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. **See step 6. of Battery Replacement on page 14-5.** 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 14-5.**

SINGLE POINT WATERING SYSTEM (SPWS)

⚠ WARNING

- **When replacing batteries in the Single Point Watering System, place the battery cap from the new replacement battery onto the used battery being removed from the car. Important safety warnings on the battery cap must remain with the battery after it has been removed from the car**

CAUTION

- **Water the batteries only AFTER charging.**
- **Use water that meets the quality standards shown on page 14-6. Maximize battery life by removing ions and heavy metals from water with the use of a single point watering system deionizer. A deionizer for vehicles with SPWS, Club Car Part Number 105166801 is available from Service Parts (DC powered water quality indicator light). Replacement cartridge: 104005901. Bottled distilled water, with hand pump, Club Car Part Number 104006101, is recommended for private consumer applications.**

INITIAL MAINTENANCE OF THE SPWS

After six weeks of operation, remove the valves from the batteries and manually check the battery water level to ensure that the SPWS is not leaving any cells dry. This initial electrolyte level check on all the battery cells verifies that all the valves in the SPWS are functioning correctly. If a valve fails to open, the cell will eventually dry out. The initial one-time inspection of all cells will identify any occurrence of a valve that fails to open. If a valve fails to close, it will become evident due to the cell overflowing during routine watering. Either failure scenario is rare, but should be monitored in the initial inspection and during routine watering sessions. Replace malfunctioning valves to ensure maximum battery life.

After the initial six-week inspection, manually check the battery water levels at least once per year, particularly after winter storage or any other period of vehicle inactivity. **See following NOTE.**

NOTE: *For the longest battery life, be sure the mineral contents of the water meet the minimum requirements as stated in the vehicle's appropriate maintenance and service manual.* ***See Battery Care on page 14-6.***

WATERING BATTERIES WITH THE SPWS

Checking the Water Flow Rate

1. Connect the water hose with the built-in screen filter (2) to the water faucet (1) **(Figure 14-4)**. **See following CAUTION.**

CAUTION

- **Make sure the screen filter is clean.**

- **Do not use a longer garden hose than provided with the System (20 feet or 6 meters), as a decrease in water pressure can overfill the batteries and damage the refill system.**

2. Before screwing the hose-end assembly (3) onto the opposite end of the water hose, check the screen filter (4) inside the end of the assembly to make sure it is clean **(Figure 14-4)**.
3. Connect the purger (5) to the female coupler (8) on the end of the hose-end assembly **(Figure 14-5)**.

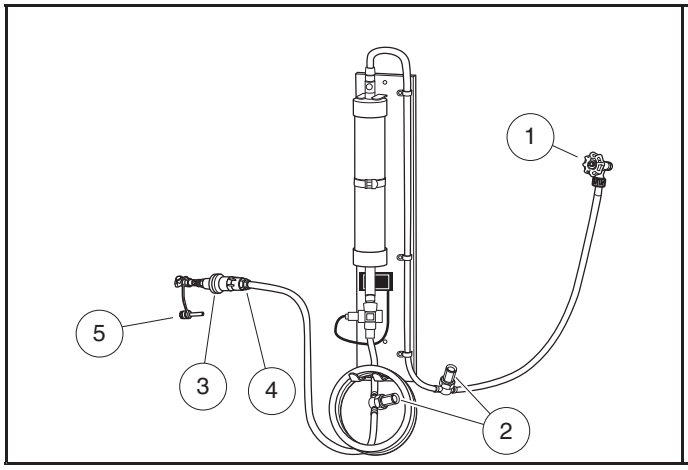

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Figure 14-4 Connecting Hose with Filter to Water Source

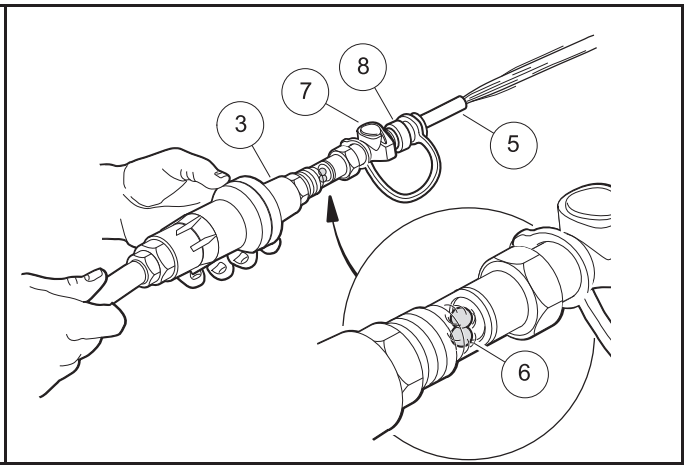

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Figure 14-5 Checking the Water Flow Rate

