminal from the same large post as the removed wire.
5. Set a multimeter to 200k ohms. Place the black (–) probe on the solenoid large post with the 6-gauge yellow wire and place the red (+) probe on the large post with the 6-gauge red wire. The reading should be no continuity.
6. Connect the 6-gauge yellow wire and resistor to the large solenoid post. Install washer and nut on large solenoid post and tighten to 77 in-lb (8.7 N·m).
7. Place the Tow/Run switch in the TOW position and connect the battery cables, positive (+) cable first. Tighten battery terminals to 110 in-lb (12.4 N·m).
8. Place the Tow/Run switch in the RUN position, turn the key switch to the ON position, place the Forward/Reverse rocker switch in the FORWARD position, and press the accelerator pedal. The solenoid should click and the multimeter should indicate continuity. If the reading is no continuity, replace the solenoid.

TEST PROCEDURE 15 – FORWARD/REVERSE ROCKER SWITCH

See General Warning, Section 1, Page 1-1.

Forward/Reverse Rocker Switch Test with the Diagnostic Handset

1. Turn the key switch to the OFF position and place the Forward/Reverse switch in the NEUTRAL position.
2. Connect the handset to the vehicle as described in the Diagnostic Handset Owner's Manual.
3. Test FORWARD INPUT.
   3.1. Access the Test menu and select FORWARD INPUT by using the SCROLL DISPLAY buttons. The handset should indicate OFF when the Forward/Reverse switch is in the NEUTRAL or REVERSE position.
   3.2. Place the Forward/Reverse switch in the FORWARD position. The handset should indicate that FORWARD INPUT is ON. If the handset indicates any other reading, check vehicle wiring. **See Wiring Diagram on page 18-2.** Also check the 16-pin connector at the speed controller. **See Test Procedure 9 – 16-Pin Connector on page 18-19.**
4. Test REVERSE INPUT.
   4.1. Access the Test menu and select REVERSE INPUT by using the SCROLL DISPLAY buttons. The handset should indicate OFF when the Forward/Reverse switch is in the NEUTRAL or FORWARD position.
   4.2. Place the Forward/Reverse switch in the REVERSE position. The handset should indicate that REVERSE INPUT is ON. If the handset indicates any other reading, check vehicle wiring. **See Wiring Diagram on page 18-2.** Also check the 16-pin connector at the speed controller. **See Test Procedure 9 – 16-Pin Connector on page 18-19.**
5. If the handset displays readings other than those described above and the wiring is found to be correct, proceed to the following procedure, Forward/Reverse Rocker Switch Test without the Diagnostic Handset.

Forward/Reverse Rocker Switch Test without the Diagnostic Handset

1. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.**
2. Remove the three screws securing the rocker switch case to the vehicle body.
3. Disconnect the three wires from the rocker switch. Using a multimeter set to 200 ohms, place the black (–) probe on the blue wire terminal 3 position on the rocker switch, and place the red (+) probe on the orange wire terminal 2 position. With the switch in NEUTRAL or REVERSE, there should be no continuity. With the switch in FORWARD, there should be continuity. If the readings are incorrect, replace the switch.
4. Place the black (–) probe on the brown wire terminal 1 position on the rocker switch and place the red (+) probe on the orange wire terminal. With the switch in REVERSE, there should be continuity. If the readings are incorrect, replace the switch.

TEST PROCEDURE 16 – REVERSE BUZZER

See General Warning, Section 1, Page 1-1.

1. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.**
2. Remove the instrument panel:
3. Remove the dash panel.
   3.1. Loosen seven Tuflok screws, but do not remove screws completely, as shown in Detail A. **See Figure 19-1, Section 19, Page 19-1.**
   3.2. Remove Tuflok screws from dash panel as shown in Detail B.
   3.3. Pull forward on top of dash panel.
4. Place the Tow/Run switch in the TOW position and connect the battery cables, positive (+) cable first. Tighten battery terminals to 110 in-lb (12.4 N·m).
5. Place the Tow/Run switch in the RUN position.
6. Set a multimeter to 200 volts DC. Place the black (–) probe on battery no. 4 negative post and place the red (+) probe on the red wire terminal end that was disconnected from the reverse buzzer. The reading should be approximately 48 volts (full battery voltage).
   6.1. If the voltage reading is correct, proceed to step 7.
   6.2. If reading is zero volts, check red wire continuity and Tow/Run switch. **See Test Procedure 2 – Onboard Computer Solenoid Lockout Circuit on page 18-11. See also Test Procedure 6 – Tow/Run Switch on page 18-16.**
   6.3. If the continuity readings are not correct, repair or replace the red wire.
   6.4. If the continuity readings are correct, proceed to step 7.
7. Place the Forward/Reverse switch in REVERSE. Using a multimeter set to 200 volts DC, place the black (–) probe on the orange/white wire terminal end (that was disconnected from the reverse buzzer) and place the red (+) probe on battery no. 1 positive post. The reading should be approximately 48 volts (full battery voltage).
   7.1. If the voltage reading is correct, replace the reverse buzzer.
   7.2. If reading is zero volts, check orange/white wire continuity and connection at Pin 10 in 23-Pin connector.
   7.3. If there is no continuity in the orange/white wire, or the Pin 10 terminal in the 23-Pin connector is not properly seated, repair or replace as required.
   7.4. If the orange/white wire continuity and 23-Pin connector are correct and there is no voltage at the orange wire, replace the controller.

TEST PROCEDURE 17 – REBOOTING THE ONBOARD COMPUTER

See General Warning, Section 1, Page 1-1.

It is possible the Onboard Computer (OBC) can become “locked up,” causing the OBC solenoid lockout circuit to malfunction. If this condition is suspected, restart the computer as follows:

1. Disconnect the battery cables as instructed. **See WARNING “To avoid unintentionally starting...” in General Warning, Section 1, Page 1-1. See following NOTE.**

NOTE: *Wait at least 90 seconds for the capacitors in the speed controller to discharge. The capacitors in the speed controller must be fully discharged in order to reboot the OBC.*

2. Place the Tow/Run switch in the TOW position and connect the battery cables, positive (+) cable first. Tighten battery terminals to 110 in-lb (12.4 N·m) and coat terminals with Battery Terminal Protector Spray (CCI P/N 1014305) to minimize corrosion.
3. Place Tow/Run switch in the RUN position.
4. Test drive the vehicle. If the problem has been fixed, the vehicle will function normally. If the problem still exists, refer to Wiring Diagram on page 18-2.

TEST PROCEDURE 18 – BATTERY WARNING LIGHT

See General Warning, Section 1, Page 1-1.

1. Reboot the OBC and drive the vehicle a short distance. When vehicle is first driven, the battery warning light should illuminate for 10 seconds. **See Test Procedure 17 – Rebooting the Onboard Computer on page 18-34.** If the battery warning light does not illuminate when rebooting the OBC, proceed to step 2.
2. Turn key switch OFF, place Tow/Run switch in TOW and place Forward/Reverse rocker switch in NEUTRAL.
3. Disconnect the six-pin connector at the OBC.
4. Remove the wedge lock from the six-pin connector housing that is connected to the vehicle wire harness. Remove the brown/white wire from the connector plug.
5. Use a jumper wire with an alligator clip at each end and connect one alligator clip to the negative post of battery no. 1 and the other alligator clip to the brown/white wire terminal socket that was removed from the six-pin connector plug.
6. Install the wedgelock in the six-pin connector housing and reconnect the six-pin connector plug. Place the Tow/Run switch in the RUN position and the battery light should illuminate. If the light does not illuminate, replace the battery warning light assembly.

COMMUNICATION DISPLAY MODULE (CDM)

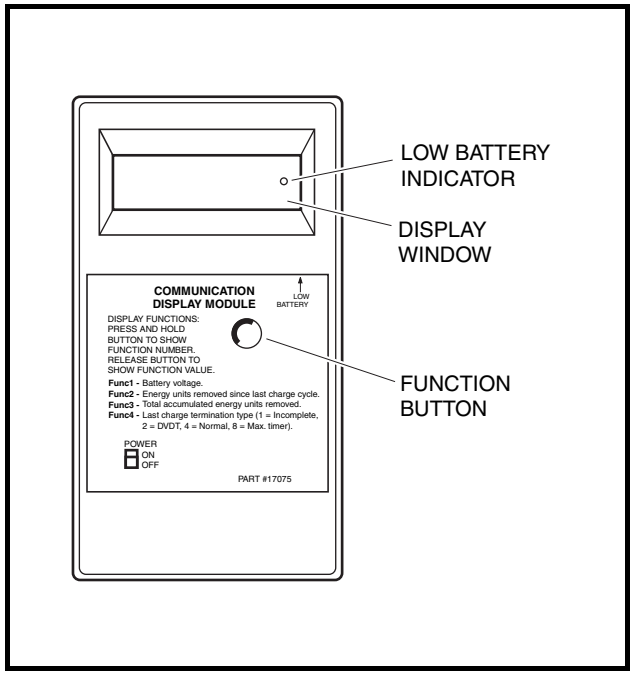


Figure 18-18 CDM

The CDM can be used to retrieve from the onboard computer four important items of information that can be useful in troubleshooting the electric vehicle. To access one of these items, the item's corresponding Function Code must be selected on the CDM. This is done by pressing the Function Button until the desired function code is displayed in the window. **See Figure 18-18, Page 18-35 for CDM features**. Releasing the button when the desired code is displayed will display the data. Function codes and corresponding data are as follows:

- **F1 – Battery voltage:**

  This displays the battery pack's current state of charge. A reading of less than 48 volts indicates that the batteries need to be charged. If a reading of less than 48 volts is obtained immediately after a charge cycle, there may be a problem in the charge circuit.

- **F2 – Energy units removed since last charge cycle:**

  If the display reads over 75 (the vehicle battery warning light should be illuminated), the vehicle batteries need to be recharged before being used again. This data can be used to make sure all vehicles in a fleet receive equal usage on a short-term basis.

- **F3 – Total accumulated energy units removed since initial vehicle start-up:**

  This information is most useful in making sure that all vehicles in a fleet receive equal usage over long periods of time.

- **F4 – Last charge termination type (1 = incomplete, 2 = DVDT, 4 = normal, 8 = max. timer):**

  A **1**, **2**, **4**, or **8** will be displayed.

  1 – Indicates the last charge cycle was incomplete and the batteries were not fully charged. Batteries should be charged again at the earliest opportunity.

2 – Indicates a back-up charge program was employed by the OBC to complete the charge cycle. A DVDT charge may be displayed the first few times a new set of batteries is charged, and the first time a set of batteries is charged after the batteries have been disconnected and reconnected. A problem may exist if persistent DVDT readings are obtained.

4 – Indicates the last charge cycle was normal.

8 – Indicates the charger ran for sixteen hours and shut itself off without completing the charge cycle. This means there may be a problem in the charge circuit.

The CDM also has a low battery indicator, which illuminates when CDM batteries are weak and need to be replaced. Weak batteries in the CDM may cause the CDM to register inaccurate information or no information.

USING THE CDM TO RETRIEVE DATA FROM THE ONBOARD COMPUTER

1. Turn the CDM ON.
2. Position CDM on seat bottom so it is aligned directly with the battery warning light. Ensure CDM infrared LED receiver is pointed at battery warning light and there is a clear path between them. **See following NOTE.**

NOTE: *If, by positioning CDM on seat bottom, the CDM is unable to collect the data stream from the onboard computer, hold CDM approximately 6 inches (15.2 cm) from battery warning light.*

3. Wait approximately 30 seconds for a value to appear in the display window.
4. If a value does not appear in the display window after 30 seconds, try adjusting the aim of the CDM and repeating step 3 until a value appears. If there is still no reading, check for weak batteries in the CDM.
   - 4.1. Adjust aim of CDM.
   - 4.2. Drive vehicle a short distance to ensure OBC is not in powerdown mode.
   - 4.3. Check for weak batteries in CDM.
   - 4.4. If reading is still not obtained, go to the CDM Troubleshooting Guide on page 18-37.

Once a value has been obtained in the display window, the CDM may be removed from its receiving position and the data reviewed. The CDM will hold the values for F1, F2, F3, and F4 until the CDM is turned OFF or it receives another line of data from the same or another onboard computer. Use the following procedure to review the data stored in the CDM:

- The value currently displayed will be F1 (battery voltage). **See following NOTE.**
- To view F2, press and hold the button on the CDM. When “Func 2” appears in the display window, release the button. The value for F2 will then be displayed.
- To view F3, press and hold the button on the CDM until “Func 3” appears in the display window. Release the button. The value for F3 will be displayed.
- To view F4, press and hold the button on the CDM until “Func 4” appears in the display window. Release the button. The value for F4 will be displayed.

NOTE: *The values of all four functions can be recalled by pressing and releasing the CDM button.*

CDM TROUBLESHOOTING GUIDE

Use the following chart as a starting point for troubleshooting problems with communication between the CDM and onboard computer. Contact your nearest distributor/dealer representative for more comprehensive information.

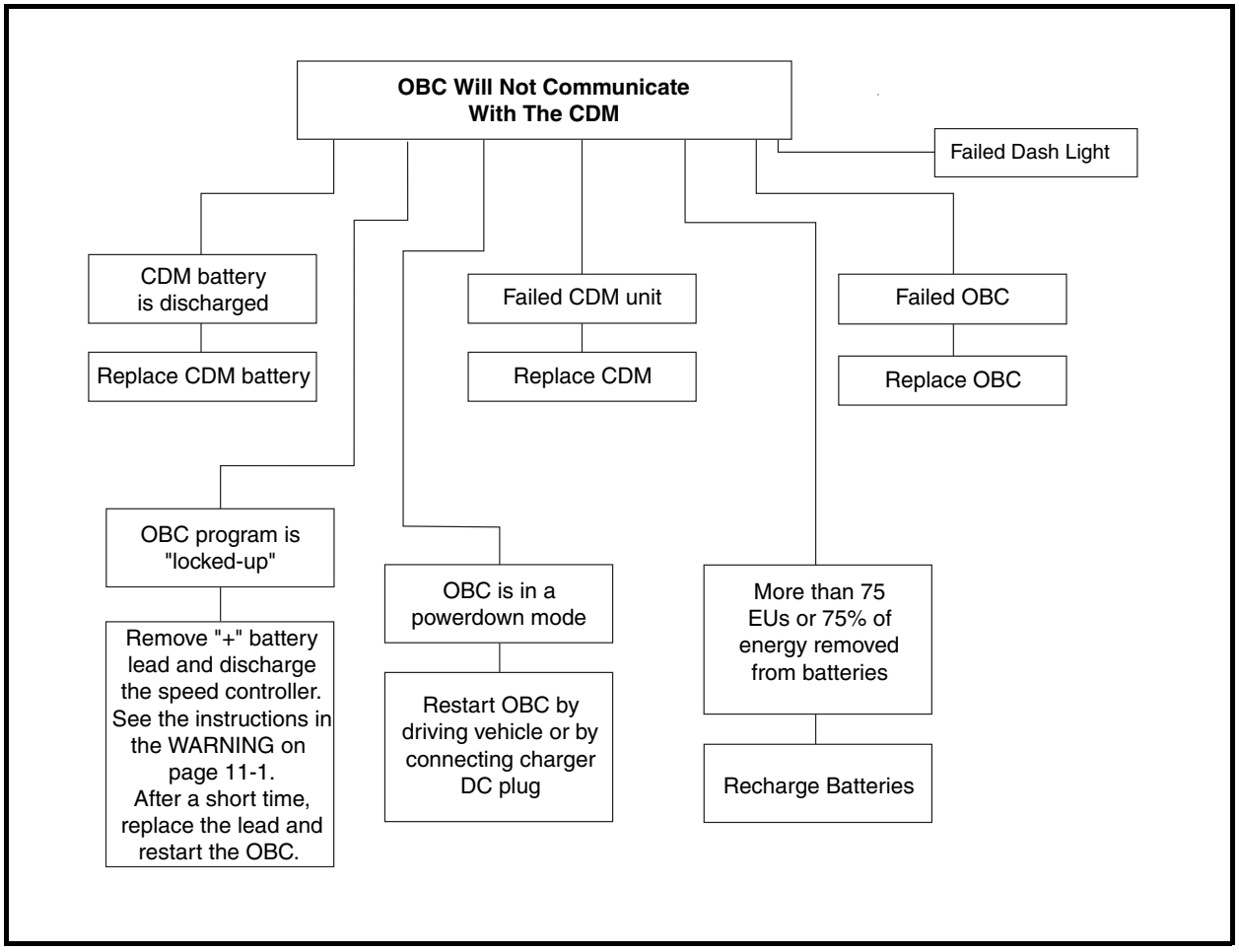


Figure 18-19 Flow Chart – CDM Troubleshooting Guide

SECTION 19 – ELECTRICAL COMPONENTS: ELECTRIC VEHICLE

⚠ DANGER

- **See General Warning, Section 1, Page 1-1.**

⚠ WARNING

- **See General Warning, Section 1, Page 1-1.**

KEY SWITCH

See General Warning, Section 1, Page 1-1.

Testing the Key Switch

See Test Procedure 8, Section 18, Page 18-17.

Key Switch Removal

1. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.**
2. Remove the dash panel.
   2.1. Loosen seven Tuflok screws, but do not remove screws completely, as shown in Detail A **(Figure 19-1, Page 19-1)**.
   2.2. Remove Tuflok screws from dash panel as shown in Detail B.
   2.3. Pull forward on top of dash panel to access back side of key switch.
   2.4. Disconnect the wire connectors from the key switch.

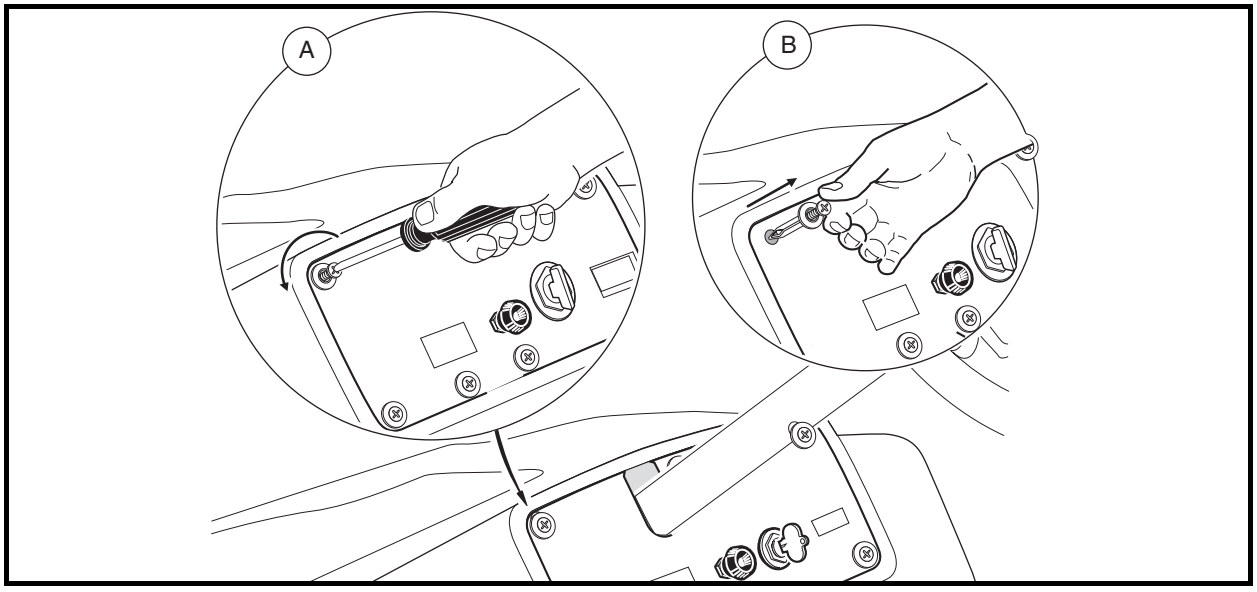


Figure 19-1 Dash Removal

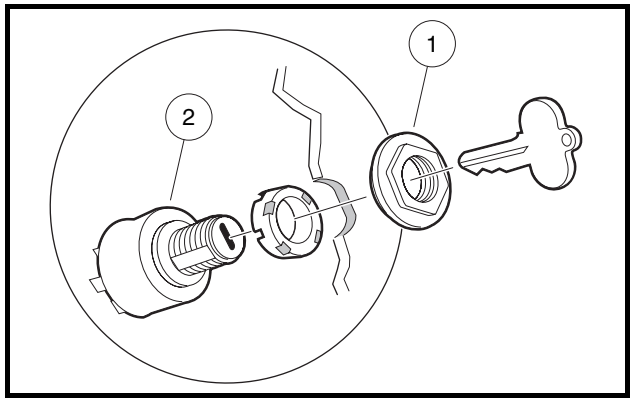


Figure 19-2 Key Switch Removal

Key Switch Installation

1. Install the key switch in the dash in reverse order of removal. Tighten the key switch nut firmly. Reconnect the wire connector to the key switch.
2. Install the dash in reverse order of removal. **See Key Switch Removal on page 19-1.**
3. Place the Tow/Run switch in the TOW position and connect the battery cables, positive (+) cable first. Tighten battery terminals to 110 in-lb (12.4 N·m) and coat terminals with Battery Terminal Protector Spray (CCI P/N 1014305) to minimize corrosion.

FORWARD/REVERSE ROCKER SWITCH

See General Warning, Section 1, Page 1-1.

Testing the Forward/Reverse Rocker Switch

See Test Procedure 15, Section 18, Page 18-32.

Forward/Reverse Rocker Switch Removal

1. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.**
1. Remove three self-tapping screws (3) that hold Forward/Reverse rocker switch case (2) to body **(Figure 19-3, Page 19-3)**.
2. Remove the 18-gauge brown, orange, and blue wires from the rocker switch.
3. Press the locking tabs (11) on each end of switch and push switch out of case.

Forward/Reverse Rocker Switch Installation

1. Press the locking tabs (11) on each end of the rocker switch and push switch into case **(Figure 19-3, Page 19-3)**.
2. Connect the 18-gauge brown, orange, and blue wires to the rocker switch exactly as shown in the wiring diagram. **See Wiring Diagram, Section 18, Page 18-2.**
3. Install the three self-tapping screws (3) that hold the Forward/Reverse rocker switch case (2) to the body. Tighten to 20 in-lb (2.3 N·m).
4. Place the Tow/Run switch in the TOW position and connect the battery cables, positive (+) cable first. Tighten battery terminals to 110 in-lb (12.4 N·m) and coat terminals with Battery Terminal Protector Spray (CCI P/N 1014305) to minimize corrosion.

5. Place the Tow/Run switch in the RUN position.
6. Inspect the vehicle for proper operation:
   - Make sure that the vehicle operates in the forward direction when the Forward/Reverse switch is in the FORWARD position.
   - Make sure that the vehicle operates in the reverse direction when the Forward/Reverse switch is in the REVERSE position. The reverse buzzer will sound as a warning when the Forward/Reverse switch is in REVERSE.
   - Make sure that the vehicle does not operate when the Forward/Reverse switch is in the NEUTRAL position.

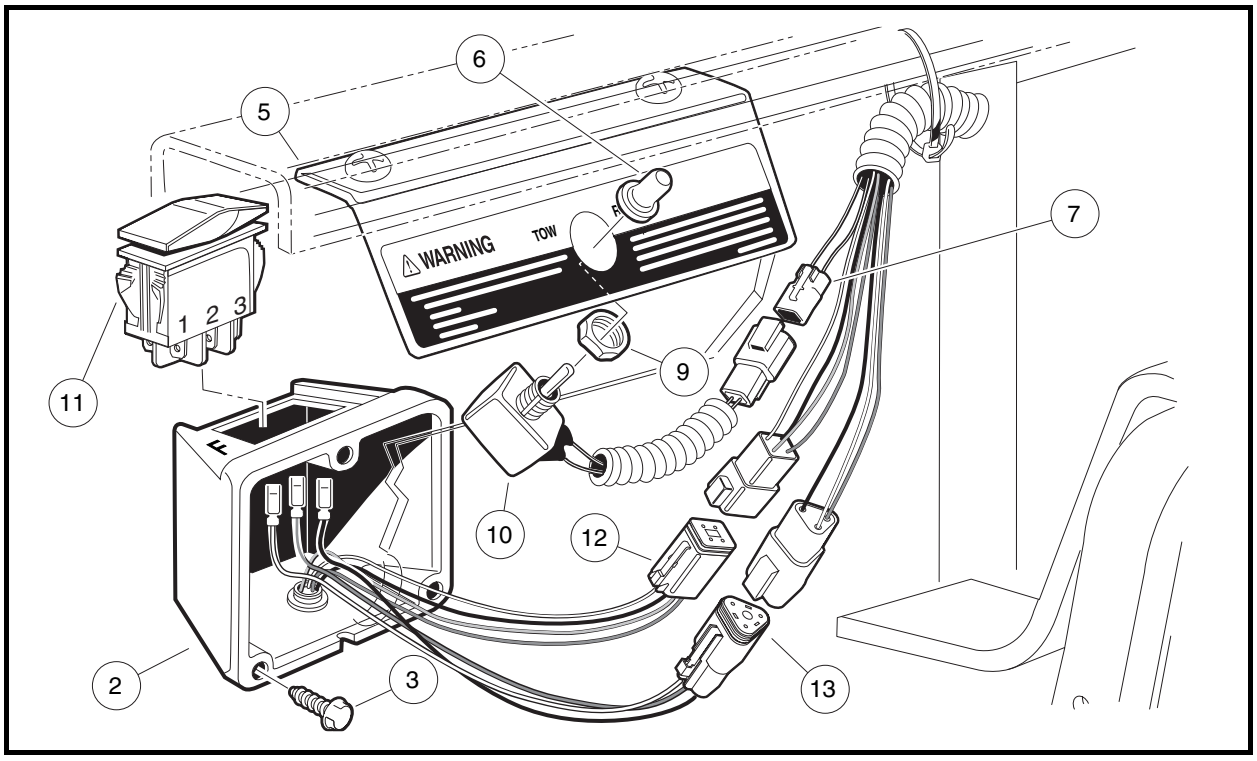


Figure 19-3 Tow/Run Switch and Forward/Reverse Rocker Switch

TOW/RUN SWITCH

See General Warning, Section 1, Page 1-1.

Testing the Tow/Run Switch

See Test Procedure 6, Section 18, Page 18-16.

Tow/Run Switch Removal

1. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.**
2. Remove Tow/Run switch boot/hex nut (6) **(Figure 19-3, Page 19-3)**.
3. Remove Tow/Run switch (10) and nut (9) from bracket (5).
4. Disconnect the two-pin connector (7) and remove switch.

Tow/Run Switch Installation

1. Installation is reverse of removal. Make sure groove on switch is aligned with tang on bracket. Tighten Tow/Run switch boot/hex nut (6) to 16 in-lb (1.8 N·m) **(Figure 19-3, Page 19-3)**.
2. Place the Tow/Run switch in the TOW position and connect the battery cables, positive (+) cable first. Tighten battery terminals to 110 in-lb (12.4 N·m) and coat terminals with Battery Terminal Protector Spray (CCI P/N 1014305) to minimize corrosion.