4. Completely open the water faucet until the water flows out of the hose-end assembly (3), and note the movement of the red flow indicator balls (6). **See following NOTE.**

NOTE: *This step also eliminates any trapped air from the water hose.*

The water flow rate must be at least 2 gallons per minute (7.6 L per minute) and the water pressure must be no more than 100 psig (689.5 kPa) when static (no flow) for the SPWS to function properly.

5. Check the water quality light on the deionizer to make sure the light is green in color, indicating acceptable water quality. If the light indicates unacceptable water quality, the cartridge must be replaced.
6. After ensuring adequate water flow rate and water quality, press the grey button (7) on the end of the female coupler (8) to disconnect the purger from the pressure regulator.

Refilling the Batteries

1. Locate the battery fill coupling (9) on the driver side of the battery compartment, remove the dust cover (10) from the male connector **(Figure 14-6)**, and connect the hose-end assembly (3) **(Figure 14-7)**. The water flow will begin immediately.

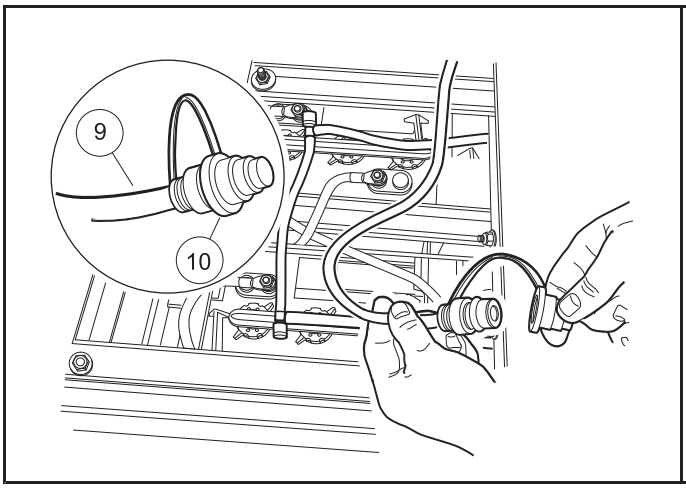

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Figure 14-6 Dust Cap

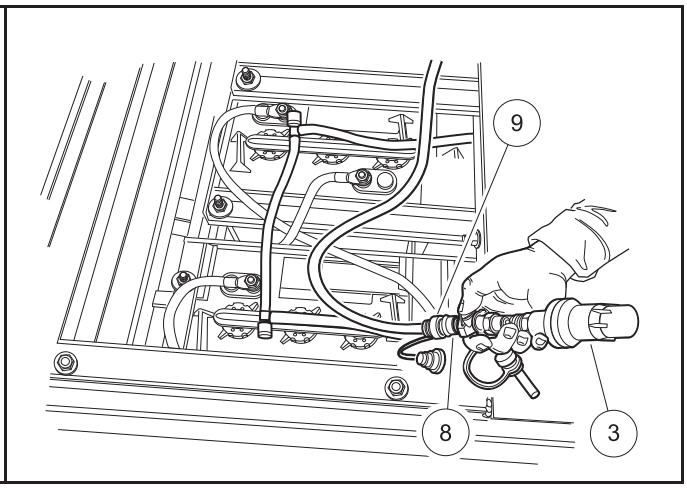

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Figure 14-7 Connecting Hose-end Assembly to Battery Fill Connector

2. The red flow indicator balls should swirl, indicating that the batteries are being filled. **See following CAUTION.**

CAUTION

- **If at any time water overflows from the batteries, immediately stop the refill process, disconnect the pressure regulator from the battery fill coupling, and call for service.**

3. When the red flow indicator balls stop moving, immediately press the grey button to disconnect the hose-end assembly from the battery fill coupling (9), and squeeze the dust cover (10) to lightly secure it to the male connector of the battery fill coupling **(Figure 14-6)**.
4. Place the battery fill coupling into the space between the batteries and the car body. Leaving the fill coupling on top of the battery bank or tucked between the batteries can result in coupling damage.
5. Turn the water faucet off when finished filling the vehicle(s).