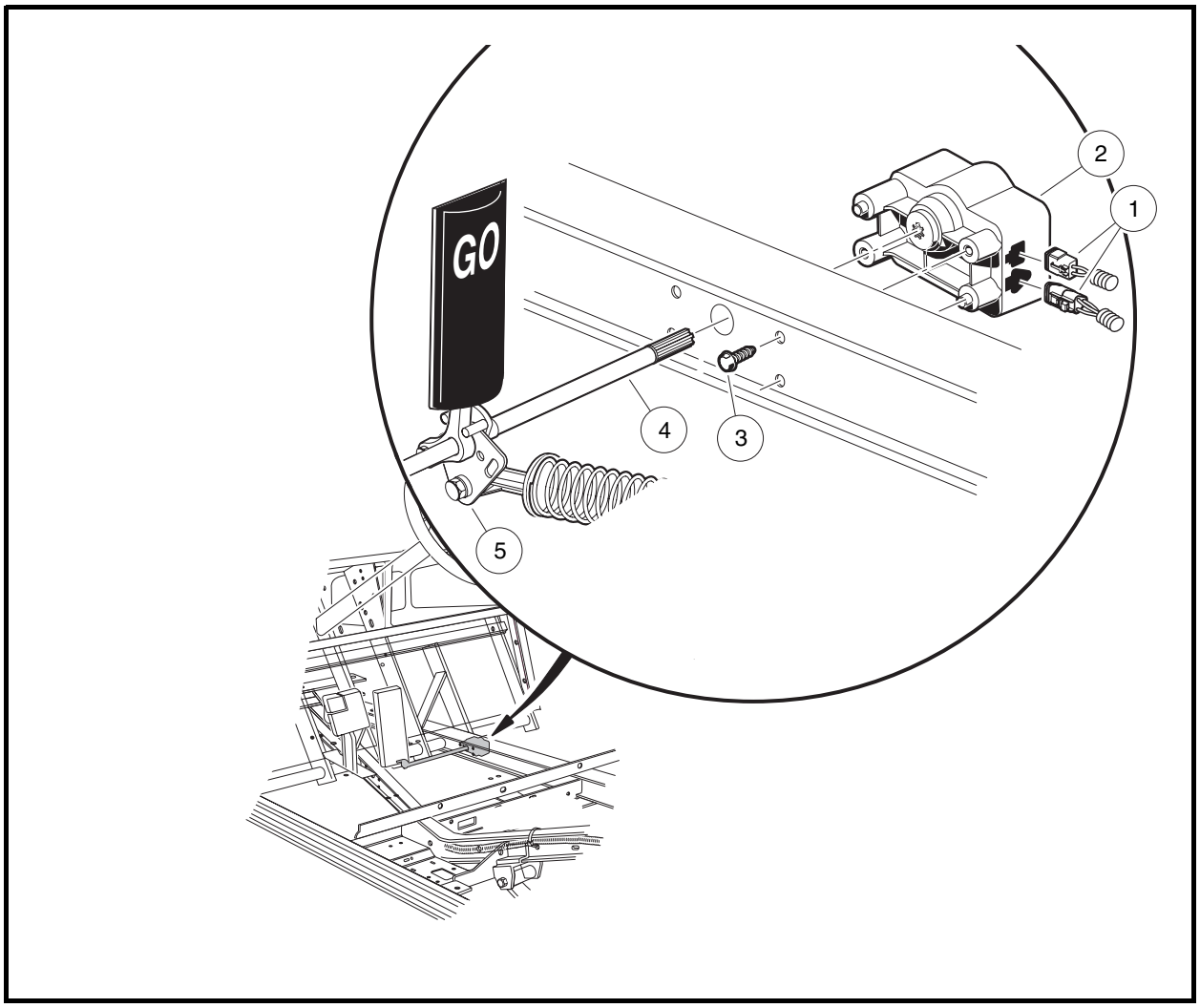


Figure 19-4 Motor Controller Output Regulator (MCOR) Mounting

MOTOR CONTROLLER OUTPUT REGULATOR (MCOR)

See General Warning, Section 1, Page 1-1.

Testing the MCOR

See Section 18, Test Procedure 4, Page 18-10 and Test Procedure 8, Page 18-17.

MCOR Removal

1. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.**
2. Place chocks at rear wheels and lift the front of the vehicle with a chain hoist or floor jack. Place jack stands under the round tube crossmember of the frame to support vehicle.
3. Disconnect the two-pin and three-pin connectors (1) from the MCOR (2) **(Figure 19-4, Page 19-4)**.
4. Remove the hex-head screws (3) connecting the MCOR to the frame I-beam.
5. Remove the MCOR from vehicle.
6. Push the drive bar (4) into the hole in the I-beam to disengage it from the accelerator pivot rod (5).

MCOR Installation

1. Insert the splined end of the drive bar (4) through the hole in the passenger-side frame I-beam as shown **(Figure 19-4, Page 19-4)**.
2. Position the opposite end of the drive bar so that the accelerator pedal sits between the two pins.
3. Place the MCOR (2) onto the splined end of the drive bar **(Figure 19-4, Page 19-4)**. **See following NOTE.**

NOTE: *The MCOR is keyed to ensure correct positioning on the drive bar.*

4. Insert the alignment pins on the MCOR into the holes in the I-beam as shown.
5. Secure the MCOR to the frame I-beam with two hex-head screws (3). Tighten screws to 23 in-lb (2.6 N·m).
6. Connect the two-pin and three-pin connectors (1) from the wire harness to the MCOR.
7. Place the Tow/Run switch in the TOW position and connect the battery cables, positive (+) cable first. Tighten battery terminals to 110 in-lb (12.4 N·m) and coat terminals with Battery Terminal Protector Spray (CCI P/N 1014305) to minimize corrosion.

REVERSE BUZZER

See General Warning, Section 1, Page 1-1.

Testing the Reverse Buzzer

See Test Procedure 16, Section 18, Page 18-33.

Reverse Buzzer Removal

1. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.**
2. Remove instrument panel. **See step 2 of Key Switch Removal on page 19-1.**
3. Disconnect the 18-gauge red and orange/white wires from reverse buzzer.
4. Remove the two screws from the reverse buzzer. Remove the reverse buzzer from the instrument panel.

Reverse Buzzer Installation

1. Install the reverse buzzer in the reverse order of removal. Tighten screws to 4 in-lb (0.45 N·m).
2. Place the Tow/Run switch in the TOW position and connect the battery cables, positive (+) cable first. Tighten battery terminals to 110 in-lb (12.4 N·m) and coat terminals with Battery Terminal Protector Spray (CCI P/N 1014305) to minimize corrosion.

SOLENOID

See General Warning, Section 1, Page 1-1.

The solenoid is located on the driver side of the electrical component mounting plate.

Testing the Solenoid

See Section 18, Test Procedure 3, Page 18-12 and Test Procedure 14, Page 18-31.

Solenoid Removal

1. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.**
2. Remove the rear body access panel.
3. Disconnect all wires from the solenoid (3) **(Figure 19-5, Page 19-6)**.
4. Loosen, but do not remove, the two screws (12) that hold the solenoid (3) to the component mounting plate.
5. Lift the solenoid (3) up and off of the component mounting plate.

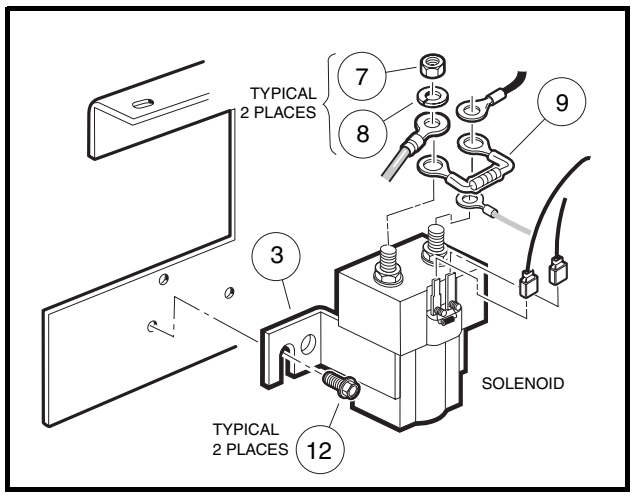


Figure 19-5 Solenoid

Solenoid Installation

1. Mount solenoid (3) onto component mounting plate with screws (12) **(Figure 19-5, Page 19-6)**.
2. Tighten screws (12) to 60 in-lb (6.8 N·m).
3. Using the wiring diagram, install the wires, resistor (9), washers (8), and nuts (7) onto the large mounting posts. Tighten nuts to 77 in-lb (8.7 N·m). **See Wiring Diagram, Section 18, Page 18-2.**
4. Install the blue/white and light blue wires onto the small terminals of the solenoid **(Figure 19-5, Page 19-6)**.
5. Install rear body access panel.
6. Place the Tow/Run switch in the TOW position and connect the battery cables, positive (+) cable first. Tighten battery terminals to 110 in-lb (12.4 N·m) and coat terminals with Battery Terminal Protector Spray (CCI P/N 1014305) to minimize corrosion.

ONBOARD COMPUTER (OBC)

See General Warning, Section 1, Page 1-1.

Testing the Onboard Computer

See Section 18, Test Procedure 2, Page 18-11, Test Procedure 10, Page 18-29, and Test Procedure 11, Page 18-29.

Onboard Computer Removal

1. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.**
2. Remove rear body access panel and unplug the six-pin connector (16) at the OBC **(Figure 19-6, Page 19-7)**.

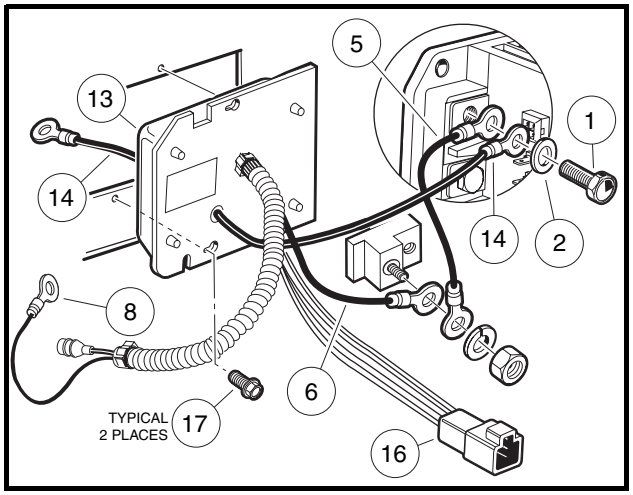


Figure 19-6 Onboard Computer

3. Remove the two screws (5) from the speed controller cover (1) and remove the cover **(Figure 19-7, Page 19-8)**.
4. Remove the wire tie (3) securing the speed controller wires to the mounting plate.
5. Remove black 6-gauge wire (14) and black 10-gauge wire (5) from the speed controller B– terminal **(Figure 19-6, Page 19-7)**.
6. Remove the black 10-gauge wire (6) from the accessory mounting terminal.
7. Disconnect the gray wire fuse holder at the charger receptacle.
8. Disconnect the black 10-gauge wire (8) at the charger receptacle.
9. Cut the wire tie that secures the OBC wire harness to the I-beam.
10. Loosen, but do not remove, the two self-tapping screws (17) holding OBC to component mounting plate.
11. Slide OBC towards outside of vehicle and align heads of self-tapping screws (17) with the two holes in the OBC face plate. Pull OBC towards rear of vehicle and remove from component mounting plate.

Onboard Computer Installation

1. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.**
2. Remove the rear body access panel.

Onboard Computer Installation, Continued:

3. Install the OBC onto the component mounting plate by aligning the two holes on the OBC face plate with two holes on component mounting plate. Slide OBC towards inside of vehicle and align heads of self-tapping screws (17) with smaller part of two holes in OBC face plate **(Figure 19-6, Page 19-7)**. Tighten screws to 60 in-lb (6.7 N·m). **See following NOTE.**

NOTE: *The aluminum plate on the OBC should face toward the rear of the vehicle. The white potting material side of the OBC should face toward the front of the vehicle.*

4. Attach wire tie so the OBC wire harness is secured to the I-beam.
5. Connect the black 10-gauge wire (8) to the charger receptacle **(Figure 19-6, Page 19-7)**. Tighten to 23 in-lb (2.6 N·m).
6. Connect the gray wire fuse holder to the charger receptacle.
7. Connect the black 10-gauge wire (6) to the accessory mounting terminal. Install the nut on the accessory terminal and tighten to 9 ft-lb (12.2 N·m).
8. Connect the black 6-gauge wire (14) and black 10-gauge wire (5) to the speed controller B– terminal with the washer (2) and bolt (1) and tighten to 9 ft-lb (12.2 N·m) **(Figure 19-6, Page 19-7)**.
9. Plug the six-pin connector (16) from the OBC into the vehicle wire harness.
10. Install a wire tie (3) to tightly secure the speed controller wires to the component mounting plate **(Figure 19-7, Page 19-8)**.
11. Place the edge of the speed controller cover (1) into the slot (2). Press the controller cover onto the component mounting plate over the speed controller and install the two screws (5) **(Figure 19-7, Page 19-8)**. Tighten the screws (5) to 60 in-lb (6.8 N·m). **See following NOTE.**

NOTE: *Make sure that the speed controller cover gasket forms a tight seal between the cover and the component mounting plate.*

12. Install rear body access panel.
13. Place the Tow/Run switch in the TOW position and connect the battery cables, positive (+) cable first. Tighten battery terminals to 110 in-lb (12.4 N·m) and coat terminals with Battery Terminal Protector Spray (CCI P/N 1014305) to minimize corrosion.

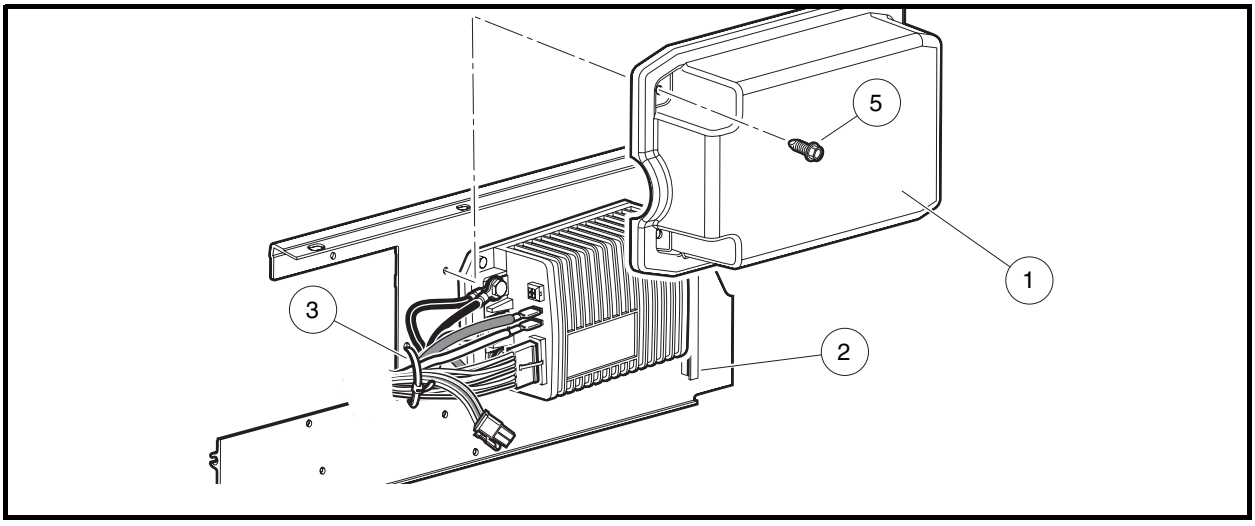


Figure 19-7 Speed Controller Cover

SOLID STATE SPEED CONTROLLER

See General Warning, Section 1, Page 1-1.

Testing the Solid State Speed Controller

See Test Procedure 5, Section 18, Page 18-15.

Speed Controller Removal

1. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.**
2. Remove the rear body access panel.
3. Remove the two screws (5) from the speed controller cover (1) and remove the cover **(Figure 19-7, Page 19-8)**.
4. Disconnect all wires and multi-pin connectors from the speed controller **(Figure 19-8, Page 19-9)**.
5. Remove the three self-tapping screws (17) that hold the controller (6) to the component mounting plate and remove the controller from the vehicle.

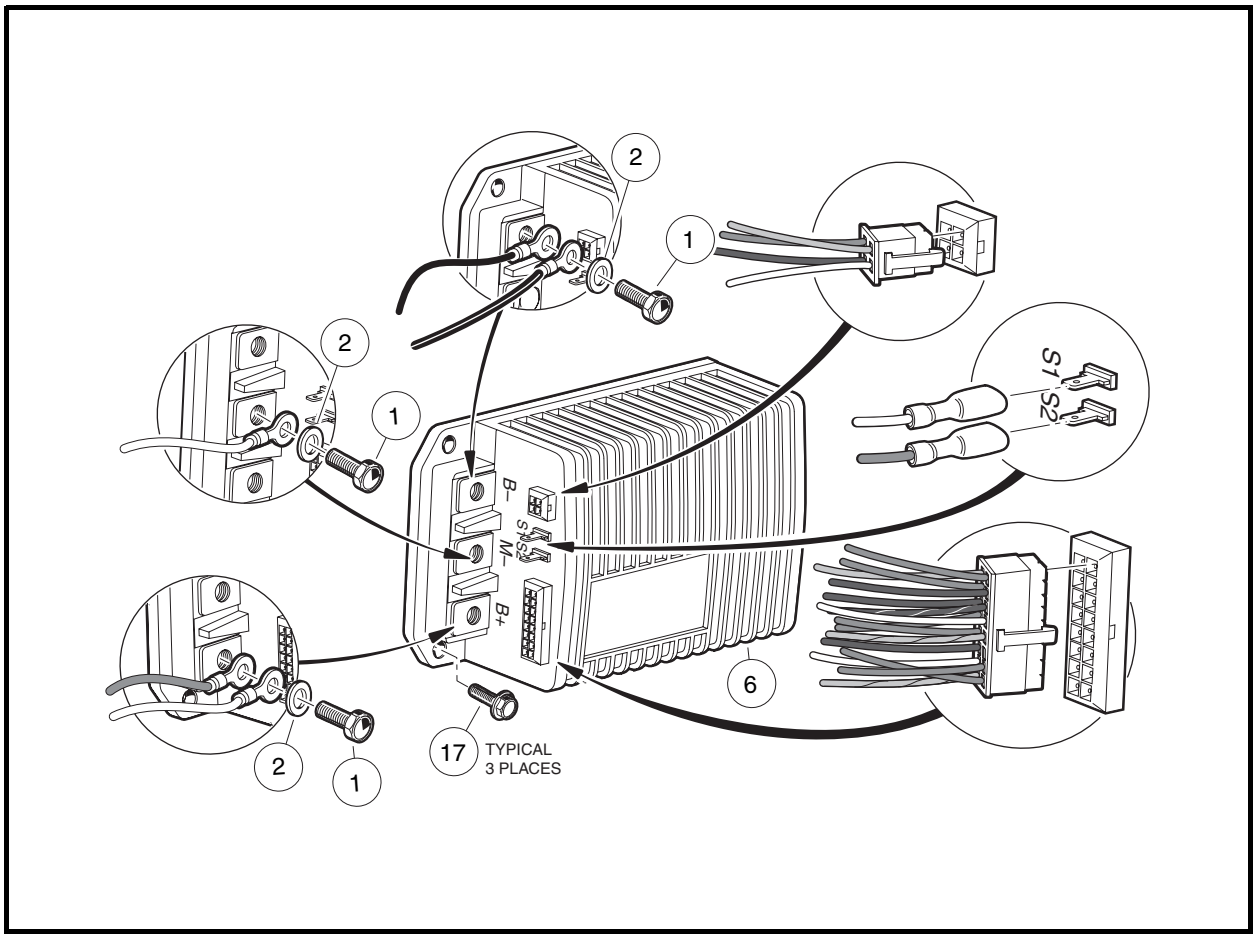


Figure 19-8 Speed Controller

Speed Controller Installation

1. Install the three self-tapping screws (17) that hold the controller (6) to the component mounting plate and tighten to 60 in-lb (6.8 N·m) **(Figure 19-8, Page 19-9)**.
2. Using the wiring diagram, install the multi-pin connectors and all wires as illustrated. **See Wiring Diagram, Section 18, Page 18-2.** Tighten bolts (1) to 9 ft-lb (12.2 N·m) **(Figure 19-8, Page 19-9)**.
3. Place the edge of the speed controller cover (1) into the slot (2). Press the controller cover onto the component mounting plate over the speed controller and install the two screws (5) **(Figure 19-7, Page 19-8)**. Tighten the screws (5) to 60 in-lb (6.8 N·m). **See following NOTE.**

NOTE: *Make sure that the speed controller cover gasket forms a tight seal between the cover and the component mounting plate.*

4. Install rear body access panel.
5. Place the Tow/Run switch in the TOW position and connect the battery cables, positive (+) cable first. Tighten battery terminals to 110 in-lb (12.4 N·m) and coat terminals with Battery Terminal Protector Spray (CCI P/N 1014305) to minimize corrosion.
6. Place the Tow/Run switch in the RUN position.
7. Inspect the vehicle for proper operation:
   - Make sure that the vehicle operates in the forward direction when the Forward/Reverse switch is in the FORWARD position.
   - Make sure that the vehicle operates in the reverse direction when the Forward/Reverse switch is in the REVERSE position. The reverse buzzer will sound as a warning when the Forward/Reverse switch is in REVERSE.
   - Make sure that the vehicle does not operate when the Forward/Reverse switch is in the NEUTRAL position.

CHARGER RECEPTACLE

See General Warning, Section 1, Page 1-1.

The charger cord, plug, and receptacle are wear items and should be inspected daily. Visually inspect them for cracks, loose connections, and frayed wiring; they must be replaced when worn or damaged. If charger plug or receptacle show signs of corrosion or the plug is difficult to insert or remove, the receptacle contacts and plug terminals should be cleaned with a good electrical contact cleaner or lightly sprayed with WD-40® brand spray lubricant. The plug should then be inserted and removed several times to ensure ease of insertion, ease of removal, and good electrical contact.

Testing the Charger Receptacle

See Test Procedure 12, Section 18, Page 18-29.

See also the appropriate battery charger maintenance and service manual.

Charger Receptacle Inspection

Inspect the receptacle for cracks, loose connections and frayed wiring. **See following NOTE.**

NOTE: *Disassembly of the charger receptacle, for the purpose of removal or installation, is not recommended.*

Charger Receptacle Removal

1. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.**
2. Remove the 10-gauge red wire (4) from the positive post of battery no. 1 **(Figure 19-9, Page 19-11).**
3. Remove black 10-gauge OBC wire (5) from charger receptacle.
4. Disconnect the gray wire (9) from the receptacle at the yellow fuse holder.
5. Remove the four screws (1) that secure the charger receptacle bezel (7) to the receptacle backing plate (8) and to the vehicle body.
6. Move the receptacle assembly toward the front of the vehicle and tilt receptacle upwards in order for the receptacle to pass through the hole in the vehicle body.

Charger Receptacle Installation

1. Insert the 10-gauge red wire (4) and the 18-gauge gray wire (3) through the hole in the vehicle body and the receptacle backing plate **(Figure 19-9, Page 19-11)**.
2. Insert receptacle into vehicle body.
3. Install the four screws (1) that secure the receptacle to the vehicle body and receptacle backing plate (8). Tighten screws to 16 in-lb (1.8 N·m).
4. Connect 18-gauge gray wire (9) to yellow fuse holder. Make sure fuse (11) is installed in fuse holder.
5. Connect the 10-gauge black wire (5) to the receptacle fuse link (6) on the charger receptacle **(Figure 19-9, Page 19-11).** Tighten to 23 in-lb (2.6 N·m).
6. Connect the 10-gauge red wire (4) to the positive post of battery no. 1.
7. Place the Tow/Run switch in the TOW position and connect the battery cables, positive (+) cable first. Tighten battery terminals to 110 in-lb (12.4 N·m) and coat terminals with Battery Terminal Protector Spray (CCI P/N 1014305) to minimize corrosion.

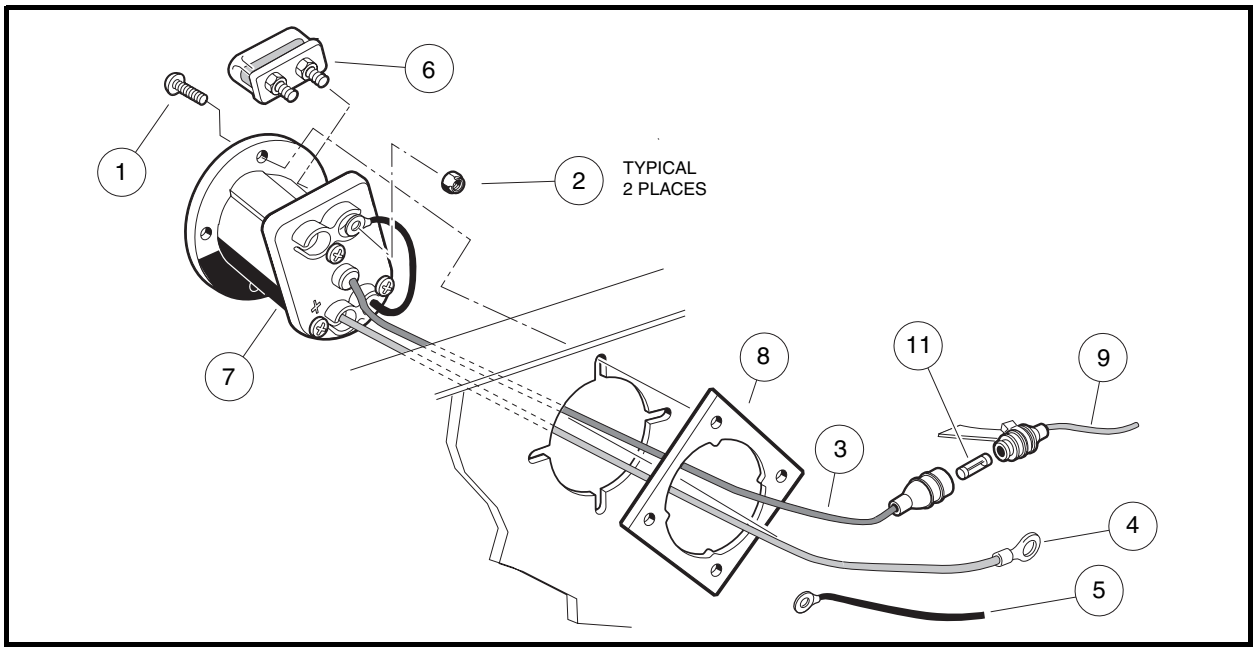


Figure 19-9 Charger Receptacle

RECEPTACLE FUSE LINK

The fuse link on the 48-volt electric vehicle should not blow under normal operating conditions; however, if the fuse link has blown, the vehicle will not charge and the fuse must be replaced. The fuse link (6) is mounted on top of the charger receptacle in the battery compartment **(Figure 19-9, Page 19-11)**.

Receptacle Fuse Link Removal

1. Remove the fuse link (6) from the charger receptacle (7) by removing the two nuts and washers used to secure the 10-gauge black wire from the computer (5) and the 10-gauge black wire to the receptacle **(Figure 19-9, Page 19-11)**.
2. Remove the fuse link (6) from the charger receptacle.

Receptacle Fuse Link Installation

1. Insert the two fuse link mounting posts into the mounting holes in the charger receptacle.
2. Place the two 10-gauge black wires in their original positions on the fuse link mounting posts. Tighten to 23 in-lb (2.6 N·m).
3. Install nuts (2) on fuse link mounting posts and tighten to 23 in-lb (2.6 N·m) **(Figure 19-9, Page 19-11)**.

BATTERY WARNING LIGHT

See General Warning, Section 1, Page 1-1.

Testing the Battery Warning Light

See Test Procedure 18, Section 18, Page 18-34.

Battery Warning Light Removal

1. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.**
2. Remove instrument panel. **See step 2 of Key Switch Removal on page 19-1.**
3. Disconnect the two wires from the battery warning light.
4. Press the two retaining tabs (11) and remove the light from the instrument panel.

Battery Warning Light Installation

1. Install in reverse order of removal.
2. Place the Tow/Run switch in the TOW position and connect the battery cables, positive (+) cable first. Tighten battery terminals to 110 in-lb (12.4 N·m) and coat terminals with Battery Terminal Protector Spray (CCI P/N 1014305) to minimize corrosion.

PIN 9 DIODE

See General Warning, Section 1, Page 1-1.

Testing the Pin 9 Diode

See Test Procedure 9F, Section 18, Page 18-25.

If the pin 9 diode has failed open, it should be removed from the harness. Instead of replacing the diode with a new one, we recommend installing a Main Dropout Harness (CCI P/N 102355201) between the Tow/Run switch and the wire harness.

Pin 9 Diode Removal

1. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.**
2. Remove the diode from the gray/white and gray wires as indicated **(Figure 19-10, Page 19-13)**.
3. Splice the ends of the two wires together.
4. Install a Main Dropout Harness. **See Main Dropout Harness Installation on page 19-13.**

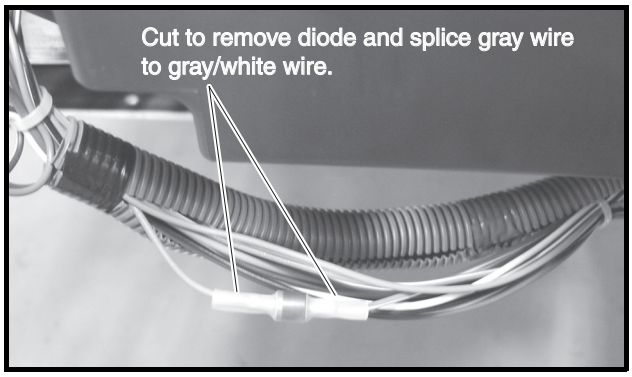


Figure 19-10 Diode Removal

Main Dropout Harness Installation

1. Disconnect the two-pin connector (1) at the Tow/Run switch **(Figure 19-11, Page 19-13)**.
2. Connect the main dropout harness (2) between each end of the two-pin connector.

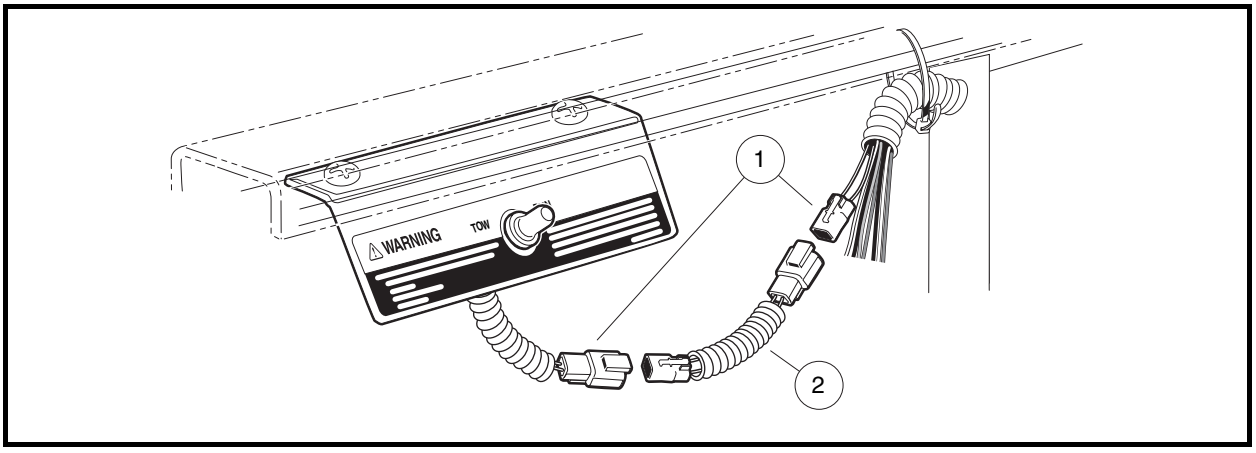


Figure 19-11 Install Main Dropout Harness

SECTION 20 – BATTERIES: ELECTRIC VEHICLES

⚠ DANGER

- **See General Warning, Section 1, Page 1-1.**

⚠ WARNING

- **See General Warning, Section 1, Page 1-1.**

⚠ DANGER

- **Battery – Explosive gases! Do not smoke. Keep sparks and flames away from the vehicle and service area. Ventilate when charging or operating vehicle in an enclosed area. Wear a full face shield and rubber gloves when working on or near batteries.**
- **Charge batteries in a well-ventilated area only. Batteries emit hydrogen while being charged. Hydrogen is an explosive gas and must never exceed a level of 2% of the air.**
- **Battery – Poison! Contains acid! Causes severe burns. Avoid contact with skin, eyes, or clothing. Antidotes:**
  - **External: Flush with water. Call a physician immediately.**
  - **Internal: Drink large quantities of milk or water. Follow with milk of magnesia or vegetable oil. Call a physician immediately.**
  - **Eyes: Flush with water for 15 minutes. Call a physician immediately.**
  - **Use insulated tools when working near batteries or electrical connections. Use extreme caution to avoid shorting of components or wiring.**

GENERAL INFORMATION

The batteries supplied with an electric vehicle are different from those supplied with an automobile. The outward appearance of these two batteries is similar, but the operating characteristics are very different. The electric vehicle battery is a deep-cycle battery, and the automotive battery is a “starting, lighting and ignition” (SLI) battery. They should never be substituted for one another. For gasoline vehicles, **See Battery – Gasoline Vehicles, Section 10, Page 10-9.**

BATTERY REPLACEMENT

See General Warning, Section 1, Page 1-1.

⚠ WARNING

- **To prevent electrolyte leakage from the battery vents, batteries must be kept in an upright position. Tipping a battery beyond a 45° angle in any direction can allow a small amount of electrolyte to leak out the vent hole. Do not exceed this 45° angle when lifting, carrying, or installing batteries. Battery acid can cause severe personal injury to skin or eyes, and can damage clothing.**

Battery Replacement, Continued:

1. Before removing batteries, note the orientation of the batteries and the connecting wires. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.** Remove remaining wires and batteries. **See Wiring Diagram, Section 18, Page 18-2.**
2. Visually inspect the new batteries for any damage that may have occurred in transit.If the battery cables are to be reused, inspect them for broken or frayed wires, damaged terminals, or worn insulation. Remove any corrosion on the connectors. A solution of baking soda and water (1 cup (237 mL) baking soda per 1 gallon (3.8 L) of water) does an excellent job of neutralizing and removing the corrosion. Be careful not to allow the baking soda solution to enter the battery.

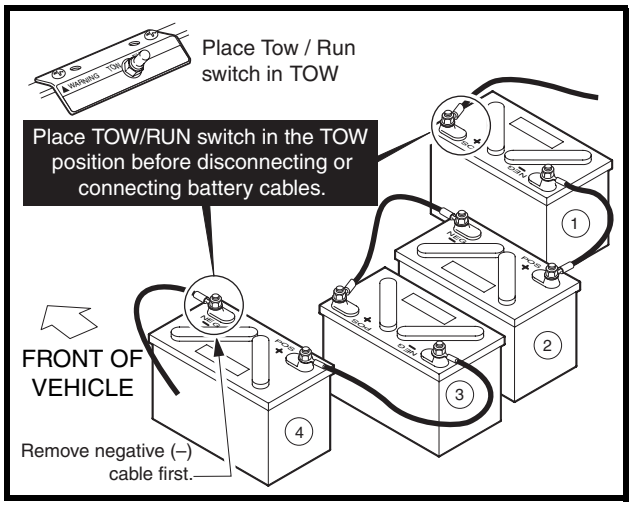


Figure 20-1 Electric Vehicle Battery Configuration

3. Check and clean the battery rack and hold-downs. The nuts and bolts on the hold-downs may corrode. It is therefore advised they be cleaned periodically and replaced as necessary.
4. Install batteries in the proper orientation **(Figure 20-1, Page 20-2)**. Install battery hold-downs. The hold-downs should be tight enough so batteries do not move while vehicle is in motion, but not so tight as to crack or buckle battery case. Tighten to 97.4 in-lb (11 N·m), alternating between hold-down bolts.
5. Install wires in proper sequence **(Figure 20-1, Page 20-2)**. Install black wire to negative post of battery no. 4 last. Make sure all connections are tight. Tighten to 110 in-lb (12.4 N·m). Coat all terminals with Battery Terminal Protector Spray (CCI P/N 1014305) to minimize future corrosion.
6. Give the batteries a full charge prior to operation. This ensures all the batteries are fully charged and the cells are equalized prior to use.

BATTERY CARE

See General Warning, Section 1, Page 1-1.

PREVENTIVE MAINTENANCE

To keep batteries in sound operating condition, follow these steps on a regular basis.

1. Any corrosion build-up on or around batteries should be removed immediately. Terminal connections should be clean and tight. Any frayed or worn wires should be replaced. After all cables have been connected, coat all terminals with Battery Terminal Protector Spray (CCI P/N 1014305) to help prevent future corrosion.

2. Batteries should be clean and free of corrosion. Wash tops and terminals of batteries with a solution of baking soda and water (1 cup (237 mL) baking soda per 1 gallon (3.8 L) of water). Rinse solution off batteries. Do not allow this solution to enter the batteries. Be sure terminals are tight. Let the terminals dry and then coat them with Battery Terminal Protector Spray (CCI P/N 1014305). **See Self-Discharge on page 20-3.**
3. Maintain proper electrolyte level. **See Electrolyte Level on page 20-3.**
4. Batteries should be properly charged every day they are used. Check the batteries periodically to see that they are in a full state of charge. **See Battery Charger on page 20-4.**
5. Keep hold-downs tight. **See Vibration Damage on page 20-4.**

SELF-DISCHARGE

Contaminants on dirty batteries can provide a path for a small current draw that can slowly discharge batteries, thus wasting valuable energy. To prevent self-discharge, batteries should always be kept clean.

Hot weather also has an effect on a battery's self-discharge rate. The higher the temperature, the quicker a set of batteries will discharge. In hotter climates, batteries should be checked more often. When storing batteries, keep in a cool place. **See Battery Storage on page 20-12.**

ELECTROLYTE LEVEL

⚠ CAUTION

- **Do not allow battery acid from battery caps or hydrometer to drip onto the front or rear body of the vehicle. Battery acid will cause permanent damage. Wash immediately.**

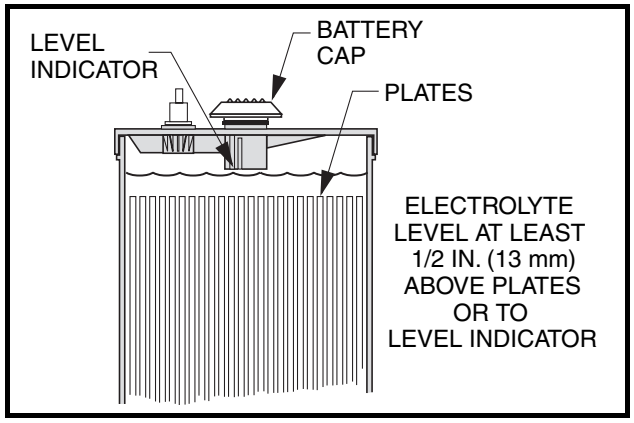


Figure 20-2 Battery Electrolyte Level

Add water only after charging unless the electrolyte is below the level of the plates. If the electrolyte level is below the level of the plates, add just enough water to cover the plates and then charge the batteries. After charging, fill with water to the level indicator. Filling a battery to the level indicator before charging will result in overfilling because the electrolyte level will rise during charging and some of the electrolyte may bubble out of the cap. This reduces the battery's capacity and corrodes the metal parts around it.

Electrolyte Level, Continued:

The electrolyte level should be checked weekly to be sure electrolyte is at its proper level **(Figure 20-2, Page 20-3)**. Never allow the electrolyte level to fall below the tops of the plates because this will cause the exposed part of the plate to become permanently inactive. For best results, use a battery watering gun to add water to batteries. Check the electrolyte level more frequently in hot weather or when batteries are old.

MINERAL CONTENT

For the longest battery life, use distilled water in batteries. However, if tap water is to be used, be sure the mineral contents are below these levels:

IMPURITY	ALLOWABLE CONTENT (PARTS PER MILLION)
Suspended matter	Trace
Total solids	100.0
Calcium and Magnesium Oxides	40.0
Iron	5.0
Ammonia	8.0
Organic matter	50.0
Nitrates	10.0
Nitrites	5.0
Chloride	5.0

VIBRATION DAMAGE

The battery hold-downs should always be tight enough to keep the battery from bouncing. Battery life may be severely shortened if the battery hold-downs are too loose. Battery hold-downs should be tightened to 97 in-lb (11 N·m). Excessive vibration causes the plates to shed prematurely and shortens the life of the battery. It may also cause acid to leak out of the vent caps and corrosion to build up on surrounding metal parts. The acid which is lost reduces the capacity of the battery and cannot be replaced. Battery hold-downs should NOT be so tight as to crack or buckle the battery case. This may cause leaks which would dry out a cell or cause internal short circuits. **See Battery Replacement on page 20-1.**

BATTERY CHARGER

See General Warning, Section 1, Page 1-1.

The charger supplied with the electric vehicle resolves the most common problems associated with battery charging. Undercharging and overcharging are prevented provided the charger is allowed to shut off by itself. Also, all cells are automatically given an equalization charge at low current, which prolongs battery life. Batteries should never be left in a discharged state, as this too affects the internal components and can reduce the capacity of the battery. The batteries should be charged every day they are used. However, the batteries should not be charged if they have not been used.

CHARGER SHUTS OFF AFTER 16 HOURS

This may be due to 1) new batteries, 2) hard use, or 3) cold temperatures. A catch-up charge may be necessary when these conditions are present. On those days when all or some of the vehicles do not get used, check the batteries for state of charge. Any battery with a specific gravity lower than 1.250 will need a catch-up charge. If the problem continues after a catch-up charge has been performed, check the battery charger. Refer to the appropriate battery charger maintenance and service manual. **See Section 21 – Battery Charger: Electric Vehicle.**

DEEP-DISCHARGE

Never discharge batteries to the point the vehicle will no longer operate. This will considerably shorten the cycle life of the batteries, and may permanently damage the batteries. It is possible the batteries will not accept a charge if they are completely discharged. The deeper the discharge, the harder it is on the batteries. For this reason, it is recommended that electric vehicle batteries be charged after each use (provided the charge cycle will not be interrupted and the charger will be allowed to shut off automatically). Placing the batteries on charge after each use reduces the depth of discharge and prolongs battery life.

EARLY EXCESSIVE DISCHARGING

When vehicle batteries are new, they do not reach their full capacity until they have been used and recharged 20 to 50 times. If they are excessively discharged early in their life, their effective service life will be shortened. It is advisable to limit the use of any vehicle with new batteries for at least the first four weeks and then gradually increase their range.

INCOMING AC SERVICE

Make sure the incoming AC line service is sufficient. If circuit breakers are tripping, fuses blow during the night or the charger does not give the required starting rate when sound batteries are put on charge, an AC line problem exists. The electrical service to the vehicle storage facility should be sufficient to deliver adequate voltage and current to each charger with all the chargers turned on. If not, consult your local power company or electrical contractor. Refer to the appropriate battery charger maintenance and service manual. **See Section 21 – Battery Charger: Electric Vehicle.**

FLEET ROTATION

Rotate vehicle usage. It is very hard on batteries if the last vehicles in at night are the first ones out in the morning. Spread the workload evenly, giving all vehicles the same amount of use. This will keep your fleet in balance and will not overwork certain sets of batteries.

NOTE: *When vehicles are being rotated, the CDM (Communication Display Module) can be a very helpful service tool. Monitoring the value of function 3 with the CDM simplifies vehicle usage scheduling.* ***See Communication Display Module (CDM), Section 18, Page 18-35.***

NUMBERING VEHICLES AND CHARGERS

Return the vehicles to the same charger each night if possible. If the vehicles are put in a storage facility at random and a vehicle dies while in use and testing shows the batteries are sound, then the problem is most likely with the charger. However, finding the problem charger may prove to be quite time consuming. Numbering the vehicles and the chargers and returning each vehicle to its designated charger each night can significantly reduce the amount of time spent troubleshooting a problem.

BATTERY TROUBLESHOOTING CHART

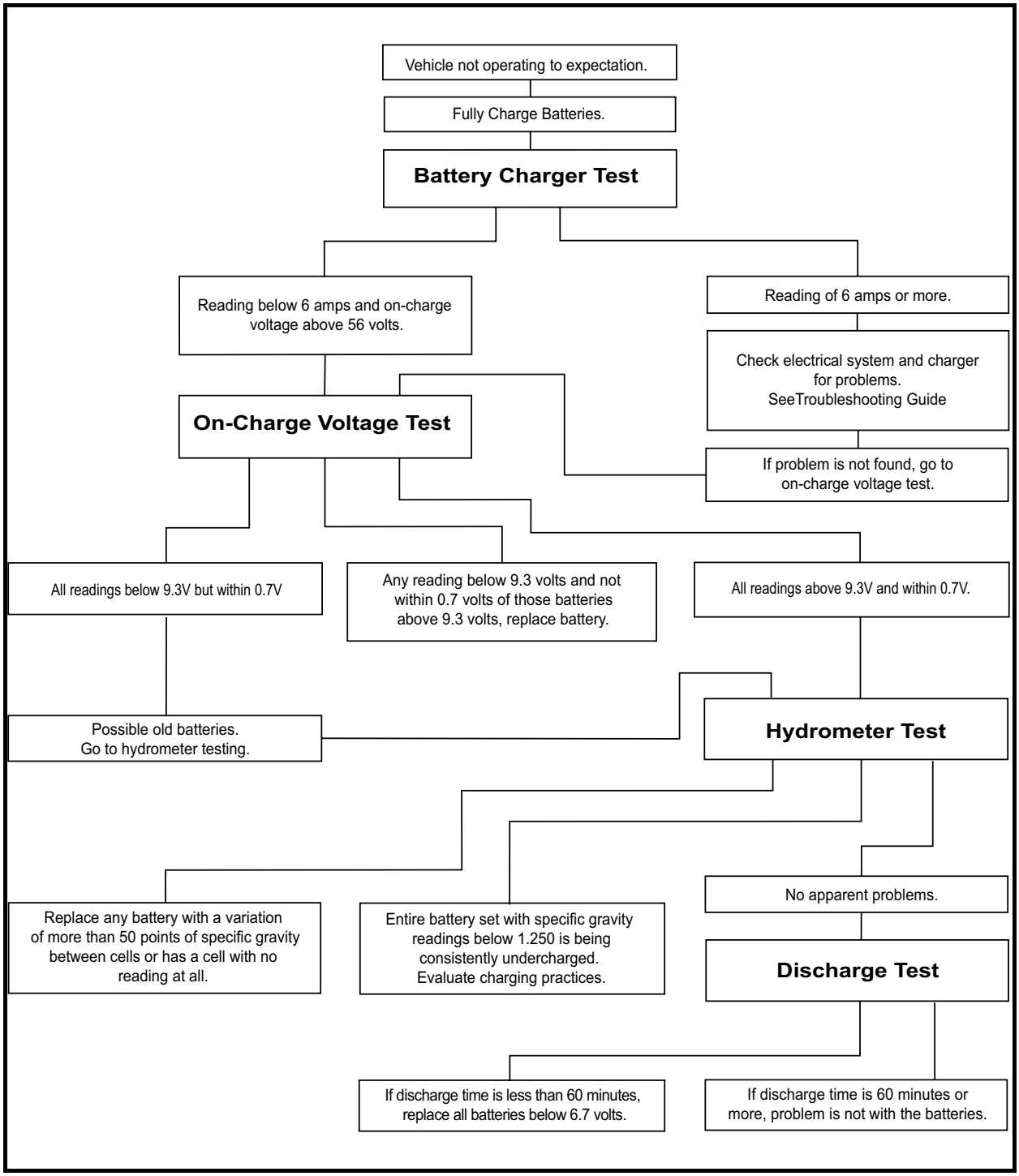


Figure 20-3 Battery Troubleshooting Chart

BATTERY TESTING

See General Warning, Section 1, Page 1-1.

Four tests have been developed to help diagnose problems with batteries that have not performed as expected. Because each test becomes progressively more detailed and time-consuming, begin with the first test and follow through with the other tests until the problem has been identified as outlined in the Battery Troubleshooting Chart **(Figure 20-3, Page 20-6)**.

BATTERY CHARGER TEST

The easiest way to monitor the condition of a vehicle's batteries is simply to observe the reading on the battery charger ammeter at the end of the charge cycle. After a full charge, disconnect the charger DC plug, wait 20 to 30 seconds and reconnect the charger DC plug. The ammeter needle will jump to 15 amps or more and then taper to below 6 amps within 10 to 20 minutes, indicating sound, fully charged batteries.

Continued poor performance may indicate a problem in the vehicle electrical system, brakes or battery charger. If the problem is not found in the vehicle or charging system, proceed to the on-charge voltage test. Batteries that remain at 8 amps or higher should be tested further using the on-charge voltage test.

ON-CHARGE VOLTAGE TEST

When the batteries are fully charged, disconnect the charger DC plug. Wait 20 to 30 seconds and reconnect the DC plug to restart the charger. After 5 minutes, use a multimeter to check and record the voltage of the battery set as well as the individual batteries. Set the multimeter to 200 volts DC. Place the red (+) probe on the positive (+) post of battery no. 1 and the black (–) probe on the negative (–) post of battery no. 4 **(Figure 20-1, Page 20-2)**. Record reading. Then set multimeter to 20 volts DC and place the red (+) probe on the positive (+) post and the black (–) probe at the negative (–) post of each battery. Record the readings.

The on-charge voltage for the set should be between 56.0 volts and 63.0 volts depending on the age and state of charge of the batteries being tested. If individual batteries read above 14.0 volts and are within 1.0 volts of each other, go to the hydrometer test. If any battery reads below 14.0 volts and not within 1.0 volts of those batteries above 14.0 volts, replace battery. If readings are below 14.0 volts but within 1.0 volts of each other, the batteries are old. Old batteries may have enough capacity left to last several more months. Go to hydrometer test. **See Battery Troubleshooting Chart on page 20-6 and the examples on the following pages.**

HYDROMETER TEST

A hydrometer measures the specific gravity of the battery's electrolyte. The higher the specific gravity, the higher the state of charge of the batteries. A fully charged battery should read between 1.250 and 1.280 at 80 °F (26.7 °C). Never add acid to batteries to obtain a higher specific gravity.

Performing the Hydrometer Test

1. Be sure batteries have sufficient electrolyte to cover plates by approximately 1/2 inch (13 mm) and are fully charged prior to beginning test. If water must be added, recharge the batteries before performing the hydrometer test.
2. Remove the vent cap. Using a battery thermometer (CCI P/N 1011767), record electrolyte temperature of the no. 2 cell.
3. Squeeze the rubber bulb of the hydrometer and insert into the cell. Slowly release the bulb, drawing electrolyte up into the glass tube of the hydrometer.
4. When the float rises off the bottom, adjust the electrolyte level so that the float rides free of the bottom but does not strike the top of the glass tube. Remove the hydrometer from the cell and release the pressure from the bulb.

Performing the Hydrometer Test, Continued:

5. Hold the hydrometer vertically, ensuring that the float is not touching the sides of the barrel. Hold the hydrometer at eye level and read the scale at the level of electrolyte **(Figure 20-4, Page 20-8)**.
6. Record the reading and return the electrolyte to the cell from which it was taken. Replace vent cap.
7. Repeat steps 2 through 6 on all cells.

Hydrometer Calibration

Most hydrometers are calibrated to read correctly at 80 °F (26.7 °C). The readings obtained as described above must be corrected for temperature. For each 10 °F (5.6 °C) above 80 °F (26.7 °C), add 0.004 to the reading. For each 10 °F (5.6 °C) below 80 °F (26.7 °C), subtract 0.004 from the reading.

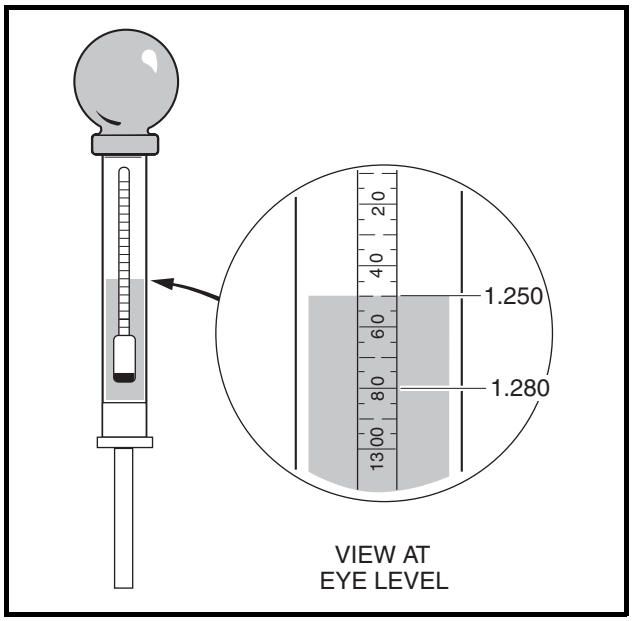


Figure 20-4 Hydrometer

Interpreting the Results of the Hydrometer Test

The approximate state of charge can be determined from the following table:

SPECIFIC GRAVITY (TEMPERATURE CORRECTED)	APPROXIMATE STATE OF CHARGE
1.250-1.280	100%
1.220-1.240	75%
1.190-1.210	50%
1.160-1.180	25%

If the difference between the cells is 0.020 or more, the low cell should be suspected. It may require a catch-up charge or it may be a weak cell. When the variations between cells reach 0.050 or more, the battery with the low cell should be replaced.

VEHICLE NO.	BATTERY NO.	ELECTROLYTE TEMPERATURE	CORRECTION FACTOR	CORRECTED SPECIFIC GRAVITY						REQUIRED ACTION
				CELL 1	CELL 2	CELL 3	CELL 4	CELL 5	CELL 6	
12	1	20 °F (–6.6 °C)	–0.024	1.275 – 0.024 = 1.251	1.280 – 0.024 = 1.256	1.280 – 0.024 = 1.256	1.275 – 0.024 = 1.251	1.280 – 0.024 = 1.256	1.280 – 0.024 = 1.256	Sound Battery – Fully Charged
54	3	50 °F (10 °C)	–0.012	1.260 – 0.012 = 1.248	1.200 – 0.012 = 1.188	1.270 – 0.012 = 1.258	1.265 – 0.012 = 1.253	1.270 – 0.012 = 1.258	1.260 – 0.012 = 1.248	Bad no. 2 Cell
38	2	100 °F (37.8 °C)	+.008	1.200 + 0.008 = 1.208	1.180 + 0.008 = 1.188	1.170 + 0.008 = 1.178	1.200 + 0.008 = 1.208	1.180 + 0.008 = 1.188	1.198 + 0.008 = 1.198	Discharged Battery – Recharge and Recheck
22	4	80 °F (26.7 °C)	.000	1.240 – 0 = 1.240	1.245 – 0 = 1.245	Float does not rise	1.235 – 0 = 1.235	1.250 – 0 = 1.250	1.240 – 0 = 1.240	no.3 Cell Dead – Replace Battery

DISCHARGE TEST

If the previous tests have failed to identify the problem, conduct a discharge test. The discharge test comes closest to simulating actual vehicle operating conditions by continuously drawing current from the batteries until voltage drops to 42.0 volts.

The discharge test is the hardest test on the batteries and the most time-consuming to perform. Use the battery discharge tester (CCI P/N 101831901).

Performing the Discharge Test

1. Be sure the batteries are fully charged and that the electrolyte level is correct in all cells.
2. Connect the tester leads to the positive (+) post of battery no.1 and negative (–) post of battery no. 4 **(Figure 20-5, Page 20-9)**.