BATTERY STORAGE

See Storage – Electric Vehicles, Section 3, Page 3-2.

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. **See following NOTE.**

NOTE: *When vehicles are being rotated, the CDT (Controller Diagnostic Tool) can be a very helpful service tool. Monitoring the value of the Odometer or Amp-Hours with the CDT simplifies vehicle usage scheduling.* ***See Monitor Menu, Section 11, Page 11-10.***

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 discharged and recharged 50 to 70 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.

SECTION 15 — QUIQ HIGH FREQUENCY CHARGER

15

⚠ DANGER

- **See General Warnings on page 1-1.**

⚠ WARNING

- **See General Warnings on page 1-1.**

GENERAL INFORMATION

This section includes information pertaining to servicing the QuiQ™ high frequency battery charger. Do not attempt to service a battery charger that has not been properly identified. If a charger cannot be properly identified, contact your local authorized Club Car dealer or distributor.

The High Frequency Battery Charger functions as an integral part of the vehicles' electrical system and will not work with other electric vehicles. The charger is programmed with a specific charge algorithm that is appropriate to the specific battery type used in the vehicle. **See Battery Charger Algorithms on page 15-2.**

The charger utilizes sophisticated charge termination criterion to shut off automatically, preventing the possibility of either undercharging or overcharging. The charger accomplishes this by monitoring battery Voltage, charge current, charge time and using strict dV/dt termination criterion.

FEATURES

Charge Interlock

When the AC power cord is inserted into a wall receptacle, the charger locks out the vehicle drive system. This prevents the possibility of driving the vehicle while the charger is plugged in and potentially damaging the vehicle and charger.

Long-Term Storage Charge

This charger is designed to be left connected to AC power during off-season or long-term storage. Be sure to check the charger monthly to ensure the charger is operating correctly during storage. The charger will enter maintenance mode if supported by the charge algorithm or automatically activate if battery voltage drops less than 2.1 volts per cell (24 cells is 50.4 volts) or 30 days have elapsed. To return the vehicle to service, disconnect the AC cord from the wall outlet, wait 15 seconds and then plug the AC cord back in. The charger will activate. Allow the vehicle to complete one full charge cycle before putting it into service.

UL AND CSA LISTING

When operated on a 120 volt / 60 Hz electrical system, this battery charger has been listed by Underwriters Laboratories and by the Canadian Underwriters (thereby meeting the criteria of the Canadian Standards Association).

CE COMPLIANCE

This battery charger is compliant with the EU EMC Directive 2004/108/EC.

IP (INGRESS PROTECTION) RATING

The enclosure of the charger has been tested successfully to EN60529, meeting IP66. The AC supply inlet is rated to IP20, which is suitable for indoor use only. Keep all AC connections clean and dry.

HOW TO IDENTIFY CHARGE ALGORITHM NUMBER

The algorithm numbers offered can be found in **See Battery Charger Algorithms on page 15-2.** The charger can display its algorithm number by initiating Algorithm Display Mode. To enter Algorithm Display Mode, do the following:

1. Unplug the AC power supply cord from the wall outlet.
2. Disconnect the heavy-gauge red wire from the positive (+) post of battery no. 1.
3. Plug the AC power supply cord into the wall outlet. **See following NOTE.**

NOTE: *When the charger AC cord is connected, LED lights on the charger and dash perform start-up self-test (LEDs light up in sequence).*

4. After the start-up self-test, the 80% LED will display a series of flashes that represent the algorithm number **(Figure 15-1, Page 15-2)**. [Example: Algorithm number 125 is represented as “one flash”, pause, “two flashes”, pause, “five flashes”.] The charger will not repeat this series of flashes. To see the number again, repeat steps 1 and 3 with a 20 second pause between them.