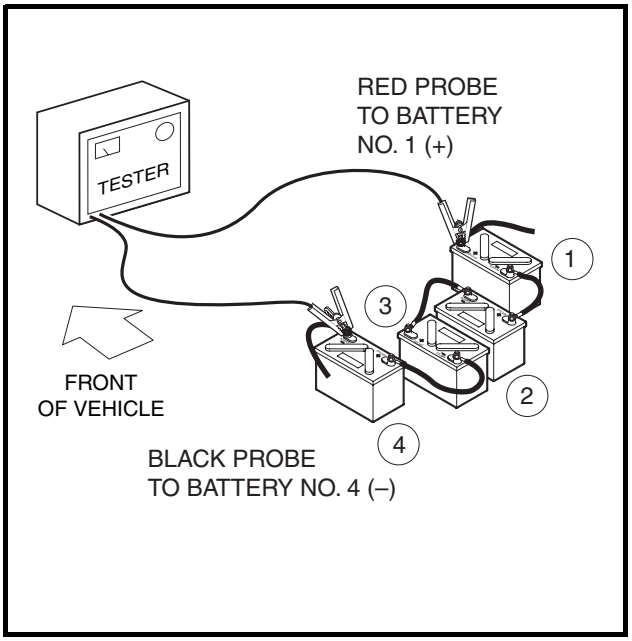


Figure 20-5 Battery Discharge Test

Performing the Discharge Test, Continued:

3. Check and record the electrolyte temperature of the battery packs. Check cell no. 2 (second cell from positive post) in each battery.
4. Reset discharge machine and turn the tester ON.
5. When the batteries have been discharging for approximately 60 minutes, set the discharge machine to function 3 and check battery set voltage. Check voltage every 10 minutes throughout the rest of the test. As soon as the battery set voltage reaches 0.5 volts above the shut-off point (42.0 volts), use a multimeter to measure individual battery voltages. Measure and record the voltage of each battery to the nearest 0.01 volt.

NOTE: *The tester will shut off automatically when shut-off voltage is reached.*

Interpreting Discharge Test Results

1. If discharge time is 60 minutes or higher, the problem is not with the batteries.
2. If discharge times are low (less than 60 minutes), replace batteries below 10.05 volts.

BATTERY VOLTAGES				BATTERY CONDITION
1	2	3	4	
10.50 V	10.50 V	10.50 V	10.50 V	Excellent
10.60 V	10.60 V	10.83 V	9.75 V	Battery no. 4 is near end of useful life
10.8 V	10.8 V	10.01 V	9.41 V	Battery nos. 3 and 4 are near end of useful life

3. In general, battery sets that discharge in less than 60 minutes at 78 °F (25.6 °C) on the discharge test will typically not hold a charge for an entire work shift. However, discharge time is dependent on the electrolyte temperature. The table shown gives the discharge times, at various temperatures, of a set of batteries that delivers 62 minutes at 80 °F (26.7 °C).

ELECTROLYTE TEMPERATURE	DISCHARGE TIME TO SHUT-OFF POINT	ELECTROLYTE TEMPERATURE	DISCHARGE TIME TO SHUT-OFF POINT
40-49 °F (4-9 °C)	40 Minutes	85-89 °F (29-32 °C)	64 Minutes
50-59 °F (10-15 °C)	45 Minutes	89-99 °F (32-37 °C)	66 Minutes
60-64 °F (16-18 °C)	50 Minutes	100-109 °F (38-43 °C)	68 Minutes
65-69 °F (18-21 °C)	54 Minutes	110-119 °F (43-48 °C)	70 Minutes
70-74 °F (21-23 °C)	57 Minutes	120-129 °F (49-54 °C)	72 Minutes
75-79 °F (24-26 °C)	60 Minutes	130-150 °F (54-66 °C)	74 Minutes
80-84 °F (27-29 °C)	62 Minutes	*****	*****

BATTERY TROUBLESHOOTING EXAMPLES

The following information represents a few examples of troubleshooting battery problems.

Example 1

Vehicle no. 68 was suspected of having a bad battery due to its performance. As a result, the battery charger test was performed. After a full charge, the battery charger ammeter read 8.0 amps. Next, the on-charge voltage test was performed and the following results were recorded:

BATTERY NO.	1	2	3	4
On-Charge Voltage	15.22 V	15.90 V	14.70* V	15.24 V

*Battery no. 3 appears suspect. Battery nos. 1 and 4 are also suspect. Next, a hydrometer test should be conducted on all batteries.

Hydrometer test results:

CELL NUMBER	BATTERY NUMBER			
	1	2	3	4
Cell 1 (Positive Post)	1.200*	1.265	1.300	1.250
Cell 2	1.285	1.275	1.290	1.270
Cell 3	1.265	1.270	1.275	1.265
Cell 4 (Negative Post)	1.275	1.270	1.285	1.265
Cell 5	1.270	1.265	1.280	1.270
Cell6	1.275	1.280	1.280	1.260

*After the hydrometer test, it appears that battery no. 1 is the problem. Next, the discharge test was performed.

Discharge test results:

BATTERY NO.	1	2	3	4
Discharge Voltage	8.16* V	10.99 V	11.60 V	10.72 V

*After a discharge test which lasted 45 minutes, battery no. 1 is clearly shown to be the problem. Battery no. 4 should be watched a little more closely but appears to be okay. Battery no. 1 should be replaced with a battery that has about the same age and usage as the other batteries in the set.

Example 2

Vehicle no. 70 was also suspected of having a bad battery due to its performance. The battery charger test showed 7.0 amps after a full charge. After confirming there were no problems with the electrical system, charger or brakes, the on-charge voltage was recorded as follows:

BATTERY NO.	1	2	3	4
On-Charge Voltage	15.72 V	14.66* V	15.80 V	15.85 V

*Battery no. 2 was immediately suspected as the problem. After checking battery no. 2 with a hydrometer, it was discovered that the negative post cell was completely dead. Battery no. 2 should be replaced with a battery that has the same age and usage as the other batteries in the set.

BATTERY STORAGE

See General Warning, Section 1, Page 1-1.

When storing batteries during the off-season or when maintaining a replacement stock, follow these guidelines:

1. Keep the batteries clean and free of corrosion. **See Battery Care on page 20-2.**
2. Batteries that are in vehicles for winter storage should be left disconnected in the vehicles if the batteries are not going to be connected to a charger.
3. Fully charge the batteries prior to storage.
4. Store in a cool area. The colder the area in which the batteries are stored, the less the batteries will self-discharge. Batteries stored at 0 °F (–17.8 °C) will discharge very little over a four-month period. Batteries stored at 80 °F (26.7 °C) will have to be recharged every few weeks.
5. 48-volt electric vehicles and compatible battery chargers are designed to be left connected, with AC power to the charger ON, during off-season storage. The storage charge feature will automatically charge the batteries as needed throughout the storage period.

CHARGING A BATTERY PACK THAT HAS LOW VOLTAGE

See the appropriate battery charger maintenance and service manual.

SECTION 21 – BATTERY CHARGER: ELECTRIC VEHICLE

Refer to the battery charger maintenance and service manual (CCI P/N 102680414).

SECTION 22A – MOTOR (MODEL 5BC59JBS6365)

⚠ DANGER

- **See General Warning, Section 1, Page 1-1.**

⚠ WARNING

- **See General Warning, Section 1, Page 1-1.**

GENERAL INFORMATION

The electric vehicle is equipped with a 48-volt DC, shunt-wound, reversible traction motor. The shunt-wound motor is designed for use on electric vehicles only. It is recommended that motors requiring major repair be sent to a qualified motor repair shop; however, there are many relatively simple tasks that can be performed by a technician with general knowledge and experience in electric motor repair.

MOTOR IDENTIFICATION

There are two types of motors used in 2005-2006 model year electric vehicles: Model 5BC59JBS6365 (gray housing), and EJ4-4001 (black housing). Do not attempt to service a motor that has not been properly identified. If the motor cannot be properly identified, contact your local dealer or distributor.

EXTERNAL MOTOR TESTING

The following tests can be performed without disassembling the motor using a multimeter or continuity tester.

NOTE: *Tag the motor wires for identification before disconnecting.*

TEST PROCEDURE 1 – INTERNAL SHORT CIRCUITS

See General Warning, Section 1, Page 1-1.

1. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.**
2. Disconnect wires from terminals on motor using two wrenches to prevent posts from turning.
3. With a multimeter set to 200 ohms, place black (–) probe on motor housing. Scratch through paint to ensure a good connection. Place red (+) probe on A1, A2, F1, and F2 terminals respectively. Multimeter should indicate no continuity between the motor housing and all individual terminals. If readings are incorrect, motor will need to be removed from the vehicle and repaired by a qualified technician. **See Motor Removal on page 22a-2.**
   3.1. An incorrect reading from the A1 or A2 terminal indicates three possible problems: a grounded A1 or A2 terminal, a grounded wire in the brush area, or a grounded armature/commutator. An incorrect reading for the F1 or F2 terminal indicates a possible grounded F1 or F2 terminal or field coil.

TEST PROCEDURE 2 – ARMATURE CIRCUIT OPEN

See General Warning, Section 1, Page 1-1.

1. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.**
2. Disconnect wires from the A1 and A2 terminals on the motor using two wrenches to prevent posts from turning. Set a multimeter to 200 ohms and place the red (+) probe on the A1 motor terminal and black (–) probe on the A2 motor terminal. The multimeter should indicate continuity. If the reading is incorrect, a possible open or poor contact in a brush assembly and/or open armature windings may be the cause. The motor will need to be removed from the vehicle and repaired by a qualified technician. **See Motor Removal on page 22a-2.**

TEST PROCEDURE 3 – FIELD CIRCUIT OPEN

See General Warning, Section 1, Page 1-1.

1. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.**
2. Disconnect wires from the F1 and F2 terminals on the motor using two wrenches to prevent posts from turning. Set a multimeter to 200 ohms and place the red (+) probe on the F1 terminal and the black (–) probe on the F2 terminal. The multimeter should indicate continuity. If the reading is incorrect, a possible open field coil or bad connections at the terminals may be the cause. The motor will need to be removed from the vehicle and repaired by a qualified technician. **See Motor Removal on page 22a-2.**

MOTOR

See General Warning, Section 1, Page 1-1.

Motor Removal

1. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.**
2. Disconnect wires from the terminals on the motor using two wrenches to prevent posts from turning. Label the wires to ensure proper reconnection.
3. Slightly loosen all the lug nuts on both rear wheels.
4. Place floor jack under transaxle and raise rear of vehicle **(Figure 22a-1, Page 22a-3)** then place jack stands under frame crossmember between the spring mount and the side stringer, just forward of each rear wheel. Lower the vehicle to let the jack stands support the vehicle **(Figure 22a-2, Page 22a-3)**. **See following WARNING**.

⚠ WARNING

- **Lift only one end of the vehicle at a time. Use a suitable lifting device (chain hoist or hydraulic floor jack) with 1000 lb. (454 kg) minimum lifting capacity. Do not use lifting device to hold vehicle in raised position. Use approved jack stands of proper weight capacity to support the vehicle and chock the wheels that remain on the floor. When not performing a test or service procedure that requires movement of the wheels, lock the brakes.**

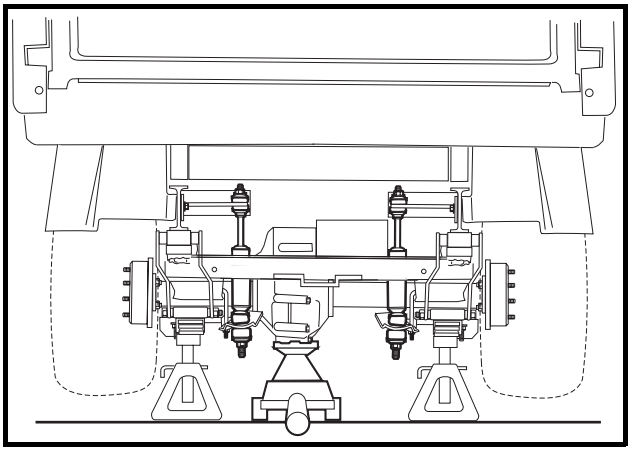


Figure 22a-1 Lift Vehicle with Floor Jack

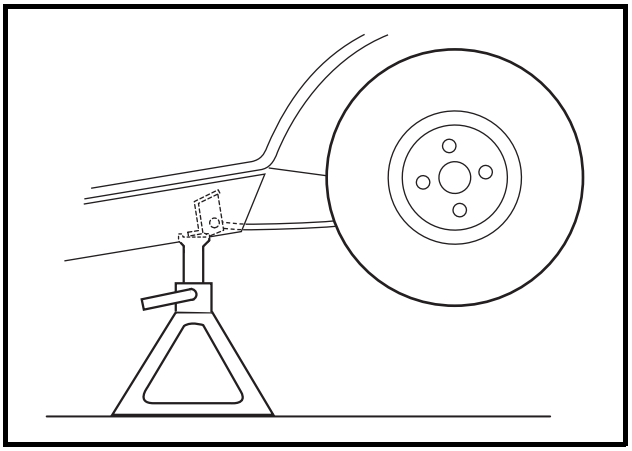


Figure 22a-2 Vehicle Supported on Jack Stands

5. Remove both rear wheels.
6. Remove the nut, cup washer, and bushing from the bottom side of the shock absorber. Compress the shock absorber (pushing upwards) to move it out of the way **(Figure 22a-3, Page 22a-3)**.
7. Remove the nuts and bolts mounting the rear leaf springs to the shackles.
8. To gain easier access to the motor, lower the transaxle as low as it will go. If more room is needed, remove the jack from beneath the transaxle and allow the springs to rest on the floor **(Figure 22a-3, Page 22a-3)**.

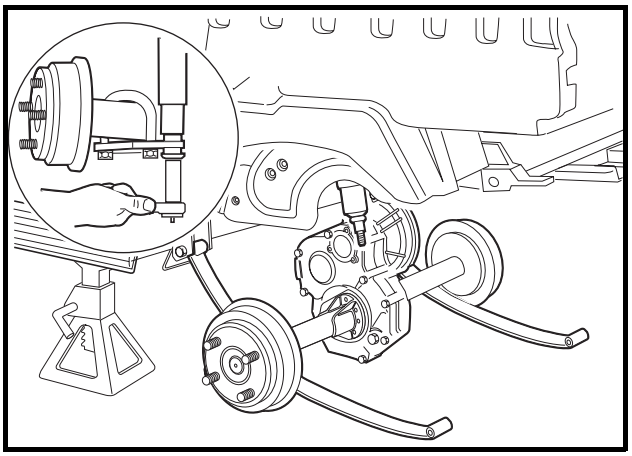


Figure 22a-3 Lower Axle

9. Remove the four bolts that mount the motor to the transaxle **(Figure 22a-18, Page 22a-14). See following CAUTION.**

⚠ CAUTION

- **Do not position fingers under motor when sliding motor off of the input shaft in step 9. Fingers may get pinched when motor disengages.**

10. Carefully slide the motor away from the transaxle until the motor spline disengages the input shaft and remove the motor from the vehicle.

Motor Disassembly

1. Before beginning disassembly, place match marks on the motor end shield and stator shell, then place the motor in a vice with wooden blocks as shown **(Figure 22a-4, Page 22a-4)**.
2. Remove the four bolts (8) securing the end shield (10) to the stator shell (2).
3. Remove the two screws (9) attaching the end shield to the bearing retainer.
4. Slide the armature (17) out of the opposite end of the stator shell (2).
5. Remove two screws (11) attaching brush rigging (12) to the stator shell (2) **(Figure 22a-9, Page 22a-8)**.
6. Mark the brush terminal posts (A1 and A2) (13) to identify their positions in the stator shell, then remove the nuts (6) and flat washers (5) **(Figure 22a-9, Page 22a-8)**. From the outside, push the posts through the stator shell wall into the interior of the stator shell.
7. Carefully remove the brush rigging and the terminal posts from the stator shell.
8. To remove brush springs (14) from the rigging, lift the spring extensions out and over the brush mounts and then slide the springs off their mounting tabs **(Figure 22a-5, Page 22a-4)**.

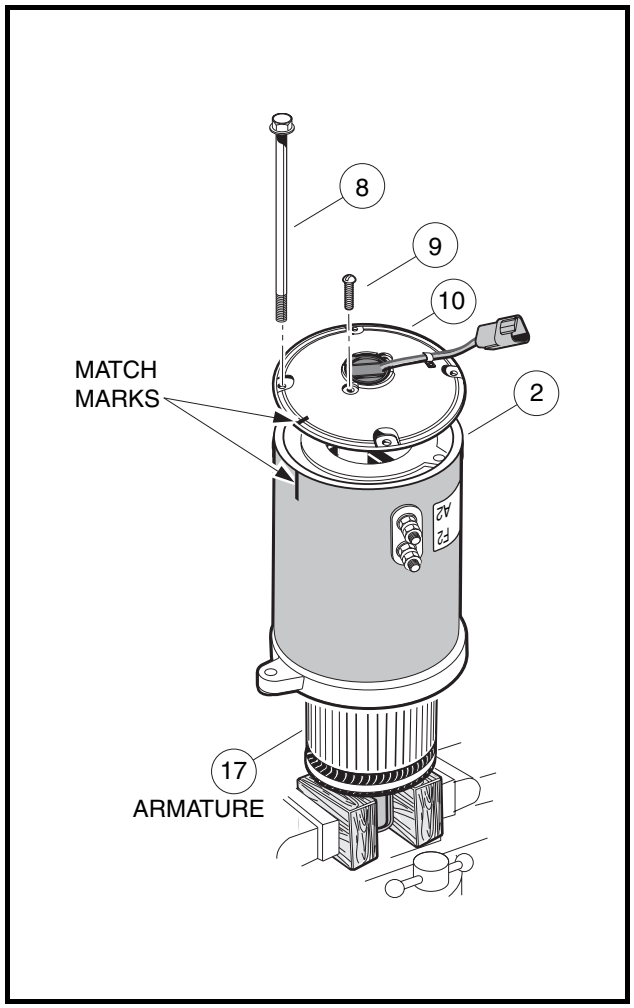


Figure 22a-4 Motor Disassembly

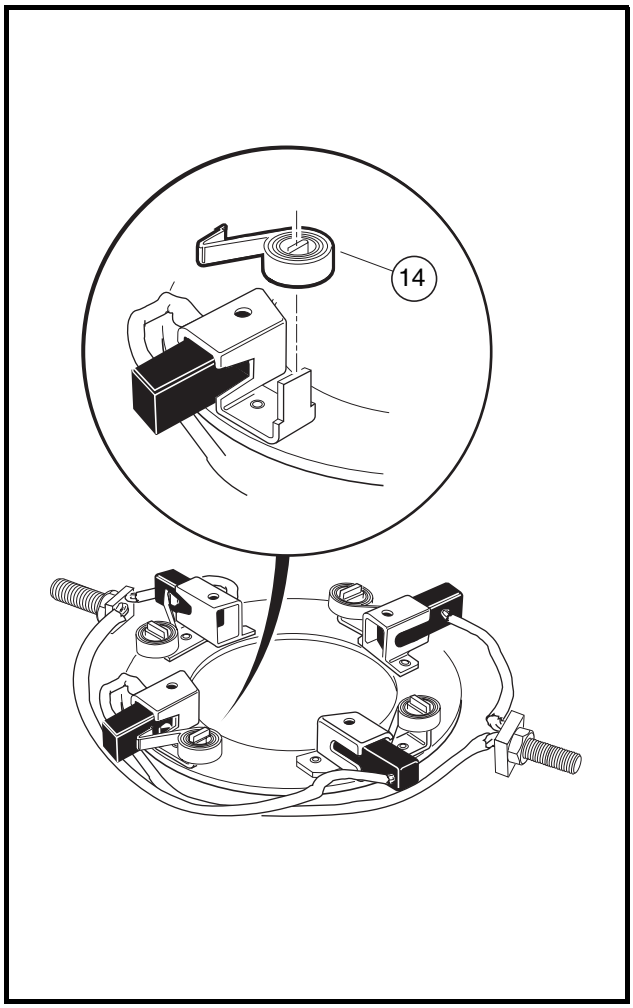


Figure 22a-5 Brush Spring Removal

MOTOR COMPONENT TESTING AND INSPECTION

See General Warning, Section 1, Page 1-1.

ARMATURE

Visual Inspection

Disassemble the motor and carefully inspect the armature for the following characteristics:

- Burned, charred or cracked insulation
- Improperly cured varnish
- Thrown solder
- Flared armature windings
- Damaged armature core laminations
- Worn, burned or glazed commutators
- Dirty or oily commutators
- Raised commutator bars
- Worn armature bearing or shaft

A dirty or oily commutator should be cleaned and wiped dry. Abnormalities identified during the inspection can help determine original cause of failure. Slight roughness of the commutator can be polished smooth with 400 grit or finer sandpaper. **See following CAUTION and NOTE.**

CAUTION

- **Do not use emery cloth to polish the commutator. Particles of emery are conductive and may short-circuit the commutator bars. Do not use oil or lubricants on the commutator or brushes.**

NOTE: *Oil on the commutator may indicate a faulty transaxle input shaft oil seal.*

Armature Ground Test

CAUTION

- **Do not submerge the armature in solvent.**

NOTE: *Before testing the armature, wipe it clean with a clean cloth. Remove any carbon dust and metal particles from between the commutator bars.*

1. With a multimeter set to 200 ohms, place one probe on the commutator and the other on the armature core. The multimeter should indicate no continuity **(Figure 22a-6, Page 22a-6)**. If the reading is incorrect, replace the armature.

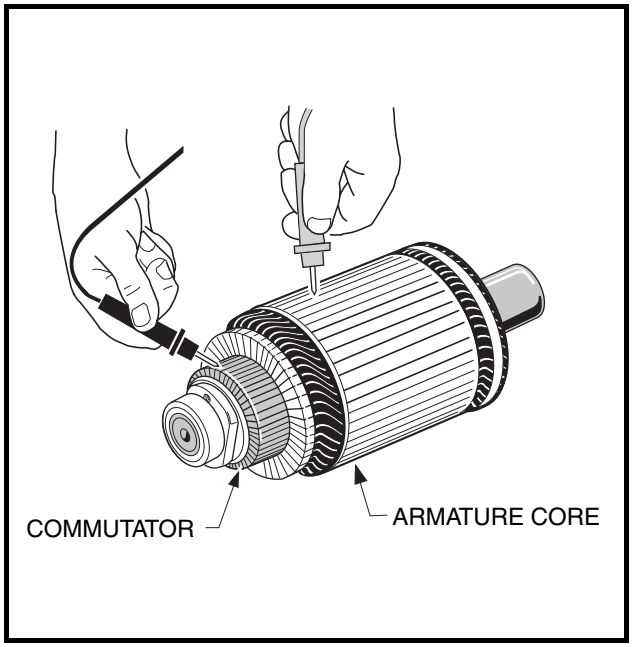


Figure 22a-6 Armature Test

FIELD WINDINGS INSPECTION

Burned or scorched insulation on the field windings indicates the motor has overheated due to overloads or grounded or shorted coil windings. If the insulation on the field windings is scorched, replace the motor or the stator shell assembly.

MOTOR COMPONENTS

1. Inspect the insulators (4 and 7) for cracks or other damage **(Figure 22a-9, Page 22a-8)**.
2. Inspect the brushes (13) for damage or excessive wear. Replace brushes if required. **See following NOTE.**
3. Inspect the brush springs (14) **(Figure 22a-9, Page 22a-8)**. Replace springs that are discolored from heat (light gold or blue tinted). Replace springs which apply a force of less than 16 oz. **(Figure 22a-7, Page 22a-7)**. **See following CAUTION and NOTE.**

CAUTION

- **When checking brush spring tension, do not over-extend the spring. Using excessive force will damage the spring.**

NOTE: *When installing new brushes, remove and replace brushes one at a time. This method ensures the terminals and brushes will be properly positioned in the rigging. Refer to Motor Assembly for brush installation.* ***See Motor Assembly on page 22a-10.***

When replacing brushes, replace all four brushes. Never replace only two.

Install the brushes in the same rigging 180° apart from each other.

BEARING INSPECTION

1. Use a clean cloth to wipe the carbon dust off of the bearing. Inspect the bearing by spinning it by hand and checking for both axial (A) and radial (B) play **(Figure 22a-8, Page 22a-7)**.
2. Replace the bearing if it is noisy, does not spin smoothly, or has excessive play. Check the bearing and replace if rusted, worn, cracked, or if there is an abnormal color change in the metal of the bearing. Do not remove the bearing from the armature shaft unless it is to be replaced.

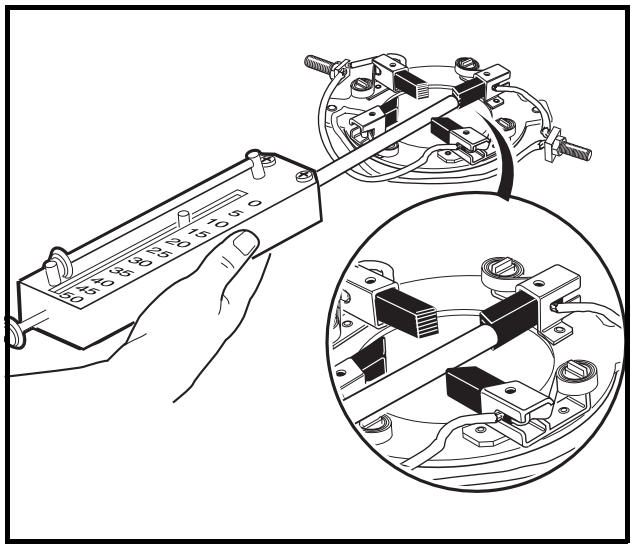


Figure 22a-7 Brush Spring Tension Test

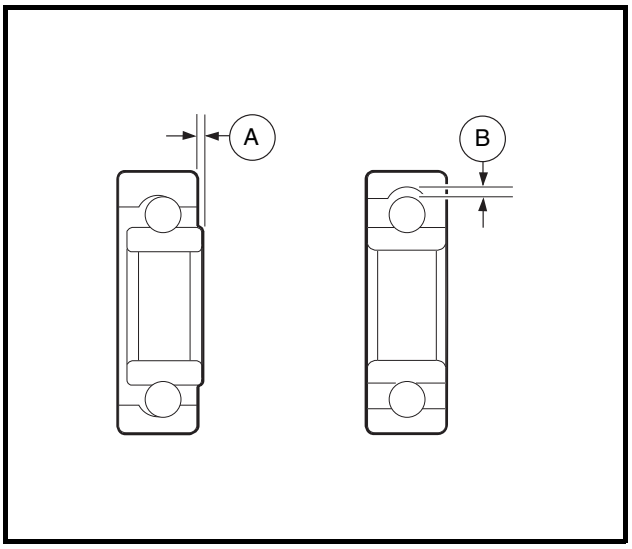


Figure 22a-8 Inspect Bearing

BEARING REMOVAL

1. Place the wedge attachment tool (CCI P/N 1012812) between the bearing (15) and the armature (17) **(Figure 22a-9, Page 22a-8)**. Make sure the wedge attachment tool is supporting the inner race of the bearing. If a press is not available, secure a bearing puller (CCI P/N 1012811) to the bearing and pull the bearing off of the end of the armature shaft. Support the shaft so it will not drop when the bearing is removed **(Figure 22a-10, Page 22a-10)**. Discard the bearing and speed sensor magnet. **See following NOTE.**

NOTE: *The speed sensor magnet will be pressed off by the bearing when the bearing is removed.*

BEARING INSTALLATION

1. Press a new bearing (15) onto the armature **(Figure 22a-9, Page 22a-8)**. Use an arbor press that exerts pressure on the inner race only. **See following NOTE**.

NOTE: *Make sure the bearing retainer (16) is positioned on the armature shaft before the bearing is pressed onto the armature* ***(Figure 22a-9, Page 22a-8)****.*

An arbor with an outside diameter of less than 5/8 inch (16 mm) should be used to press the bearing onto the armature.

2. Install the speed sensor magnet. **See Speed Sensor Magnet Installation on page 22a-9.**

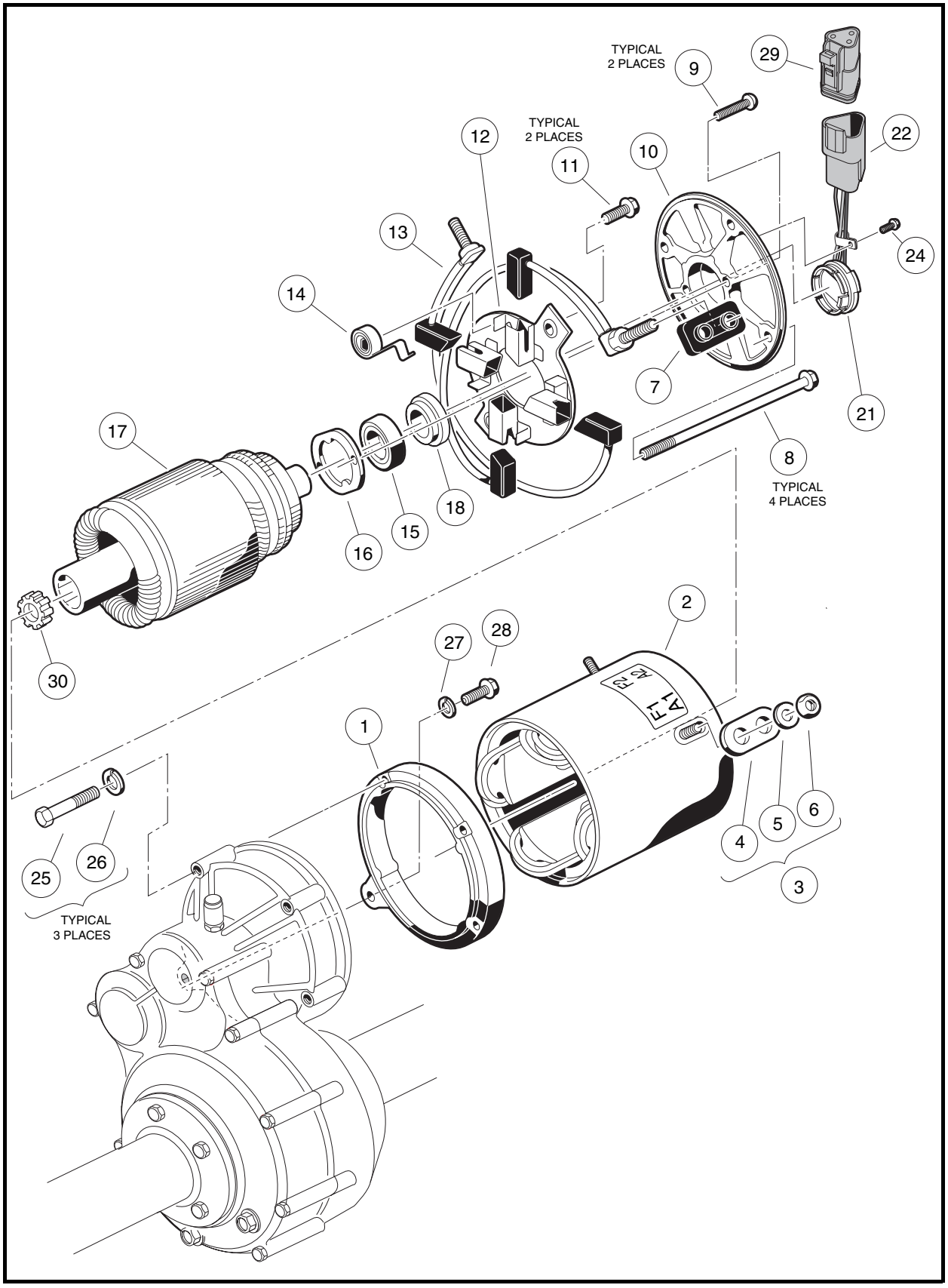


Figure 22a-9 Motor – Model 5BC59JBS6365

SPEED SENSOR MAGNET INSPECTION

Inspect the speed sensor magnet (18) for rust, wear, and cracks **(Figure 22a-9, Page 22a-8)**. Replace the magnet if necessary.

SPEED SENSOR MAGNET REMOVAL

1. To remove the speed sensor magnet (18), remove the motor bearing **(Figure 22a-9, Page 22a-8)**. **See Bearing Removal on page 22a-7.**

SPEED SENSOR MAGNET INSTALLATION

1. Using a solid bearing driver with a diameter of no less than 1 inch (2.54 cm), press the motor speed sensor magnet (18) onto the shaft until the magnet hub is flush with the armature shaft.

RECONDITIONING THE MOTOR

See General Warning, Section 1, Page 1-1.

Motor reconditioning must be performed by a qualified motor repair technician. The use of proper tools and procedures is absolutely essential for successful motor reconditioning.

Motor Specifications

Any rework must be performed by a qualified technician. Motor service specifications are listed in the following table.

ITEM	SERVICE LIMIT
Commutator diameter (minimum)	2.265 in. (66.675 mm)
Commutator concentric with armature shaft within	0.001 in. (0.0254 mm)
Limit depth of cut when machining commutator	0.005 in. (0.127 mm)
Bar to bar runout should not exceed	0.002 in. (0.00508 mm)
If undercut of segment insulator is less than 0.016 inch (0.406 mm), it should be undercut to	0.031 in. (0.8 mm)
Machined face of commutator	8-16 microinches (203.2-406.4 nm)
Field coil resistance (shunt-wound, 3.20 hp)	1.61 ohms

MOTOR ASSEMBLY

See General Warning, Section 1, Page 1-1.

1. If the bearing has been removed, replace the bearing. **See Bearing Installation on page 22a-7.**
2. Install the brushes. **See following NOTE.**

NOTE: *When installing new brushes, remove and replace brushes one at a time. This method ensures the terminals and brushes will be properly positioned in the rigging. Refer to Motor Assembly for brush installation.* ***See Motor Assembly on page 22a-10.***

When replacing brushes, replace all four brushes. Never replace only two.

Install the brushes in the same rigging 180° apart from each other.

2.1. With brush rigging facing down and held slightly above stator shell, insert the two terminal posts through insulators in stator shell wall at the A1 and A2 positions. Insert brush holder screws through the holes in the brush rigging and into the threaded holes in the mounting bracket **(Figure 22a-11, Page 22a-11)**. Tighten the screws to 20 in-lb (2.3 N·m).

2.2. One at a time, push brush spring extensions back from brushes and slide the brushes back until they are completely retracted into their mounting slots. Then position the brush springs against the sides of the brushes so that spring pressure will hold them in the retracted position **(Figure 22a-5, Page 22a-4)**.

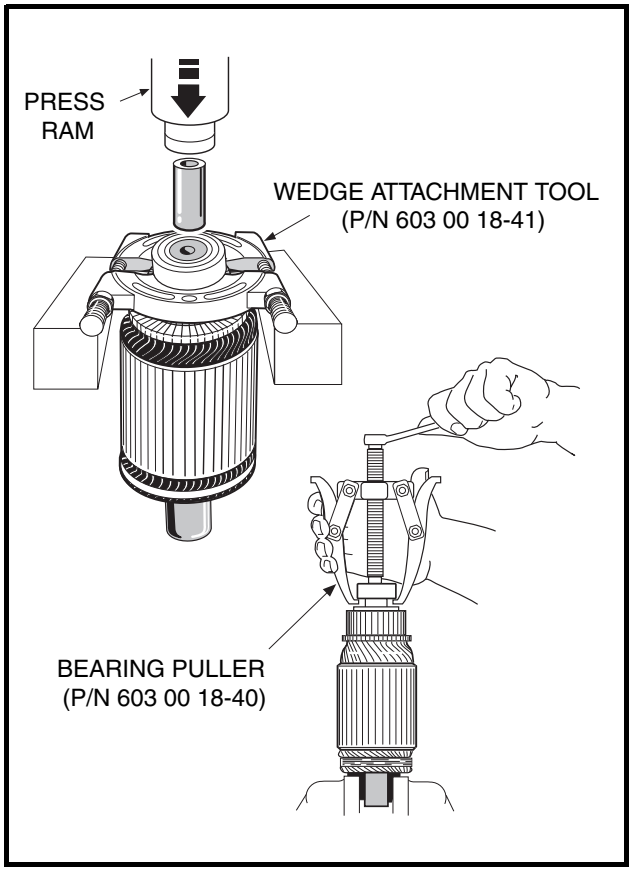


Figure 22a-10 Bearing Removal

2.3. Slide the armature, bearing end first, into the stator shell. Make sure the brushes are held back while positioning the armature for proper commutator/brush contact. Release the brushes and place the springs outside the brushes so the brushes are being held against the commutator. **See following CAUTION**.

CAUTION

- **If the motor is being assembled with the armature standing on end as the commutator is positioned, make sure the brushes are held back. Do not allow the brushes to support the weight of the stator shell. The brushes can be easily damaged by this weight.**

3. Install the end shield onto the stator shell.

3.1. Attach the end shield (10) to bearing retainer (16) by aligning the two holes in the bearing retainer with the two mating holes in the end shield and installing the screws (9) **(Figure 22a-9, Page 22a-8)**. Tighten the screws to 17 in-lb (1.9 N·m). **See following NOTE.**

NOTE: *Use a long screw with the same thread specifications as the mounting screws to maintain hole alignment while starting the first mounting screw* ***(Figure 22a-12, Page 22a-11).***

3.2. Align the match marks on the end shield and the stator shell, then install the four screws (8) **(Figure 22a-9, Page 22a-8)**. Tighten the screws to 90 in-lb (10 N·m). **See following NOTE.**

NOTE: *Make sure the motor speed sensor wires located on the end shield are aligned between the terminals on the motor housing.*

4. Make sure the armature turns freely. If it does not turn freely, disassemble the motor to find the problem. Make sure the bearing is properly seated in the end shield when assembling the motor.

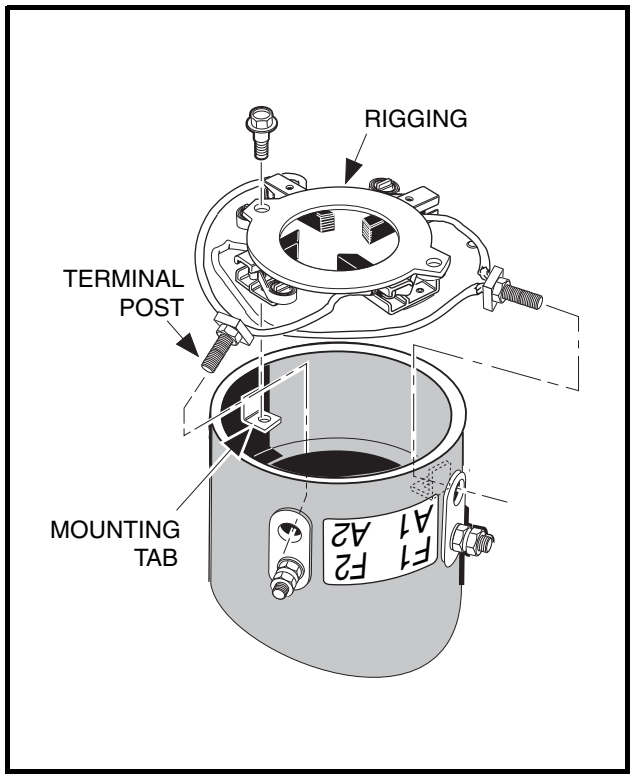


Figure 22a-11 Brush Installation

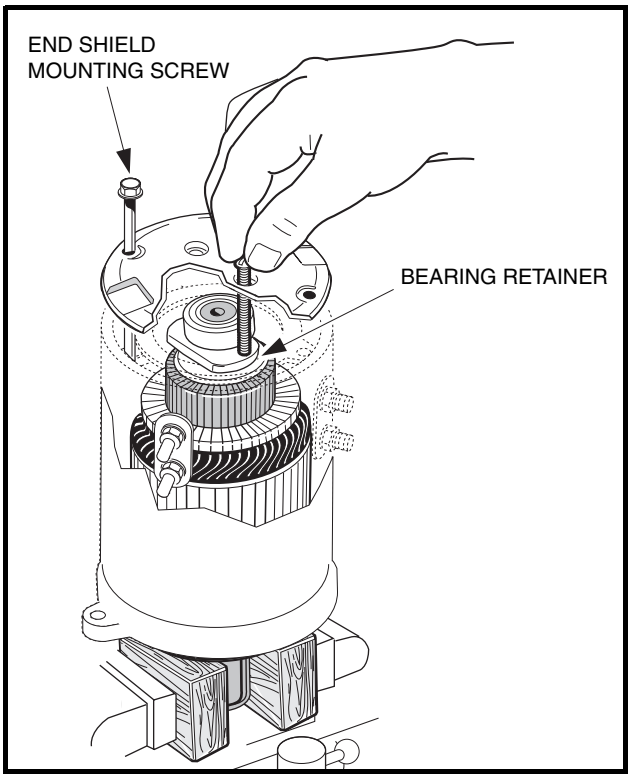


Figure 22a-12 End Shield Installation

MOTOR INSTALLATION

See General Warning, Section 1, Page 1-1.

1. Clean the transaxle input shaft.
   1.1. Spray the input shaft thoroughly with CRC® Brakleen™ or equivalent brake cleaner degreaser.
   1.2. Wipe input shaft with a clean cloth.
   1.3. Inspect the grooves of the input shaft and remove any remaining debris.
   1.4. Repeat steps 1.1 through 1.3 until input shaft is clean.
2. Lubricate the transaxle input shaft.
   2.1. Squeeze approximately 1/2 inch (1.3 cm) of moly-teflon lubricant (CCI P/N 102243403) from tube onto a putty knife as shown **(Figure 22a-13, Page 22a-12)**.
   2.2. Rotate wheels to rotate input shaft.
   2.3. Apply motor coupling grease evenly to the rotating input shaft starting at approximately 1/8 inch (3.1 mm) from the end of the shaft and working back toward the transaxle (away from the end of the shaft) **(Figure 22a-14, Page 22a-12)**.
   2.4. The grease should be evenly distributed in the grooves to a width of approximately 3/8 inch (9.5 mm).
   2.5. Use a flat screwdriver to clean the grease out of one of the grooves and allow air to escape when the motor is pushed onto the input shaft.

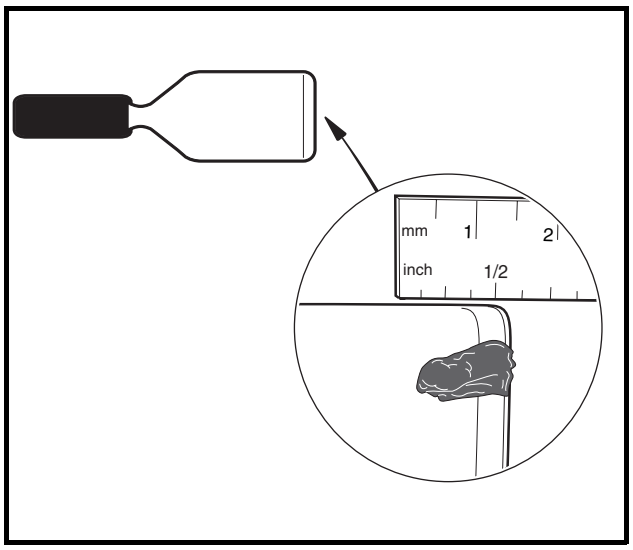


Figure 22a-13 Grease on Putty Knife

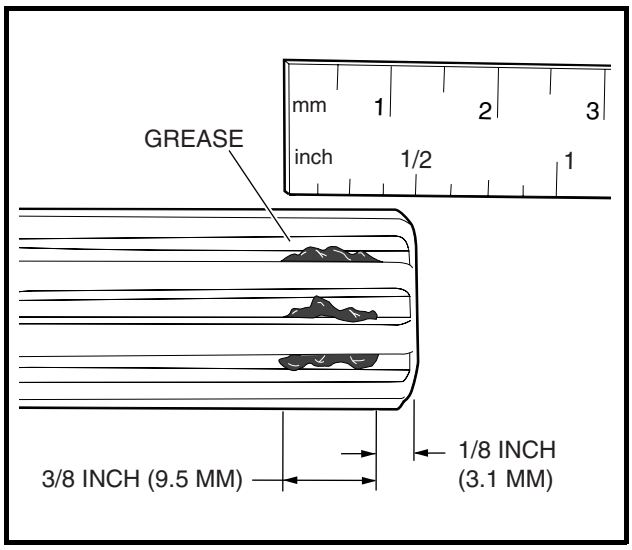


Figure 22a-14 Application of grease to Input Shaft Grooves

   2.6. Check the chamfer and end of the input shaft to ensure these areas are completely clean of grease as shown **(Figure 22a-15, Page 22a-13)**.
3. Install the molded bumper.
   3.1. With the flat side toward the bottom of the coupling, install the molded bumper (30) into the motor coupling **(Figure 22a-9, Page 22a-8)**. **See following NOTE.**

NOTE: *The motor coupling and the new molded bumper must be free of grease and debris.*

   3.2. Ensure that the installed bumper is seated at the bottom of the coupling.

4. Install motor on transaxle.
   4.1. Slide the motor coupling onto the transaxle input shaft. **See following NOTE.**

NOTE: *The coupling will push any excess grease on the input shaft along the shaft toward the transaxle.*

*When the motor is pushed onto the input shaft, the motor adapter ring (1) will not bottom out against the transaxle housing **(Figure 22a-9, Page 22a-8)**. There will be approximately 1/16 inch (1.6 mm) gap between the motor adapter ring and transaxle housing as shown **(Figure 22a-16, Page 22a-13)**.*

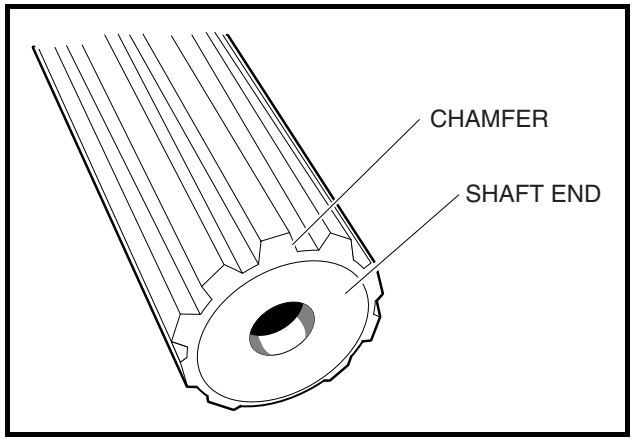


Figure 22a-15 Clean Chamfer and Input Shaft End

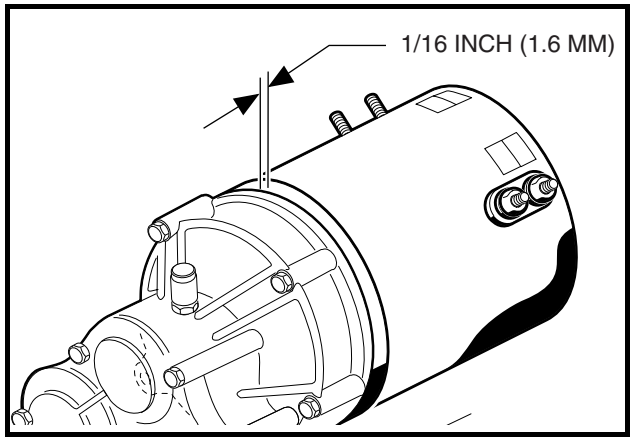


Figure 22a-16 Gap at Motor and Transaxle

   4.2. Loosely install four motor bolts and washers that secure the motor to the transaxle. Do not tighten.
   4.3. Begin finger-tightening the bolts (1 and 2) in the sequence indicated **(Figure 22a-18, Page 22a-14)**. Continue tightening by hand until the motor is seated in the transaxle housing. **See following CAUTION and NOTE.**

CAUTION

- **Make sure the motor is properly seated in the transaxle housing.**

NOTE: *Failure to install and tighten the motor mounting bolts in the proper sequence and to the proper tightness may result in motor noise during operation.*

   4.4. Tighten the bolt (24) inserted through the tab to 155 in-lb (17.5 N·m) **(Figure 22a-17, Page 22a-14)**.
   4.5. Tighten the center bolt (2) to 65 in-lb (7.3 N·m) **(Figure 22a-18, Page 22a-14)**.
   4.6. Tighten the right bolt (3) to 65 in-lb (7.3 N·m).
   4.7. Tighten the left bolt (4) to 65 in-lb (7.3 N·m).
   4.8. Install the motor wires, making sure they are connected to the correct motor terminals and that the terminal orientation is correct. **See Wiring Diagram, Section 18, Page 18-2.** Tighten the terminal retaining nuts to 65 in-lb (7.3 N·m).
   4.9. Secure the white, orange, green, and blue wires with a wire tie so that none of the motor wires will scrub the motor or transaxle when the vehicle is in operation.
   4.10. Connect the three-pin speed sensor wire to the vehicle wire harness.
5. If using a chain hoist, lower the vehicle and guide the leaf springs into the shackles. If using a floor jack, raise the transaxle until the leaf springs can be guided into the shackles.

Motor Installation, Continued:

6. Insert the mounting bolts through the spring shackles and the bushings in the leaf spring eyes and install locknuts. Tighten the bolts to 23 ft-lb (31 N·m). **See Leaf Spring Installation, Section 9, Page 9-4.**
7. Install the shock absorbers. Tighten nut until rubber bushing expands to the diameter of the cup washer.
8. If removed, install wheels and finger tighten the lug nuts.
9. Lift vehicle and remove jack stands. Lower vehicle to the floor and tighten lug nuts, using a crisscross pattern, to 55 ft-lb (74.6 N·m).
10. Place the Tow/Run switch in the TOW position and connect the batteries, positive (+) cable first. Tighten battery terminals to 110 in-lb (12.4 N·m) and coat terminals with Battery Terminal Protector Spray (CCI P/N 1014305) to minimize corrosion.
11. Place the Tow/Run switch in the RUN position.
12. Inspect the vehicle for proper operation. **See following WARNING.**

⚠ WARNING

- **Make sure that the vehicle operates in the forward direction when the Forward/Reverse switch is in the FORWARD position.**
- **Make sure that the vehicle operates in the reverse direction when the Forward/Reverse switch is in the REVERSE position. The reverse buzzer will sound as a warning when the Forward/Reverse switch is in REVERSE.**
- **Make sure that the vehicle does not operate when the Forward/Reverse switch is in the NEUTRAL position.**

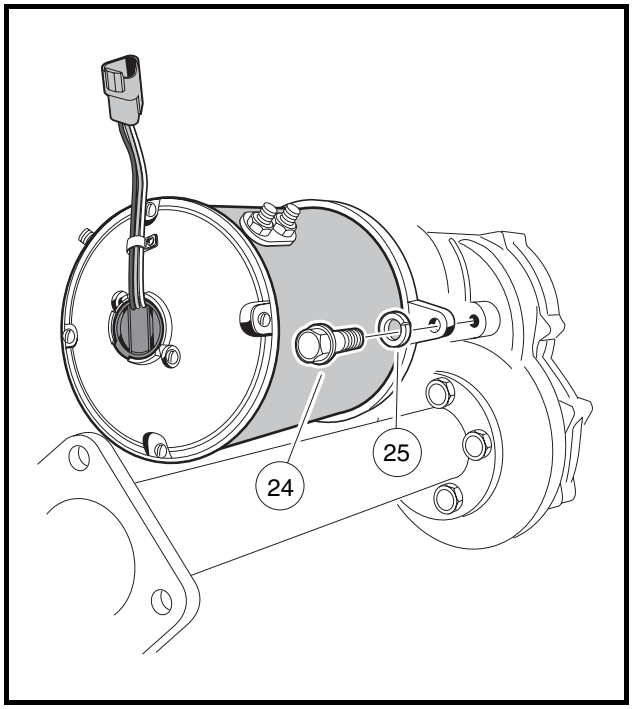


Figure 22a-17 Motor Installation

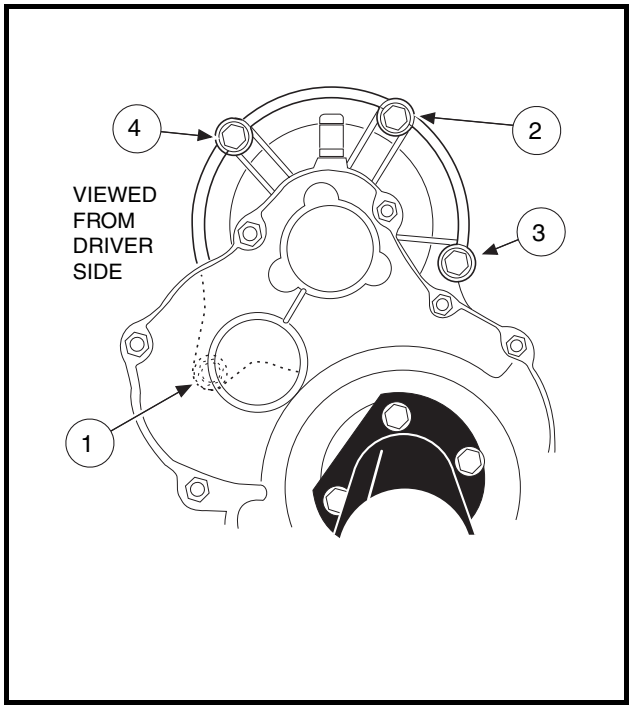


Figure 22a-18 Motor Mount

MOTOR SPEED SENSOR

See General Warning, Section 1, Page 1-1.

Testing the Motor Speed Sensor

See Test Procedure 13, Section 18, Page 18-30.

Motor Speed Sensor Removal

1. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.**
2. Disconnect the three-pin connector (22) from the vehicle wire harness **(Figure 22a-19, Page 22a-15)**.
3. Using a screwdriver, gently pry the motor speed sensor (21) from recessed area on the motor end shield.

Motor Speed Sensor Installation

1. Position the motor speed sensor (21) as shown and firmly press the speed sensor into the motor end shield. Sensor should fit flush against the motor **(Figure 22a-19, Page 22a-15)**.
2. Connect the three-pin connector (22) to the vehicle wire harness.
3. Place the Tow/Run switch in the TOW position and connect the batteries, positive (+) cable first. Tighten battery terminals to 110 in-lb (12.4 N·m) and coat terminals with Battery Terminal Protector Spray (CCI P/N 1014305) to minimize corrosion.