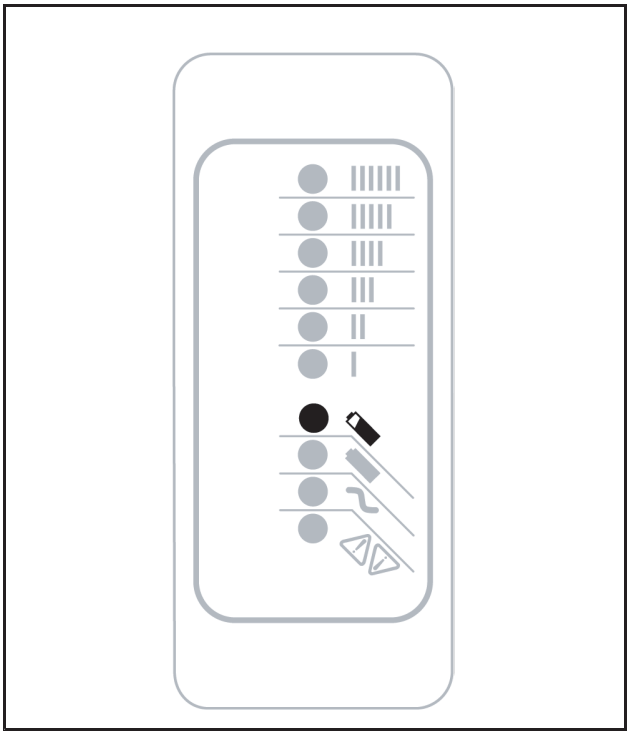

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Figure 15-1 80% LED Flashes in Algorithm Display Mode

Battery Charger Algorithms

CHARGER MODEL (PART NUMBER)	ALGORITHM	BATTERY TYPE
912–4854–04	algorithm # 72	JCI
912–4854–04	algorithm # 3	Trojan

THE CHARGE CIRCUIT

The charge circuit consists of the onboard charger, batteries and charger information light **(Figure 15-2, Page 15-3)**.