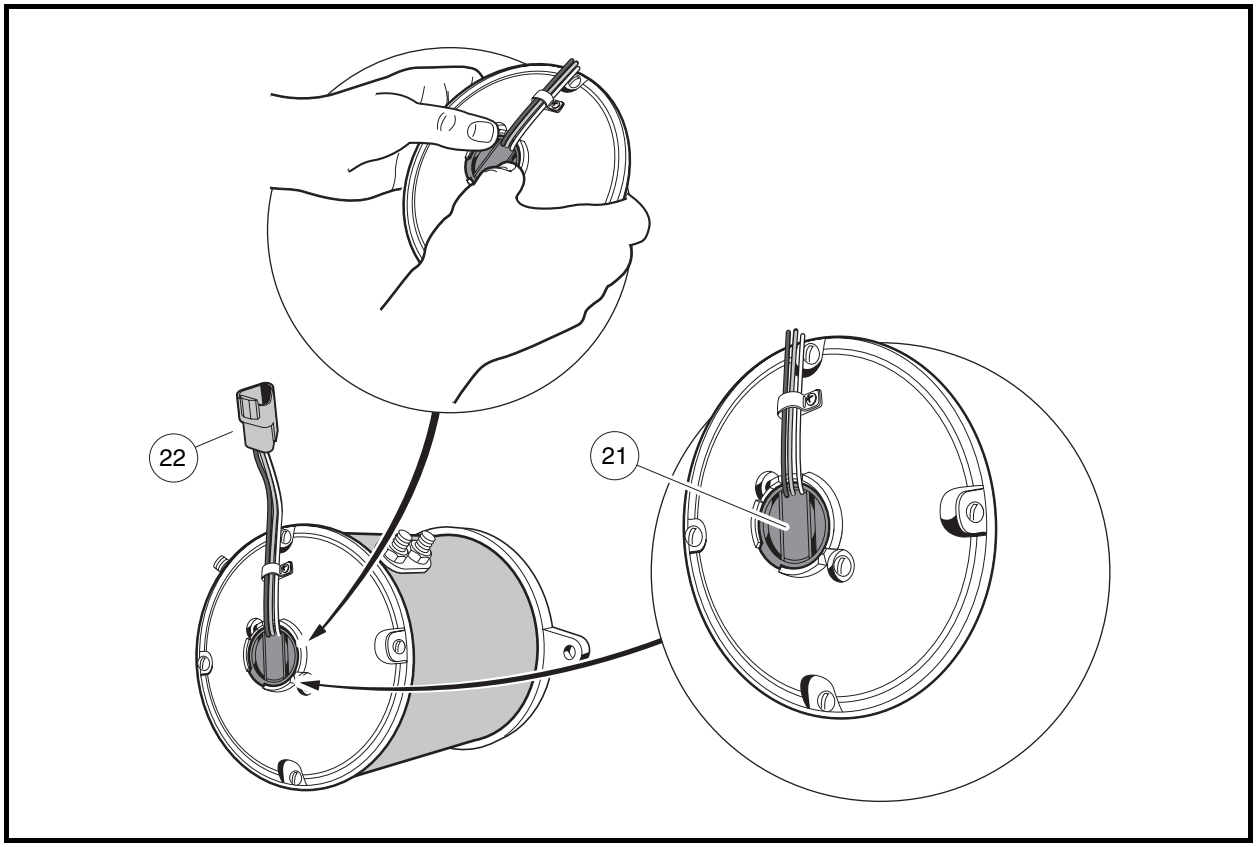


Figure 22a-19 Motor Speed Sensor

SECTION 22B – MOTOR (MODEL EJ4-4001)

⚠ DANGER

- **See General Warning, Section 1, Page 1-1.**

⚠ WARNING

- **See General Warning, Section 1, Page 1-1.**

GENERAL INFORMATION

The electric vehicle is equipped with a 48-volt DC, shunt-wound, reversible traction motor. The shunt-wound motor is designed for use on electric vehicles only. It is recommended that motors requiring major repair be sent to a qualified motor repair shop; however, there are many relatively simple tasks that can be performed by a technician with general knowledge and experience in electric motor repair.

MOTOR IDENTIFICATION

There are two types of motors used in 2005-2006 model year electric vehicles: Model 5BC59JBS6365 (gray housing), and EJ4-4001 (black housing). Do not attempt to service a motor that has not been properly identified. If the motor cannot be properly identified, contact your local dealer or distributor.

EXTERNAL MOTOR TESTING

The following tests can be performed without disassembling the motor using a multimeter or continuity tester.

NOTE: *Tag the motor wires for identification before disconnecting.*

TEST PROCEDURE 1 – INTERNAL SHORT CIRCUITS

See General Warning, Section 1, Page 1-1.

1. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.**
2. Disconnect wires from terminals on motor using two wrenches to prevent posts from turning.
3. With a multimeter set to 200 ohms, place black (–) probe on motor housing. Scratch through paint to ensure a good connection. Place red (+) probe on A1, A2, S1, and S2 terminals respectively. Multimeter should indicate no continuity. If readings are incorrect, motor will need to be removed from the vehicle and repaired by a qualified technician. **See Motor Removal on page 22b-2.**
   3.1. An incorrect reading from the A1 or A2 terminal indicates three possible problems: a grounded A1 or A2 terminal, a grounded wire in the brush area, or a grounded armature/commutator. An incorrect reading for the S1 or S2 terminal indicates a possible grounded S1 or S2 terminal or field coil.

TEST PROCEDURE 2 – ARMATURE CIRCUIT OPEN

See General Warning, Section 1, Page 1-1.

1. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.**
2. Disconnect wires from the A1 and A2 terminals on the motor using two wrenches to prevent posts from turning. Set a multimeter to 200 ohms and place the red (+) probe on the A1 terminal and black (–) probe on the A2 terminal. The multimeter should indicate continuity. If the reading is incorrect, a possible open or poor contact in a brush assembly and/or open armature windings may be the cause. The motor will need to be removed from the vehicle and repaired by a qualified technician. **See Motor Removal on page 22b-2.**

TEST PROCEDURE 3 – FIELD CIRCUIT OPEN

See General Warning, Section 1, Page 1-1.

1. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.**
2. Disconnect wires from the S1 and S2 terminals on the motor using two wrenches to prevent posts from turning. Set a multimeter to 200 ohms and place the red (+) probe on the S1 terminal and the black (–) probe on the S2 terminal. The multimeter should indicate continuity. If the reading is incorrect, a possible open field coil or bad connections at the terminals may be the cause. The motor will need to be removed from the vehicle and repaired by a qualified technician. **See Motor Removal on page 22b-2.**

MOTOR

See General Warning, Section 1, Page 1-1.

MOTOR REMOVAL

1. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warning, Section 1, Page 1-1.**
2. Disconnect wires from the terminals on the motor using two wrenches to prevent posts from turning. Label the wires to ensure proper reconnection.
3. Slightly loosen all the lug nuts on both rear wheels.
4. Place floor jack under transaxle and raise rear of vehicle **(Figure 22b-1, Page 22b-3)** then place jack stands under frame crossmember between the spring mount and the side stringer, just forward of each rear wheel. Lower the vehicle to let the jack stands support the vehicle **(Figure 22b-2, Page 22b-3)**. **See following WARNING**.

⚠ WARNING

- **Lift only one end of the vehicle at a time. Use a suitable lifting device (chain hoist or hydraulic floor jack) with 1000 lb. (454 kg) minimum lifting capacity. Do not use lifting device to hold vehicle in raised position. Use approved jack stands of proper weight capacity to support the vehicle and chock the wheels that remain on the floor. When not performing a test or service procedure that requires movement of the wheels, lock the brakes.**

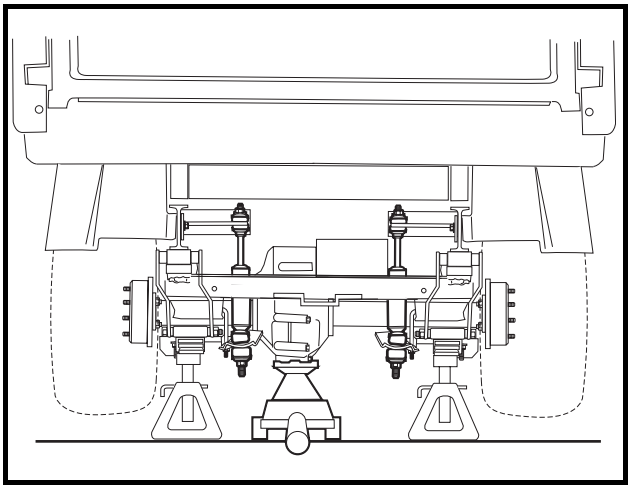


Figure 22b-1 Lift Vehicle with Floor Jack

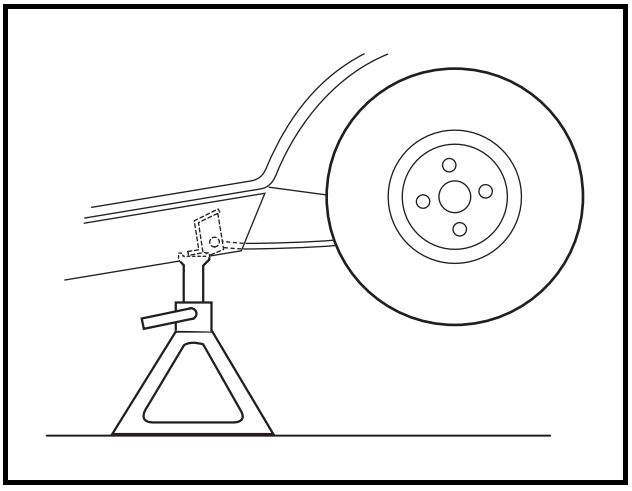


Figure 22b-2 Vehicle Supported on Jack Stands

5. Remove both rear wheels.
6. Remove the nut, cup washer, and bushing from the bottom side of the shock absorber. Compress the shock absorber (pushing upwards) to move it out of the way **(Figure 22b-3, Page 22b-3)**.
7. Remove the nuts and bolts mounting the rear leaf springs to the shackles.
8. To gain easier access to the motor, lower the transaxle as low as it will go. If more room is needed, remove the jack from beneath the transaxle and allow the springs to rest on the floor **(Figure 22b-3, Page 22b-3)**.

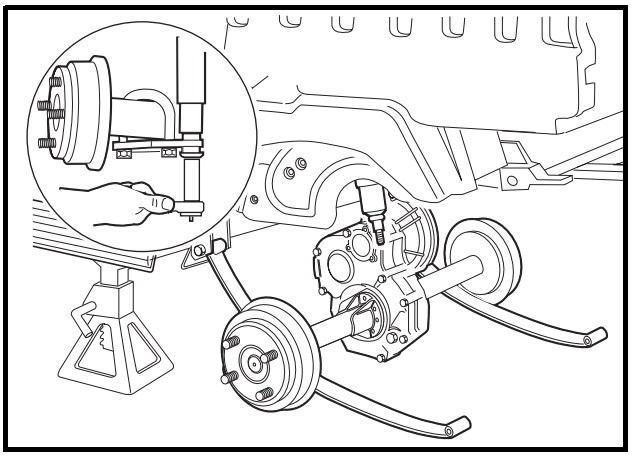


Figure 22b-3 Lower Axle

9. Remove the four bolts that mount the motor to the transaxle **(Figure 22b-24, Page 22b-15). See following CAUTION.**

⚠ CAUTION

- **Do not position fingers under motor when sliding motor off of the input shaft in step 9. Fingers may get pinched when motor disengages.**

10. Carefully slide the motor away from the transaxle until the motor spline disengages the input shaft and remove the motor from the vehicle.

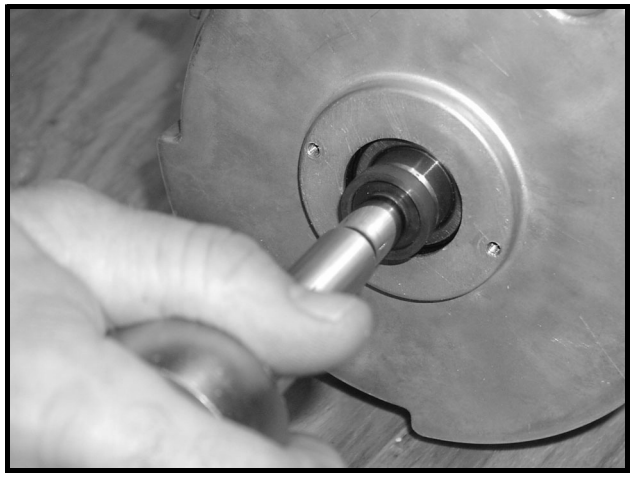


Figure 22b-4 Speed Sensor Magnet

Figure 22b-5 End Cap

MOTOR DISASSEMBLY

1. Before beginning disassembly, place match marks on the motor end cap and motor frame.
2. Remove speed sensor and magnet.
   2.1. Remove the two screws (25) that secure the speed sensor (10) to the end cap (11) **(Figure 22b-15, Page 22b-10)**.
   2.2. Remove the screw securing the magnet to the armature shaft **(Figure 22b-4, Page 22b-4)**.
   2.3. Inspect the speed sensor magnet. **See Speed Sensor Magnet Inspection on page 22b-9.**
3. Loosen, but do not remove, the two screws securing the end cap to the motor frame **(Figure 22b-5, Page 22b-4)**.

Figure 22b-6 End Cap Disengagement

Figure 22b-7 End Cap Removal

4. Orient the motor so that the splined end of the armature is facing down.
5. Inspect the area where the end cap mates with the motor frame. If the end cap appears to be loose where it connects to the motor frame, proceed to step 6; otherwise, disengage the end cap from the motor frame using the following procedure:
   5.1. With the end cap bolts loose (about 1/4 inch between the end cap and the head of the bolt), place a socket on the head of the bolt. **See following CAUTION.**

CAUTION

- **Ensure that there is sufficient thread engagement of the end cap bolts before proceeding. Performing the procedure without having adequate thread engagement could damage the motor frame, end cap, or end cap bolts.**

5.2. Gently tap each bolt, alternating between blows, until the end cap and motor frame become disengaged **(Figure 22b-6, Page 22b-4)**.

6. Remove the two end cap bolts.
7. Remove the end cap and armature from the motor frame **(Figure 22b-7, Page 22b-4)**.
8. Inspect the brush springs for proper tension. **See Motor Brush, Spring, and Terminal Insulator Inspection on page 22b-8.**
9. Remove the armature from the end cap bearing. **See following CAUTION and NOTE.**

⚠ CAUTION

- **Removing the armature from the end cap requires two people: one to operate the press, and another to hold the armature. Failure to heed this CAUTION could result in personal injury and/or damage to the armature resulting from an unsupported armature falling after it becomes disengaged from the end cap bearing.**

NOTE: *Replacement of the end cap bearing is recommended if the armature is removed.*

9.1. Place the end cap in a press with the armature facing down.

9.2. Place a bearing press tool with an outer diameter smaller than that of the armature shaft between the press ram and the armature shaft **(Figure 22b-8, Page 22b-6)**.

9.3. Have an assistant support the armature while the press is activated.

10. Inspect the armature for wear and damage. **See Armature Inspection and Testing on page 22b-6.**
11. Inspect the motor frame and field windings. **See Motor Frame and Field Windings Inspection on page 22b-8.**
12. Remove the brush rigging.

12.1. Mark the brush terminal posts (A1 and A2).

12.2. Remove the two nuts securing the brush terminals (A1 and A2) to the end cap **(Figure 22b-9, Page 22b-6)**.

12.3. Remove the two screws and the brush rigging to the end cap **(Figure 22b-10, Page 22b-6)**.

13. Inspect the terminal insulators. **See Terminal Insulator Inspection on page 22b-9.**
14. Remove the bearing from the end cap.

14.1. Remove the retaining ring that secures the bearing in the end cap **(Figure 22b-11, Page 22b-6)**.

14.2. Use an arbor press to remove the bearing from the end cap.

15. Inspect the bearing for wear and damage. **See Bearing Inspection on page 22b-9.**

Figure 22b-8 Armature Removal

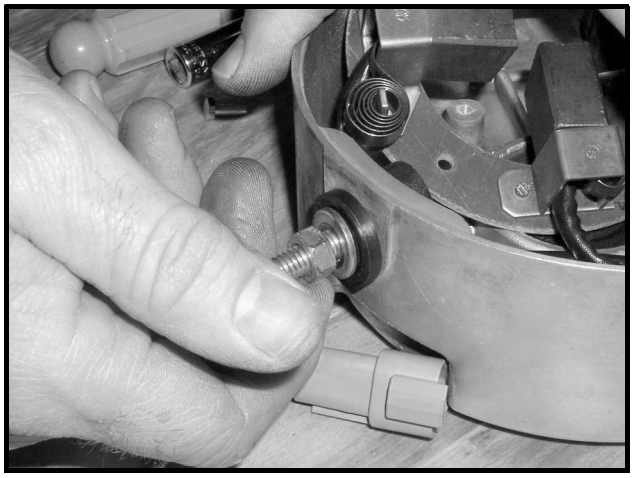


Figure 22b-9 A1 and A2 Terminals

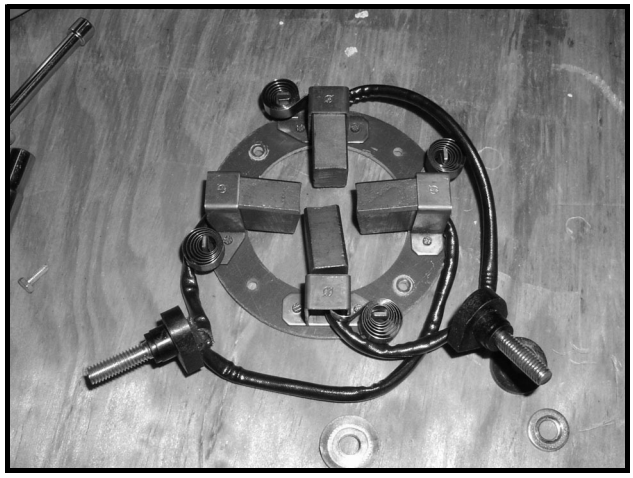


Figure 22b-10 Brush Rigging

Figure 22b-11 Bearing Retaining Ring

MOTOR COMPONENT TESTING AND INSPECTION

See General Warning, Section 1, Page 1-1.

ARMATURE INSPECTION AND TESTING

1. Remove the motor from the vehicle. **See Motor Removal, Section 22b, Page 22b-2.**
2. Remove the end cap and armature by performing steps 1 through 7 of Motor Disassembly on page 22b-4.

Visual Inspection

- Burned, charred or cracked insulation
- Improperly cured varnish
- Thrown solder
- Flared armature windings

- Damaged armature core laminations
- Worn, burned or glazed commutators
- Dirty or oily commutators
- Raised commutator bars
- Worn armature bearing or shaft

A dirty or oily commutator should be cleaned and wiped dry. Abnormalities identified during the inspection can help determine original cause of failure. Slight roughness of the commutator can be polished smooth with 400 grit or finer sandpaper. **See following CAUTION and NOTE.**

CAUTION

- **Do not use emery cloth to polish the commutator. Particles of emery are conductive and may short-circuit the commutator bars. Do not use oil or lubricants on the commutator or brushes.**

NOTE: *Oil on the commutator may indicate a faulty transaxle input shaft oil seal.*

Armature Ground Test

CAUTION

- **Do not submerge the armature in solvent.**

NOTE: *Before testing the armature, wipe it clean with a clean cloth. Remove any carbon dust and metal particles from between the commutator bars.*

1. With a multimeter set to 200 ohms, place one probe on the commutator and the other on the armature core. The multimeter should indicate no continuity **(Figure 22b-12, Page 22b-7)**. If the reading is incorrect, replace the armature.

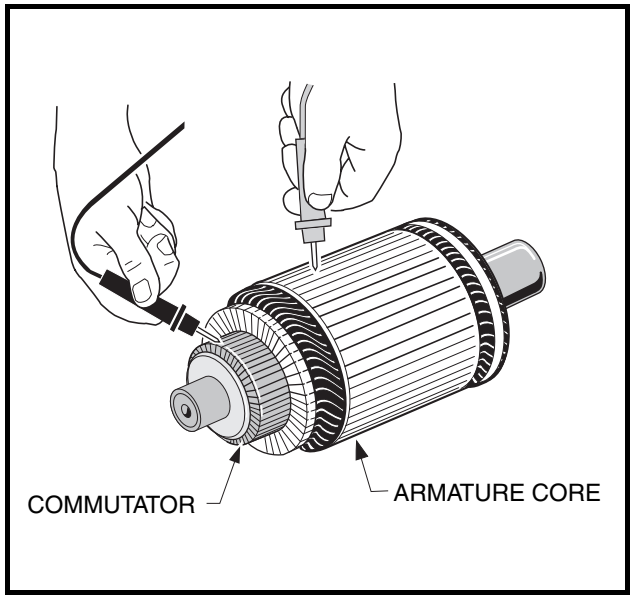


Figure 22b-12 Armature Test

MOTOR FRAME AND FIELD WINDINGS INSPECTION

1. Remove the motor from the vehicle. **See Motor Removal, Section 22b, Page 22b-2.**
2. Remove the and cap and armature by performing steps 1 through 7 of Motor Disassembly on page 22b-4.
3. Burned or scorched insulation on the field windings indicates the motor has overheated due to overloads or grounded or shorted coil windings. If the insulation on the field windings is scorched, replace the motor or the stator shell assembly.

MOTOR BRUSH, SPRING, AND TERMINAL INSULATOR INSPECTION

Brush Spring Tension Test

1. Remove the motor from the vehicle. **See Motor Removal, Section 22b, Page 22b-2.**
2. Remove the end cap and armature by performing steps 1 through 7 of Motor Disassembly on page 22b-4.
3. Inspect the brush springs (14) **(Figure 22b-15, Page 22b-10)**. Replace springs that are discolored from heat (light gold or blue tinted).
4. Test the brush springs for proper tension.
   4.1. Place a C-shaped steel plate on a scale.
   4.2. Place the end of the C-shaped plate so that it is between the spring and the brush as shown **(Figure 22b-13, Page 22b-9)**.
   4.3. Gently pull the scale to obtain the spring tension reading. **See following CAUTION.**

CAUTION

- **When checking brush spring tension, do not over-extend the spring. Using excessive force will damage the spring.**

   4.4. Replace springs which require a force of less than 35 oz. (990 grams) **(Figure 22b-13, Page 22b-9)**. **See following NOTE.**

NOTE: *When installing new brushes, remove and replace brushes one at a time. This method ensures the terminals and brushes will be properly positioned in the rigging. Refer to Motor Assembly for brush installation.* ***See Motor Assembly on page 22b-11.***

When replacing brushes, replace all four brushes. Never replace only two.

Install the brushes in the same rigging 180° apart from each other.

Brush Inspection

1. Remove the motor from the vehicle. **See Motor Removal, Section 22b, Page 22b-2.**
2. Remove the end cap and armature by performing steps 1 through 7 of Motor Disassembly on page 22b-4.
3. Inspect the brushes (13) for damage or excessive wear **(Figure 22b-15, Page 22b-10)**. Replace brushes if required. **See preceding NOTE.**
4. Use dial calipers or a micrometer to measure the brush length. The minimum-allowable brush length is 0.62 inches (16 mm). Replace the set of brushes as required. **See preceding NOTE.**

Terminal Insulator Inspection

1. Remove the motor from the vehicle. **See Motor Removal, Section 22b, Page 22b-2.**
2. Remove the terminal insulators by performing steps 1 through 12 of Motor Disassembly on page 22b-4.
1. Inspect the insulators (4 and 6) for cracks or other damage **(Figure 22b-15, Page 22b-10)**. Replace insulators as required.

Bearing Inspection

NOTE: *Replacement of the end cap bearing is highly-recommended if the end cap is removed from the motor. The following procedure is provided as a guideline for determining general bearing failure.*

1. Remove the motor from the vehicle. **See Motor Removal, Section 22b, Page 22b-2.**
2. Remove the bearing by performing steps 1 through 14 of Motor Disassembly on page 22b-4.
3. Use a clean cloth to wipe the carbon dust off of the bearing. Inspect the bearing by spinning it by hand and checking for both axial (A) and radial (B) play **(Figure 22b-14, Page 22b-9)**.
4. Replace the bearing if it is noisy, does not spin smoothly, or has excessive play. Check the bearing and replace if rusted, worn, cracked, or if there is an abnormal color change in the metal of the bearing.

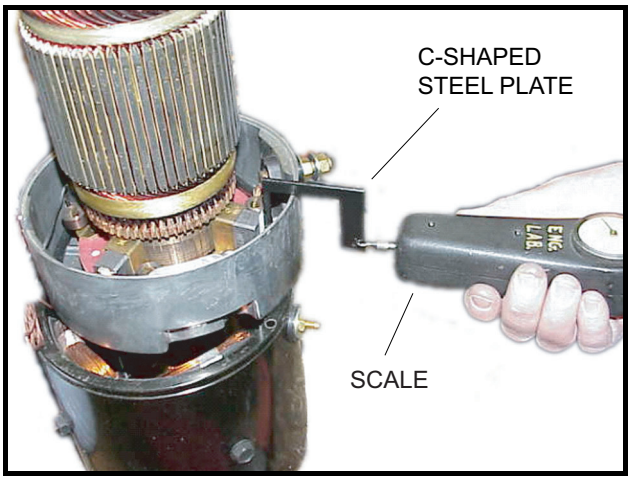


Figure 22b-13 Brush Spring Tension Test

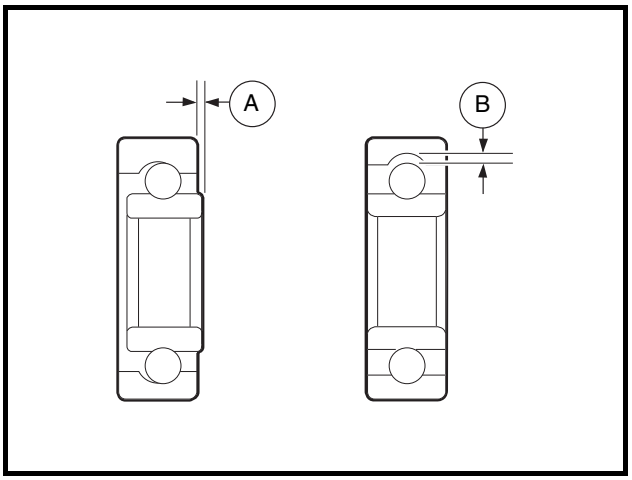


Figure 22b-14 Bearing Inspection

Speed Sensor Magnet Inspection

Inspect the speed sensor magnet (24) for rust, wear, and cracks **(Figure 22b-15, Page 22b-10)**. Replace the magnet if necessary.

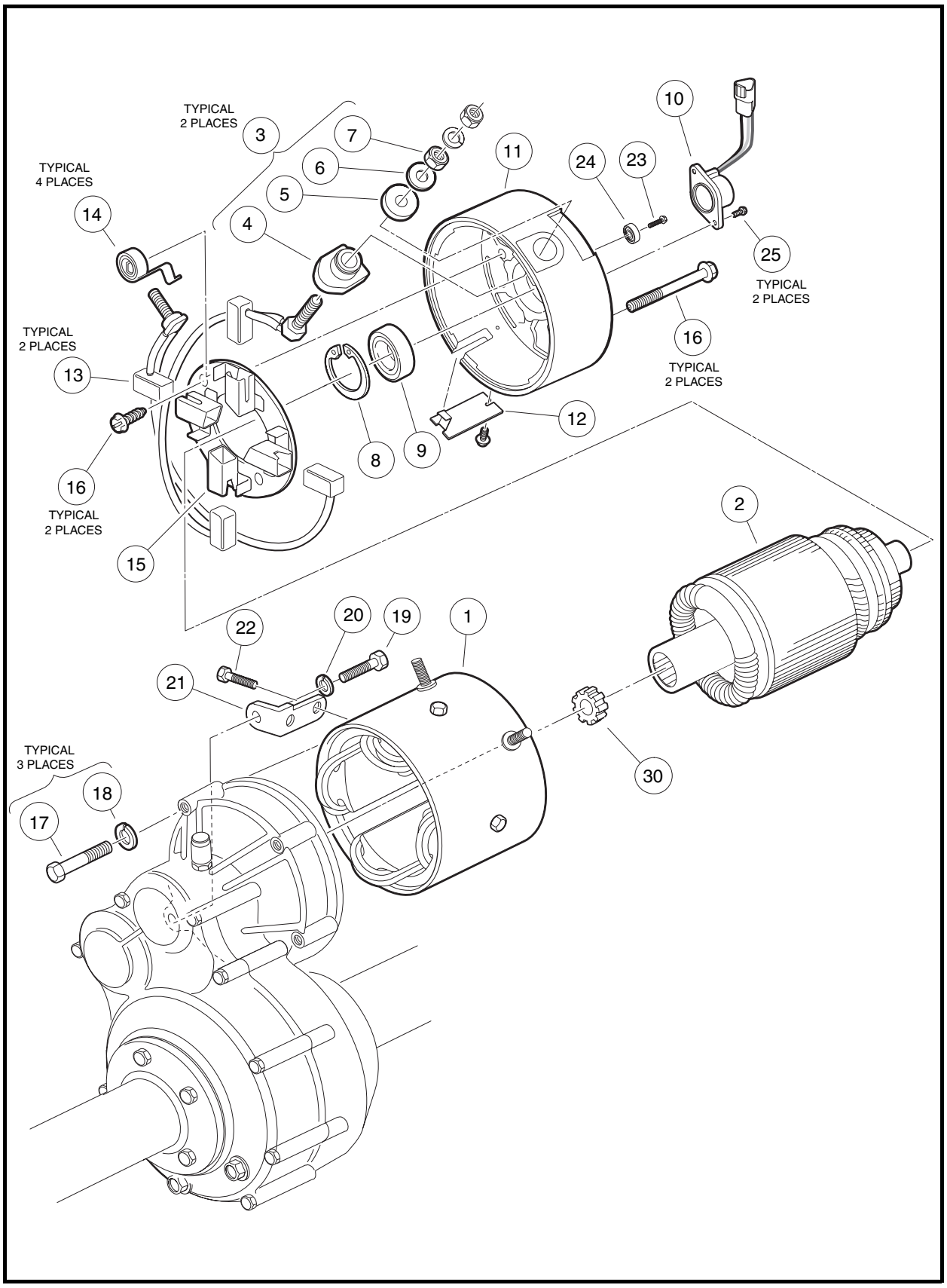


Figure 22b-15 Motor – Model EJ4-4001

RECONDITIONING THE MOTOR

See General Warning, Section 1, Page 1-1.

Motor reconditioning must be performed by a qualified motor repair technician. The use of proper tools and procedures is absolutely essential for successful motor reconditioning.

Motor Specifications

Any rework must be performed by a qualified technician. Motor service specifications are listed in the following table.

ITEM	SERVICE LIMIT
Commutator diameter (minimum)	2.80 in. (71.10 mm)
Commutator concentric with armature shaft within	0.003 in. (0.08 mm)
Bar to bar runout should not exceed	0.005 in. (0.013 mm)
Undercut of segment insulator after machining commutator	0.040 in. (1.0 mm)
Armature resistance at 75 °F (24 °C)	0.012 ohms between bar 1 and bar 15
Field coil resistance at 75 °F (24 °C)	1.75 ohms

MOTOR ASSEMBLY

See General Warning, Section 1, Page 1-1.

1. Replace the bearing.
   1.1. Use an arbor press to install a new bearing into the end cap. To help avoid damaging the bearing, apply pressure only to the outer race when installing the bearing.
   1.2. Install the retaining ring to secure the bearing **(Figure 22b-11, Page 22b-6)**.
2. Install the brushes and brush rigging. **See following NOTE.**

NOTE: *When installing new brushes, remove and replace brushes one at a time. This method ensures the terminals and brushes will be properly positioned in the rigging.*

When replacing brushes, replace all four brushes. Never replace only two.

Install the brushes in the same rigging 180° apart from each other.

   2.1. Insert the brushes into the brush rigging as shown **(Figure 22b-16, Page 22b-12)**.
   2.2. Insert the two terminal posts through insulators (4) in the end cap (11) wall at the A1 and A2 positions **(Figure 22b-15, Page 22b-10)**.
   2.3. Place external insulators (5) and washers (6) on each terminal post, and secure terminal with nuts (7). Tighten nuts (7) to 100 in-lb (11.3 N·m). Ensure that the terminal posts do not rotate when tightening the nuts **(Figure 22b-15, Page 22b-10)**.
   2.4. Secure the brush rigging to the end cap with two screws. Tighten the screws to 25 in-lb (2.8 N·m) **(Figure 22b-10, Page 22b-6)**.

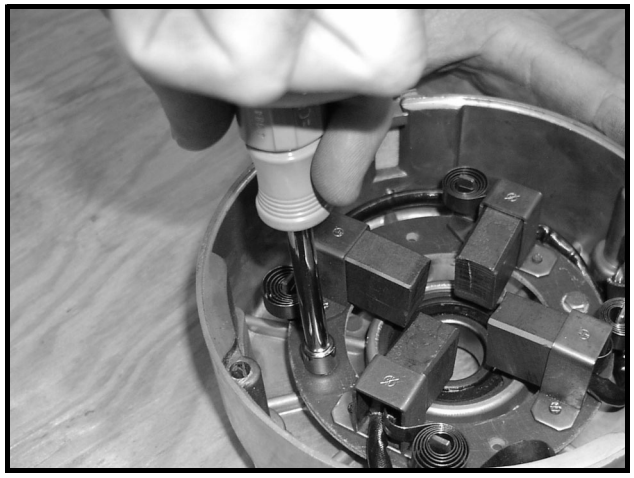


Figure 22b-16 Brush Rigging

Figure 22b-17 Retracted Brushes

Figure 22b-18 Armature Installation

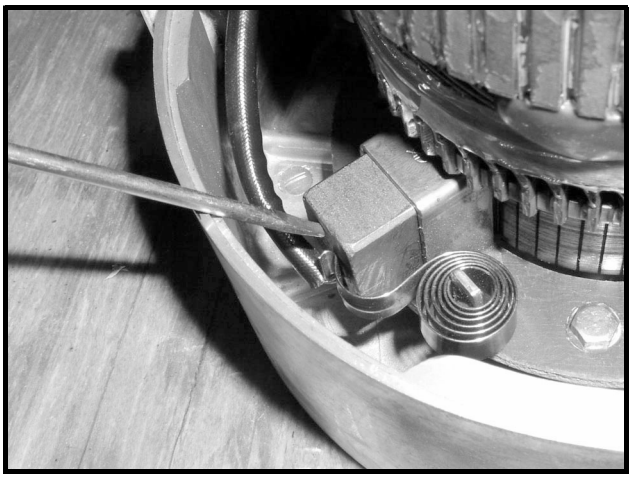


Figure 22b-19 Brush Setting

2.5. One at a time, push the brushes back until they are completely retracted into their mounting slots and the spring pressure holds them in the retracted position as shown **(Figure 22b-17, Page 22b-12)**.

3. With the brushes retracted, use an arbor press to press the armature shaft into the end cap bearing **(Figure 22b-18, Page 22b-12)**. **See following CAUTION.**

CAUTION

- **Make sure the brushes are held back. Do not allow the brushes to support the weight of the commutator. The brushes can be easily damaged by this weight.**

4. Gently press each brush with a small screwdriver until the spring rests on the end of each brush as shown **(Figure 22b-19, Page 22b-12)**.
5. Align the match marks on the end cap and the motor frame (1) and secure with two bolts (16) **(Figure 22b-15, Page 22b-10)**. Tighten bolts to 130 in-lb (14.7 N·m).
6. Install the speed sensor magnet (24) with screw (23). Tighten to 65 in-lb (7.3 N·m).
7. Install the speed sensor (10) with screws (25). Tighten to 25 in-lb (2.8 N·m).
8. Make sure the armature turns freely. If it does not turn freely, disassemble the motor to find the problem.

MOTOR INSTALLATION

See General Warning, Section 1, Page 1-1.

1. Clean the transaxle input shaft.
   1.1. Spray the input shaft thoroughly with CRC® Brakleen™ or equivalent brake cleaner degreaser.
   1.2. Wipe input shaft with a clean cloth.
   1.3. Inspect the grooves of the input shaft and remove any remaining debris.
   1.4. Repeat steps 1.1 through 1.3 until input shaft is clean.
2. Lubricate the transaxle input shaft.
   2.1. Squeeze approximately 1/2 inch (1.3 cm) of moly-teflon lubricant (CCI P/N 102243403) from tube onto a putty knife as shown **(Figure 22b-20, Page 22b-13)**.
   2.2. Rotate wheels to rotate input shaft.
   2.3. Apply motor coupling grease evenly to the rotating input shaft starting at approximately 1/8 inch (3.1 mm) from the end of the shaft and working back toward the transaxle (away from the end of the shaft) **(Figure 22b-21, Page 22b-13)**.
   2.4. The grease should be evenly distributed in the grooves to a width of approximately 3/8 inch (9.5 mm).
   2.5. Use a flat screwdriver to clean the grease out of one of the grooves and allow air to escape when the motor is pushed onto the input shaft.

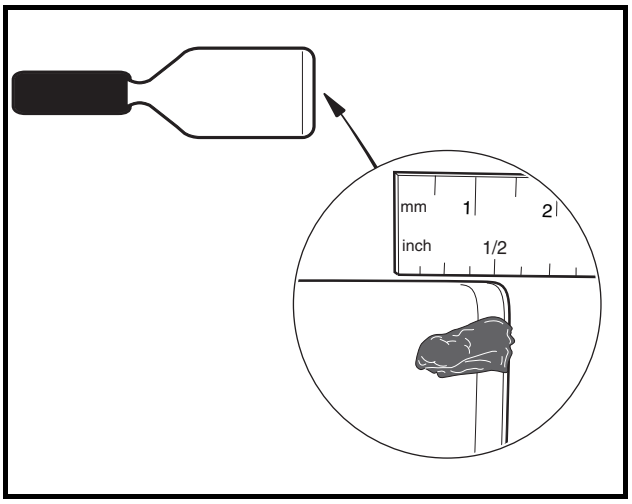


Figure 22b-20 Grease on Putty Knife

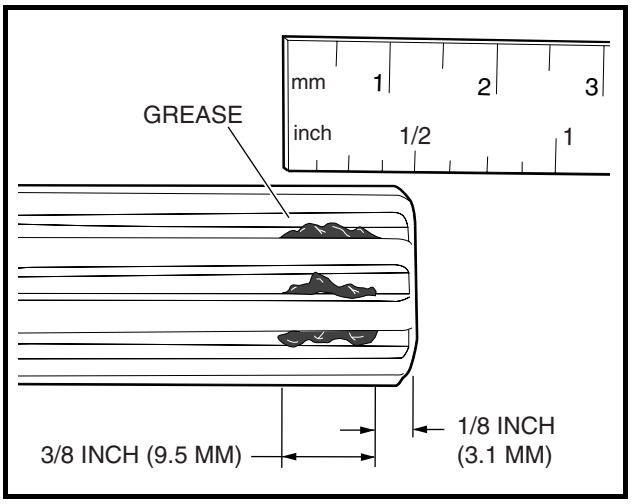


Figure 22b-21 Application of grease to Input Shaft Grooves

   2.6. Check the chamfer and end of the input shaft to ensure these areas are completely clean of grease as shown **(Figure 22b-22, Page 22b-14)**.
3. Install the molded bumper.
   3.1. With the flat side toward the bottom of the coupling, install the molded bumper (30) into the motor coupling **(Figure 22b-15, Page 22b-10)**. **See following NOTE.**

NOTE: *The motor coupling and the new molded bumper must be free of grease and debris.*

   3.2. Ensure that the installed bumper is seated at the bottom of the coupling.

4. Install motor on transaxle.
   4.1. Slide the motor coupling onto the transaxle input shaft. **See following NOTE.**

NOTE: *The coupling will push any excess grease on the input shaft along the shaft toward the transaxle.*

When the motor is pushed onto the input shaft, the motor housing will not bottom out against the transaxle housing ***(Figure 22b-15, Page 22b-10)****. There will be approximately 1/16 inch (1.6 mm) gap between the motor adapter ring and transaxle housing as shown* ***(Figure 22b-23, Page 22b-14)****.*

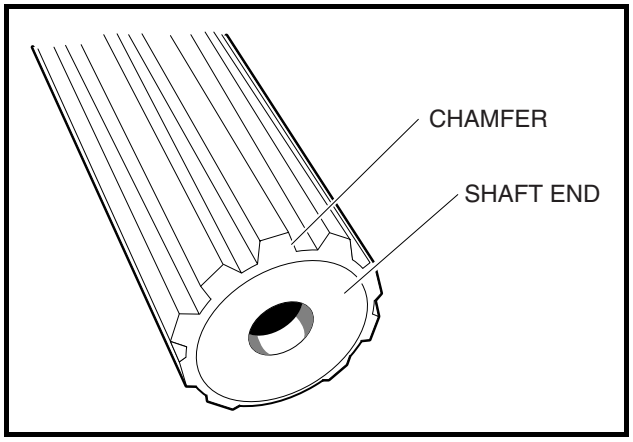


Figure 22b-22 Clean Chamfer and Input Shaft End

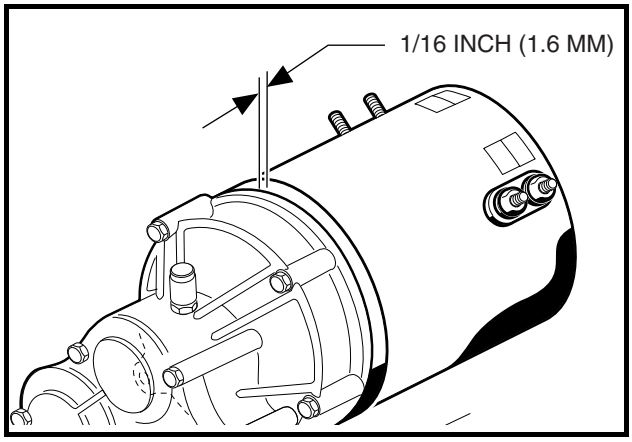


Figure 22b-23 Gap at Motor and Transaxle

   4.2. Loosely install the four bolts that secure the motor to the transaxle. Do not tighten.
   4.3. Begin finger-tightening the bolts (1 and 2) in the sequence indicated **(Figure 22b-24, Page 22b-15)**. Continue tightening by hand until the motor is seated in the transaxle housing. **See following CAUTION and NOTE.**

CAUTION

- **Make sure the motor is properly seated in the transaxle housing.**

NOTE: *Failure to install and tighten the motor mounting bolts in the proper sequence and to the proper tightness may result in motor noise during operation.*

   4.4. Tighten the bolt (1) inserted through the L-bracket to 155 in-lb (17.5 N·m) **(Figure 22b-24, Page 22b-15)**.
   4.5. Tighten the center bolt (2) to 65 in-lb (7.3 N·m) **(Figure 22b-24, Page 22b-15)**.
   4.6. Tighten the right bolt (3) to 65 in-lb (7.3 N·m).
   4.7. Tighten the left bolt (4) to 65 in-lb (7.3 N·m).
   4.8. Install the motor wires, making sure they are connected to the correct motor terminals and that the terminal orientation is correct. **See Wiring Diagram, Section 18, Page 18-2.** Tighten the terminal retaining nuts to 65 in-lb (7.3 N·m).
   4.9. Secure the white, orange, green, and blue wires with a wire tie so that none of the motor wires will scrub the motor or transaxle when the vehicle is in operation.
   4.10. Connect the three-pin speed sensor wire to the vehicle wire harness.
5. If using a chain hoist, lower the vehicle and guide the leaf springs into the shackles. If using a floor jack, raise the transaxle until the leaf springs can be guided into the shackles.

6. Insert the mounting bolts through the spring shackles and the bushings in the leaf spring eyes and install locknuts. Tighten the bolts to 23 ft-lb (31 N·m). **See Leaf Spring Installation, Section 9, Page 9-4.**
7. Install the shock absorbers. Tighten nut until rubber bushing expands to the diameter of the cup washer.
8. If removed, install wheels and finger tighten the lug nuts.
9. Lift vehicle and remove jack stands. Lower vehicle to the floor and tighten lug nuts, using a crisscross pattern, to 55 ft-lb (74.6 N·m).
10. Place the Tow/Run switch in the TOW position and connect the batteries, positive (+) cable first. Tighten battery terminals to 110 in-lb (12.4 N·m) and coat terminals with Battery Terminal Protector Spray (CCI P/N 1014305) to minimize corrosion.
11. Place the Tow/Run switch in the RUN position.
12. Inspect the vehicle for proper operation. **See following WARNING.**

⚠ WARNING

- **Make sure that the vehicle operates in the forward direction when the Forward/Reverse switch is in the FORWARD position.**
- **Make sure that the vehicle operates in the reverse direction when the Forward/Reverse switch is in the REVERSE position. The reverse buzzer will sound as a warning when the Forward/Reverse switch is in REVERSE.**
- **Make sure that the vehicle does not operate when the Forward/Reverse switch is in the NEUTRAL position.**

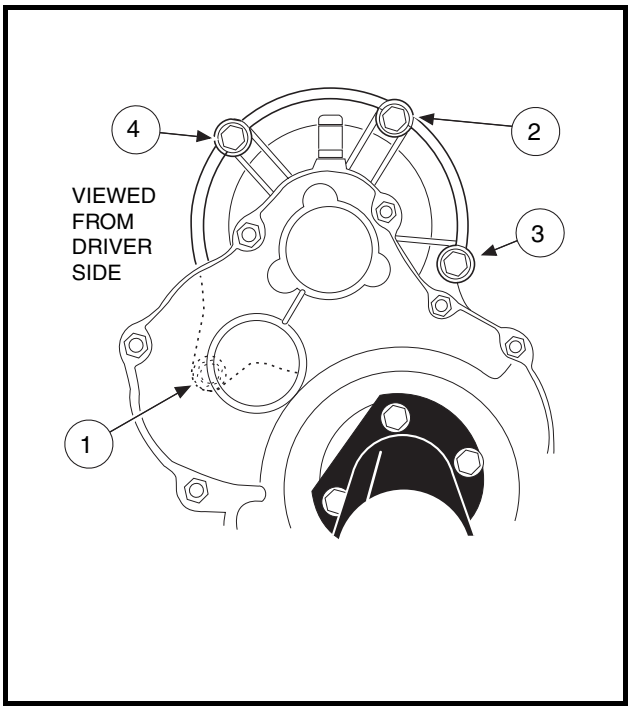


Figure 22b-24 Motor Mount

SECTION 23 – TRANSAXLE (TYPE G): ELECTRIC VEHICLE

⚠ DANGER

- **See General Warning, Section 1, Page 1-1.**

⚠ WARNING

- **See General Warning, Section 1, Page 1-1.**

TRANSAXLE IDENTIFICATION

This electric vehicle utilizes a different transaxle than does the gasoline vehicle. The different transaxles are identified by labels on the driver side axle tubes and are not interchangeable.

NOTE: *This section pertains to the electric vehicle transaxle only.*

LUBRICATION

See General Warning, Section 1, Page 1-1.

There are two plugs located on the lower half of the transaxle housing. The upper plug (21) (as viewed when the vehicle is on a level surface) is used as a lubricant level indicator **(Figure 23-5, Page 23-3)**. When the vehicle is parked on a level surface, the lubricant level should be even with the bottom of the hole. The lower plug (22) is for draining the lubricant. When draining the lubricant, the upper plug should be removed so the lubricant will drain faster. Be sure the drain plug is reinstalled before filling. **See following NOTE.**

NOTE: *Recycle or dispose of used oil or lubricant in accordance with local, state, and federal regulations.*

AXLE BEARING AND SHAFT

See General Warning, Section 1, Page 1-1.

AXLE SHAFT

Axle Shaft and Oil Seal Removal

1. Place chocks at the front wheels. Loosen lug nuts on rear wheels and lift the rear of the vehicle with a chain hoist or floor jack. Place jack stands under the axle tubes to support the vehicle.
2. Remove the rear wheel and brake drum. **See Brake Shoe Removal, Section 6, Page 6-1.**

Axle Shaft and Oil Seal Removal, Continued:

3. Use 90° internal snap ring pliers to remove the internal retaining ring (6) from the axle tube. **(Figure 23-1, Page 23-2)**.
4. Remove the axle, retaining ring, and bearing assembly by pulling the axle straight out of the housing.
5. If necessary, remove the axle oil seal (15) and adapter ring (39) **(Figure 23-2, Page 23-2)**.
   5.1. Use a bearing puller (CCI P/N 1016417) to remove the axle seal and adapter ring from the axle tube **(Figure 23-2, Page 23-2)**. **See following CAUTION and NOTE.**

CAUTION

- **Do not scar or damage the inside surfaces of the tube when removing the oil seal and adapter ring. A damaged tube might have to be replaced.**

NOTE: *Do not discard the adapter ring. If the adapter ring is lost or damaged, the axle tube will have to be replaced.*

   5.2. Use a press to separate the axle oil seal (15) from the adapter ring (39) **(Figure 23-3, Page 23-2)**. Retain the adapter ring and discard the oil seal.
6. Inspect the axle shaft assembly to be sure the bearing and collar have not slipped and are still seated against the shoulder on the axle shaft.
7. Inspect bearing (5) **(Figure 23-5, Page 23-3)**. If the bearing on the transaxle is worn or damaged, the entire axle shaft assembly (1 or 2) must be replaced.

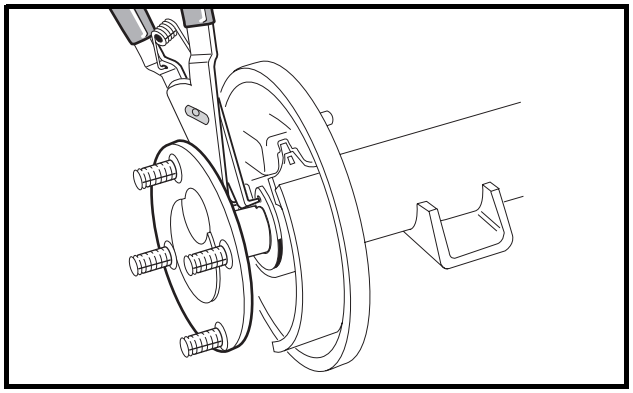


Figure 23-1 Axle Tube

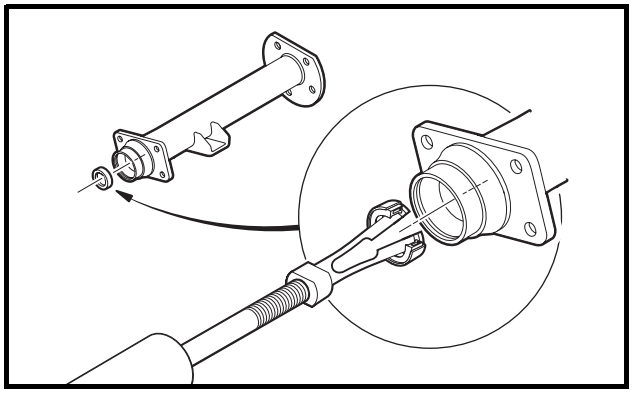


Figure 23-2 Axle Seal and Adapter Ring Removal

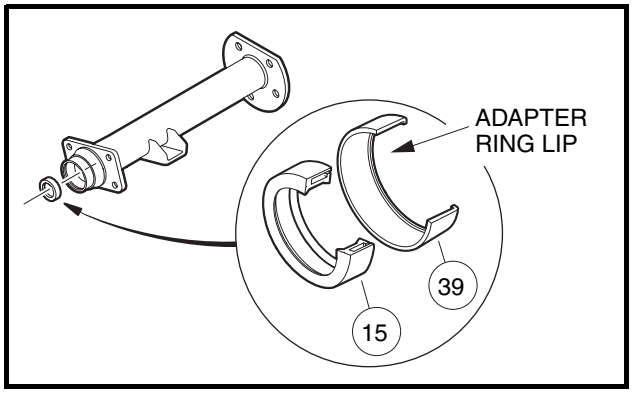


Figure 23-3 Axle Seal and Adapter Ring

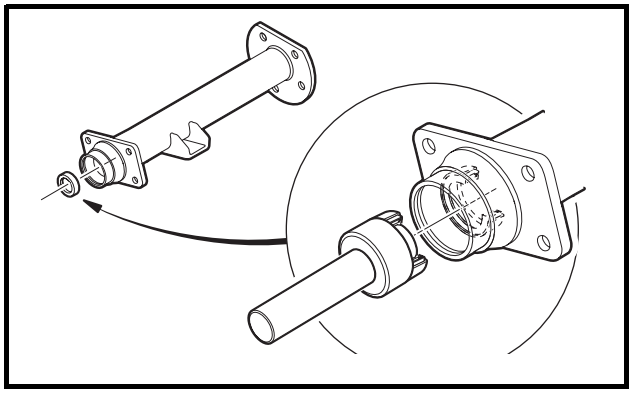


Figure 23-4 Axle Seal and Adapter Ring Installation

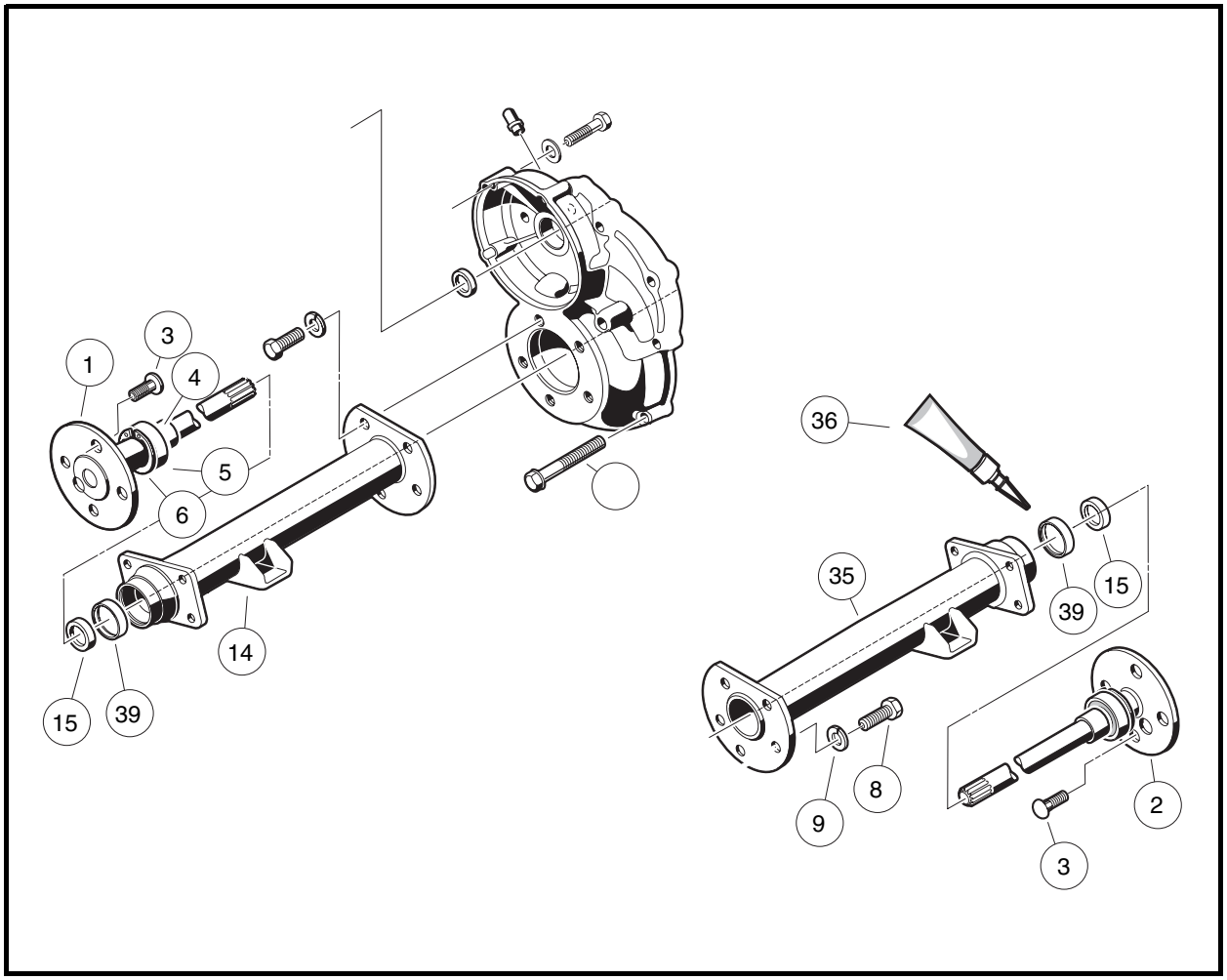


Figure 23-5 Axles And Tubes

Axle Shaft and Oil Seal Installation

1. If previously removed, install a new oil seal.
   1.1. Clean seal seat in the adapter ring (39) **(Figure 23-3, Page 23-2)**.
   1.2. Place a new seal (15) in the adapter ring (39) with the seal lip facing toward the adapter ring lip. Use an axle seal tool (CCI P/N 1014162) and mallet to tap it in until it seats firmly in position. A hydraulic press may also be used with the axle seal tool.
   1.3. Clean adapter ring seat(s) in the axle tube (14 or 35) **(Figure 23-5, Page 23-3)**.
   1.4. Apply Loctite® 603 (36) to the outer diameter of the adapter ring.
   1.5. Place the oil seal and adapter ring assembly into the axle tube with the seal lip facing away from the bearing **(Figure 23-4, Page 23-2)**. Use an axle seal tool (CCI P/N 1014162) and mallet to tap it in until it seats firmly in position. **See following CAUTION.**

⚠ CAUTION

- **Clean any residual oil from the exposed end of the axle shaft and from the oil seal area prior to installing the axle shaft.**

Axle Shaft and Oil Seal Installation, Continued:

2. Clean the shaft splines and then insert the shaft, splined end first, through the seal and into the axle tube. Be careful not to damage the seal. Then advance the shaft through the inner bearing and rotate it to align the shaft splines with the splined bore of the differential side gear. Continue advancing the shaft until the bearing seats against the axle tube shoulder.

3. Use a pair of snap ring pliers to install the retaining ring (6) inside axle tube **(Figure 23-5, Page 23-3)**. **See following NOTE.**

NOTE: *If the retaining ring (6), axle bearing (5), or sleeve (4) must be replaced, the entire axle shaft assembly (1 or 2) must be replaced* ***(Figure 23-5, Page 23-3)****.*

4. Place a 1/4 to 3/8-inch (6 to 10 mm) diameter rod against the retaining ring and tap lightly at four to five locations around the retaining ring to ensure it is properly seated. **See following WARNING.**

⚠ WARNING

- **Be sure the retaining ring is properly seated in its groove. If the ring is not properly installed, the axle assembly will separate from the transaxle and damage the axle assembly and other components. Loss of vehicle control could result, causing severe personal injury.**

5. If a new oil seal was installed, allow 24 hours before operating the vehicle to allow the Loctite® 603 to fully cure.

AXLE BEARING

Do not remove the axle bearing (5) from a Type G transaxle. If bearing is worn or damaged, the entire axle assembly (1 or 2) must be replaced **(Figure 23-5, Page 23-3)**.

TRANSAXLE

See General Warning, Section 1, Page 1-1.

TRANSAXLE REMOVAL

1. Place chocks at the front wheels and slightly loosen lug nuts on both rear wheels.

2. Place a floor jack under the transaxle and raise the rear of the vehicle. Position jack stands under the frame crossmember between the spring mount and the side stringer, just forward of each rear wheel. Lower the vehicle to let the jack stands support the vehicle **(Figure 23-6, Page 23-5)**. **See WARNING "Lift only one end of the vehicle..." in General Warning, Section 1, Page 1-1.**

3. Remove the rear wheels, then thread one lug nut onto a stud on each rear hub. This will keep the brake drums on the hubs.

4. Remove the bow-tie pins (1), brake cable clevis pins (2), and cable retaining E-clips (3). Disconnect the brake cables (4) **(Figure 23-7, Page 23-5)**.

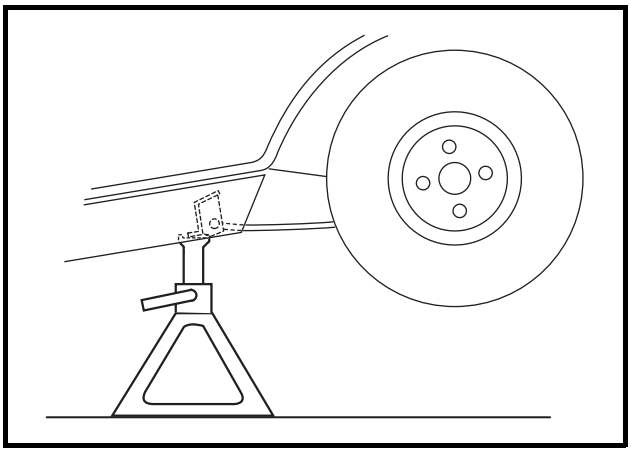


Figure 23-6 Vehicle Supported on Jack Stands

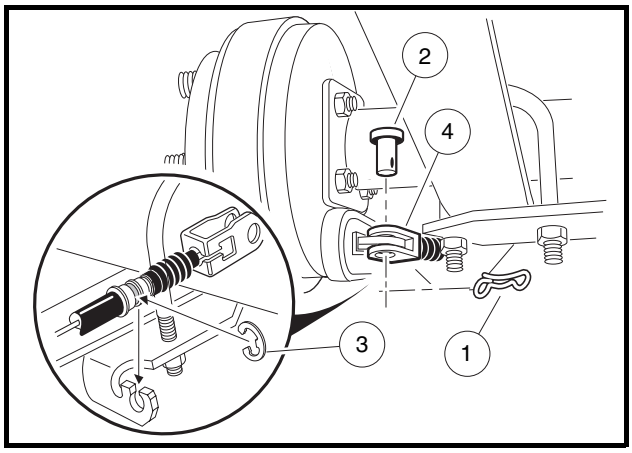


Figure 23-7 Disconnect Brakes

5. Disconnect the shock absorbers from their lower mounts **(Figure 23-8, Page 23-5)**.
6. Disconnect the four motor wires. Use two wrenches to prevent the post from turning.
7. With a floor jack supporting the transaxle, remove lower spring shackle nuts and bolts. Position shackles so they are clear of springs **(Figure 23-9, Page 23-5)**.

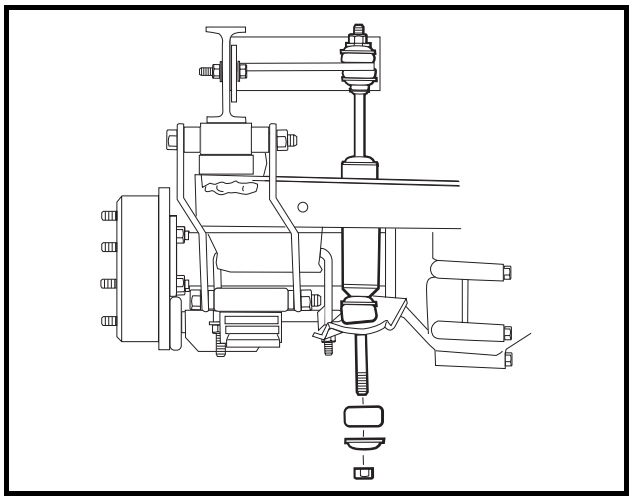


Figure 23-8 Disconnect Shocks

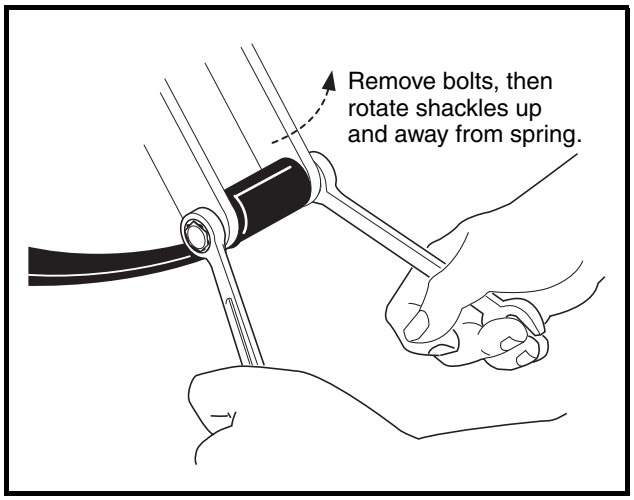


Figure 23-9 Shackles

8. If a chain hoist was used to raise the vehicle, lift the vehicle high enough to permit easy access and clearance for removal of the motor. If a floor jack was used to raise the vehicle, lower the transaxle enough to permit easy access and clearance for removal of the motor.
9. Remove the three motor mounting bolts **(Figure 23-11, Page 23-6)**, and the motor positioning bolt **(Figure 23-11, Page 23-6)**, mounting the motor to the transaxle. **See following CAUTION.**

Transaxle Removal, Continued:

⚠ CAUTION

- **Do not position fingers under motor when sliding motor off of the input shaft. Fingers may get pinched when motor disengages.**

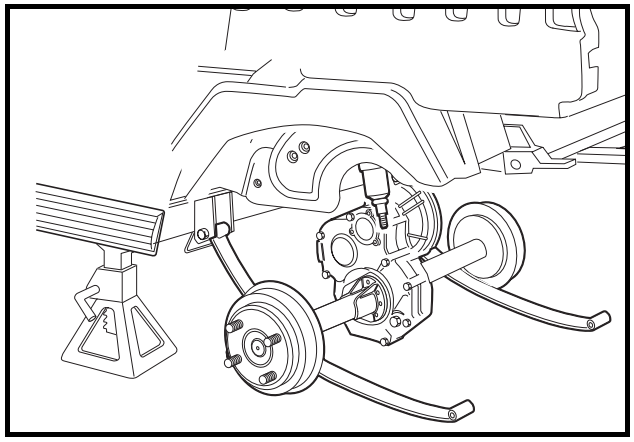


Figure 23-10 Leaf Springs

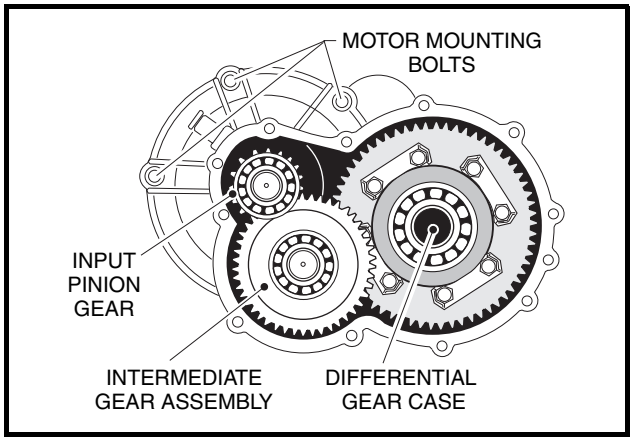


Figure 23-11 Motor And Gear Assembly

10. Carefully remove the motor from the transaxle. Slide the motor away from the transaxle until the motor spline becomes disengaged from the input shaft, then lift motor out. **See preceding WARNING.**
11. If a floor jack was used, pull floor jack from beneath the transaxle and allow the springs to rest on the floor.
12. Remove the U-bolts attaching the transaxle to the leaf springs.
13. Carefully lift each end of the transaxle off its positioning pin (on the leaf spring) and slide the transaxle to the rear and out of the vehicle.
14. Drain the lubricant from the transaxle and remove the axle shafts. **See Axle Shaft and Oil Seal Removal on page 23-1. See following NOTE.**

NOTE: *Recycle or dispose of used oil or lubricant in accordance with local, state, and federal regulations.*

15. Remove the brake assemblies if required. **See Brake Cluster Removal, Section 6, Page 6-8.**.

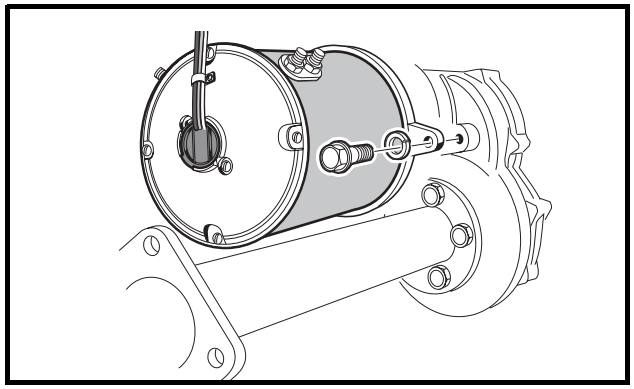


Figure 23-12 Motor Positioning Bolt

TRANSAXLE DISASSEMBLY, INSPECTION, AND ASSEMBLY

See General Warning, Section 1, Page 1-1.

TRANSAXLE DISASSEMBLY AND INSPECTION

1. To detach axle tubes (14 and 35) from the transaxle housing, remove the bolts and lock washers (8 and 9) **(Figure 23-14, Page 23-8)**.
2. Remove 11 bolts (24) that hold housing together.
3. Pull the halves of the housing (11 and 20) apart. If necessary, tap lightly on the spline of the input pinion (17). **See following CAUTION.**

CAUTION

- **To prevent damage to the housing mating seal surfaces, use caution when separating halves.**

4. Remove input pinion gear (17) by pulling gear out while rocking intermediate gear assembly (19). Lift intermediate gear assembly and differential gear case (26) unit out simultaneously **(Figure 23-14, Page 23-8)**. **See following CAUTION.**

CAUTION

- **Do not damage gears. Use extreme care when handling them.**

5. Use a bearing puller or arbor press to remove bearings (16) from the input pinion gear. If the oil seal (10) is damaged, replace it **(Figure 23-14, Page 23-8)**. **See following CAUTION**.

CAUTION

- **Do not reuse bearings after removing them. Replace bearings with new ones.**

6. To disassemble the intermediate gear assembly, press off together the bearing (16) and the gear (19) **(Figure 23-14, Page 23-8)**. **See also Figure 23-13, Page 23-7.**
7. Press the bearing (18) off the intermediate gear assembly.

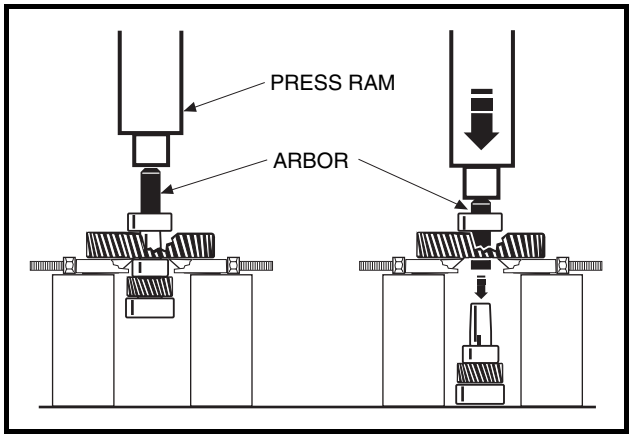


Figure 23-13 Intermediate Gear Assembly

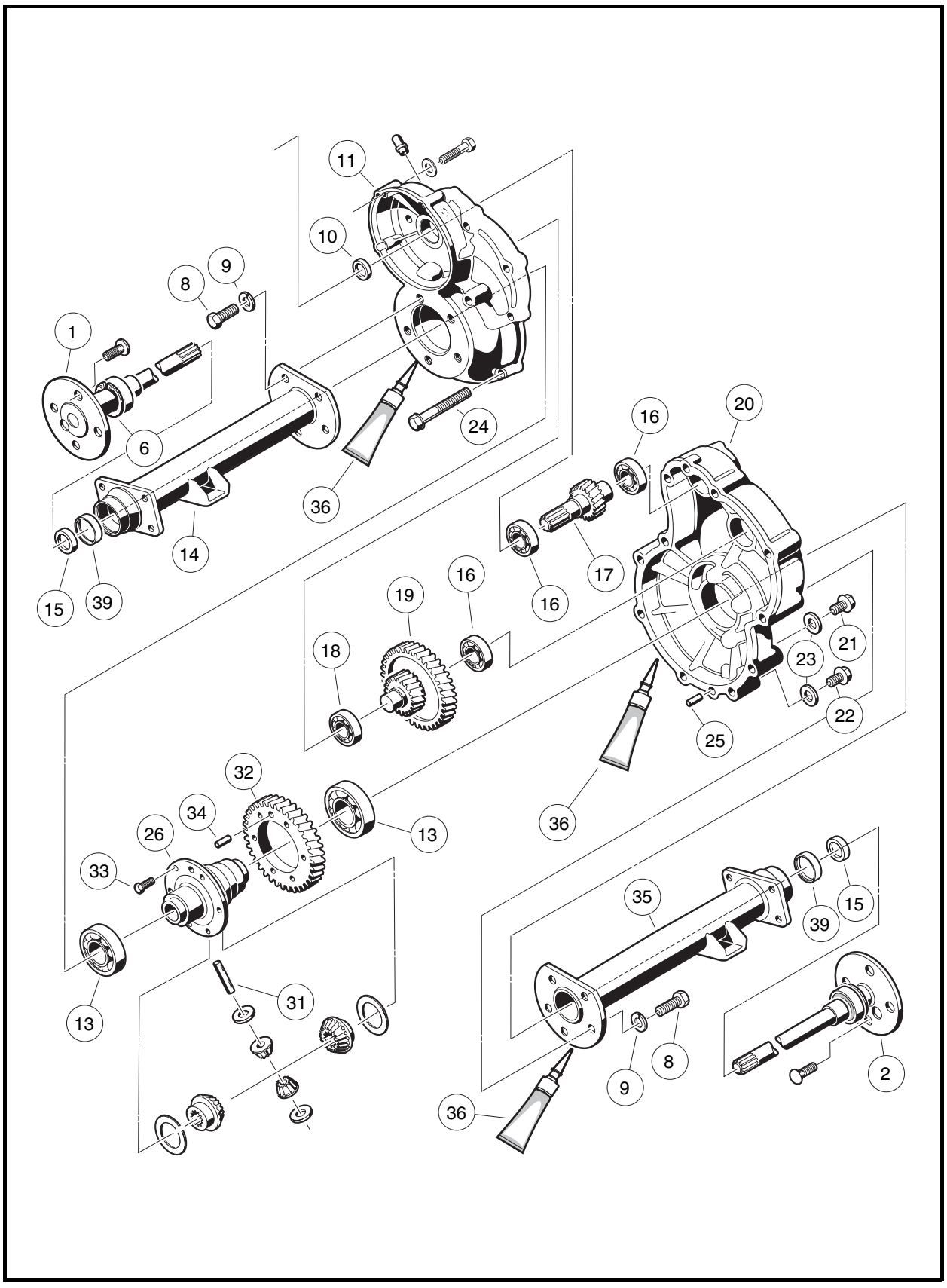


Figure 23-14 Transaxle – Type G

8. Disassemble the differential gear case:

   8.1. Remove four hex bolts (33) that secure the ring gear (32) to the differential case (26) **(Figure 23-14, Page 23-8)**.

   8.2. Remove the ring gear. Retain dowel pin (34) from between the ring gear and differential case for reassembly.

   8.3. Separate the differential gear case housing. If necessary, install two of the hex bolts (removed previously in step 8.1.) into the differential gear unit and, while holding the unit slightly above the work area, lightly tap the bolt heads **(Figure 23-15, Page 23-9)**. Remove the two bolts.

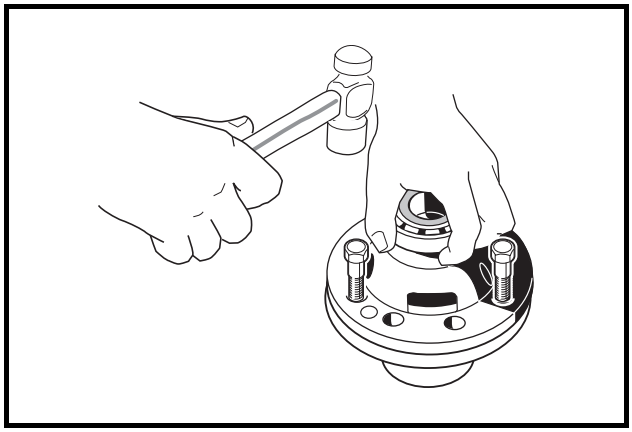


Figure 23-15 Separate Housing

   8.4. Remove the differential pin (31) by pushing pin through differential gear case from one side **(Figure 23-14, Page 23-8)**. **See also Figure 23-16, Page 23-9.**

   8.5. Remove the idler gears and thrust plates (1 and 2) **(Figure 23-17, Page 23-9)**.

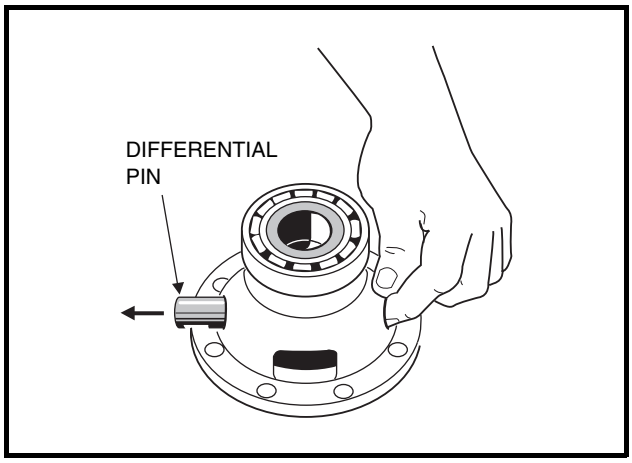


Figure 23-16 Differential Pin

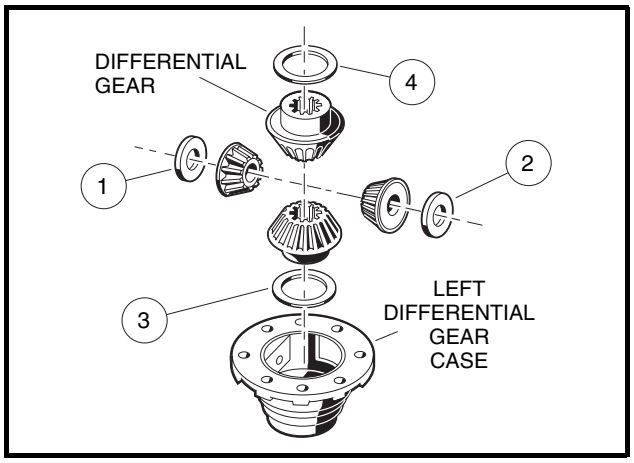


Figure 23-17 Left Differential

   8.6. Remove the differential gears and thrust plates (3 and 4).

   8.7. Inspect the bearings (13) of the differential case (26) and replace them if they are damaged **(Figure 23-14, Page 23-8)**. To remove them, press them off. **See following CAUTION.**

CAUTION

- **Do not reuse bearings after removing them. Replace bearings with new ones.**

9. Inspect parts for wear or damage. Any worn or damaged parts should be replaced. **See following NOTE.**

NOTE: *Damaged or worn gears should be replaced as sets.*

TRANSAXLE ASSEMBLY

CAUTION

- **Do not press against the bearing outer race.**
- **The housing and all parts must be wiped clean and dry before reassembly.**

1. If bearings (13) were removed during disassembly, install new bearings using an arbor press **(Figure 23-14, Page 23-8)**.
2. Assemble the differential gear case.
   2.1. Install the pin (31). Apply a small amount of oil to all thrust plates and to both ends of the pin.
   2.2. Install four hex bolts (33) and output ring gear (32). Tighten bolts to 51 ft-lb (69 N·m).
3. Press a new bearing (18) onto the intermediate gear assembly.
4. Press new bearing (16) onto input pinion gear (17).
5. Apply grease to the lip of the new oil seal (10) and install the seal using a transaxle pinion seal tool (CCI P/N 1014161). The lip of the oil seal should face the inside of the transaxle housing. Make sure the seal is firmly seated.
6. Install the differential assembly, the intermediate gear assembly, and the input pinion gear simultaneously. Be sure all bearings are seated properly in the housing. Rotate the input shaft to check for smooth gear operation **(Figure 23-11, Page 23-6)**.
7. Install both dowel pins (25) in the transaxle housing (20) **(Figure 23-14, Page 23-8)**.
8. Install left half of transaxle housing:
   8.1. Place a 1/8-inch (3 mm) bead of Three Bond liquid gasket (36) on mating surface of housing.
   8.2. Install left half of transaxle housing (20).
   8.3. Install eleven bolts (24) in the case housing and tighten to 19 ft-lb (25.7 N·m). Type G transaxles have no shims or gasket.
   8.4. Install axle tube (14 and 35) with lock washers and bolts (9 and 8). Tighten the bolts to 36 ft-lb (49 N·m).
9. Install the brake assemblies as instructed. **See Brake Cluster Installation, Section 6, Page 6-9.**
10. Apply a small amount of grease to the lip of the oil seal (15). **See following CAUTION.**

⚠ CAUTION

- **Clean any residual oil from the exposed end of the axle shaft and from the oil seal area prior to installing the axle shaft.**

11. Clean the splines on the axle shaft (1 and 2). Rotate the axle to align the shaft splines with the splined bore of the differential side gear. Push the shaft in until the bearing seats against the shoulder in the axle tube.

12. Install the retaining ring (6) in the axle tube. **See following WARNING.**

⚠ WARNING

- **Be sure the retaining ring is properly seated in its groove. If the ring is not properly installed, the axle assembly will separate from the transaxle and damage the axle assembly and other components. Loss of vehicle control could result, causing severe personal injury.**

13. Make sure the drain plug (22) is installed in the transaxle and tightened to 23 ft-lb (31 N·m). Fill the transaxle, through the level indicator hole, with 22 ounces of SAE 30 API Class SE, SF, or SG oil (a higher grade may also be used). Install and tighten the level indicator plug and washer (21) to 23 ft-lb (31 N·m).

TRANSAXLE INSTALLATION

See General Warning, Section 1, Page 1-1.

1. If using a chain hoist, raise the vehicle and place transaxle in position on the jack stands. If using a floor jack, lower the jack stands to their lowest settings and place the transaxle in position on the jack stands. **See WARNING "Lift only one end of the vehicle..." in General Warning, Section 1, Page 1-1.**
2. Align the center hole in the saddle of the transaxle with the pilot bolt in the leaf spring assembly.
3. Install the two U-bolts, jounce bumper mount and spacers, lock washers, and nuts. Tighten the nuts to 25 ft-lb (34 N·m). Tighten the U-bolt nuts so an equal amount of thread is visible on each leg of the bolt.
4. Install the motor. **See Section 22a – Motor (Model 5BC59JBS6365) or Section 22b – Motor (Model EJ4-4001).**
5. If using a chain hoist, lower the vehicle while guiding the leaf springs into the rear spring shackles. If using a floor jack, raise the differential while guiding the leaf springs into the rear spring shackles. Then raise the jack stands to support the transaxle.
6. Connect the four motor wires. Tighten the retaining nuts to 65 in-lb (7.3 N·m). Use two wrenches to prevent the posts from turning. **See following NOTE.**

NOTE: *If the motor wires were not tagged when disconnected, refer to the wiring diagram for proper connection.* ***See Wiring Diagram, Section 18, Page 18-2.***

7. Insert bolts through the spring shackles and bushings in the leaf spring eyes. Secure bolts with lock nuts. Tighten to 15 ft-lb (20.3 N·m).
8. Connect the brake cables.
9. Install the shock absorbers. Tighten shock absorber retaining nuts until the rubber bushings expand to the same size as the cup washers.
10. Install the rear wheels and finger-tighten the lug nuts.
11. Lift the vehicle and remove the jack stands.
12. Lower vehicle and tighten the lug nuts, using a crisscross pattern, to 55 ft-lb (74.6 N·m).
13. Test drive the vehicle to check for proper operation.

A

B

T

U

V

W

Z

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