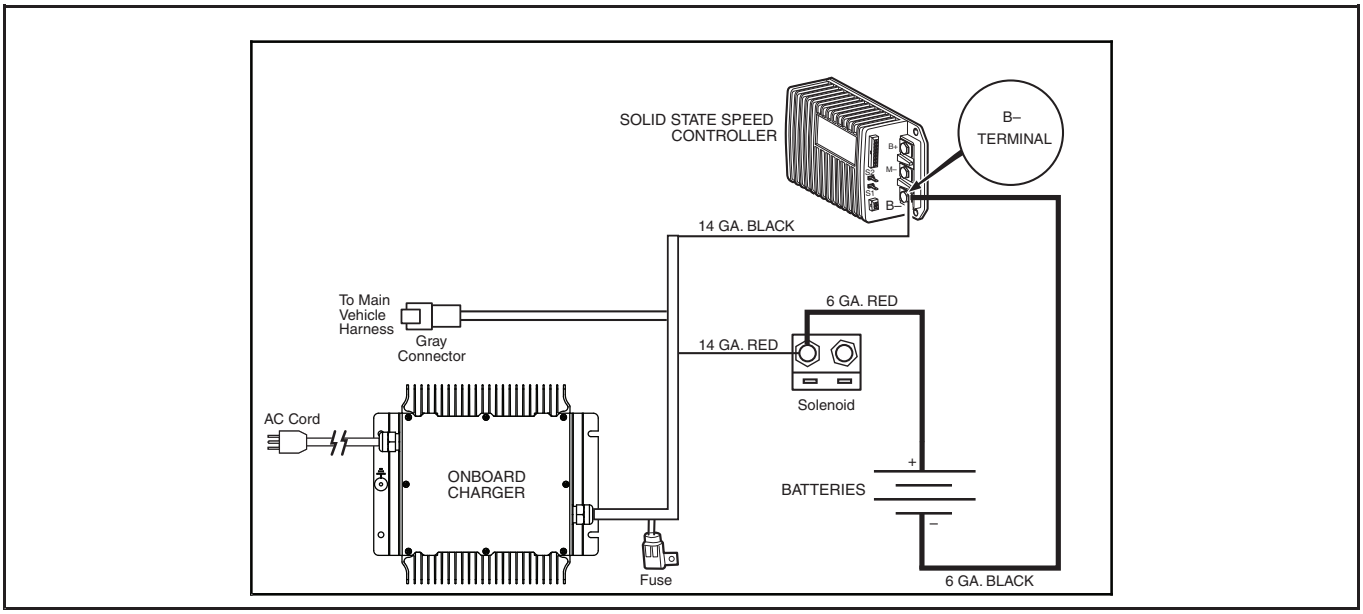

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Figure 15-2 Charge Circuit

ONBOARD CHARGER OPERATION

⚠ 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.**
- **The charging area must be ventilated. Hydrogen level in the air must never exceed 2%. The total volume of air in the charging area must be changed five times per hour. Exhaust fans should be located at the highest point of the roof. Contact a local HVAC engineer.**
- **Do not charge the vehicle batteries with the vehicle covered or enclosed. Any enclosure or cover should be removed or unzipped and pulled back when batteries are being charged. An accumulation of hydrogen gas could result in an explosion.**
- **Risk of electric shock. Connect charger power cord to an outlet that has been properly installed and grounded in accordance with all local codes and ordinances. A grounded outlet is required to reduce risk of electric shock; do not use ground adapters or modify plug.**
- **Do not touch uninsulated portion of output connector or uninsulated battery terminals.**
- **Disconnect the AC supply before making or breaking the connections to the battery.**

DANGER CONTINUED ON NEXT PAGE

⚠ DANGER

- **Do not open or disassemble charger.**
- **Do not operate this charger if the AC supply cord is damaged or if the charger has received a sharp blow, been dropped, or otherwise damaged in any way. Refer all repair work to the manufacturer or qualified personnel.**
- **This appliance is not intended for use by persons (including children) with reduced physical, sensory or mental capabilities, or lack of experience and knowledge, unless they have been given supervision or instruction concerning use of the appliance by a person responsible for their safety. Children should be supervised to ensure that they do not play with the appliance**

⚠ WARNING

- **The high frequency battery charger is programmed with an algorithm that matches the type and design specifications of the batteries originally installed in the vehicle. Never use this charger to charge batteries of a different type and design specification. Doing so will damage the non-matching batteries and greatly reduce their life span. If the batteries can not be replaced with the same as original, the charger must be replaced with one that matches the replacement batteries.**
- **Do not attempt to charge frozen batteries or batteries with bulged cases. Discard the battery in accordance with all environmental laws or return to an authorized Club Car dealer. Frozen batteries can explode.**
- **Only trained technicians should repair or service the charger. Contact your nearest Club Car distributor/dealer.**
- **Each charger should have its own dedicated 15 or 20 ampere separately protected (circuit breaker or fuse) single phase branch circuit, in accordance with all applicable electrical codes for the location.**
- **Connect the charger AC supply cord to a properly grounded, three-wire outlet of the proper Voltage and frequency as shown on the charger.**
- **Do not use an adapter to plug the charger with a three-prong plug into a two-prong outlet. Improper connection of the equipment-grounding conductor can result in a fire or an electrical shock.**
- **Use only an appropriately sized AC power cord. See AC Power Connection on page 15-7.**
- **Do not use near fuels, grain dust, solvents, thinners, or other flammables. Chargers can ignite flammable materials and vapors.**
- **Do not expose to rain or any liquid. Keep the charger dry.**
- **Prior to servicing the charger, disconnect the AC power supply cord from the wall outlet and remove the battery charger from the vehicle. See removal procedure in the appropriate maintenance and service manual.**
- **Do not use a battery charger if the cord or plug is damaged in any way. Replace worn or damaged parts immediately. Failure to heed this warning could result in a fire, property damage, severe personal injury, or death.**
- **Do not operate the charger if it has received a sharp blow, was dropped, or otherwise damaged in any way.**
- **Have worn, cut, or damaged power cords or wires replaced immediately.**
- **Install surge arrestors on incoming AC power lines. Surge arrestors will help protect electrical components in the charger and on the vehicle from all but direct or close lightening strikes**
- **Ensure battery connections are clean and properly tightened.**

WARNING CONTINUED ON NEXT PAGE

⚠ WARNING

- **Wear safety glasses or approved eye protection when servicing the vehicle or battery charger. 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 or battery charger.**
- **Use insulated tools when working near batteries or electrical connections. Use extreme caution to avoid shorting of components or wiring.**

CHARGER DISPLAYS

10-LED display on charger:

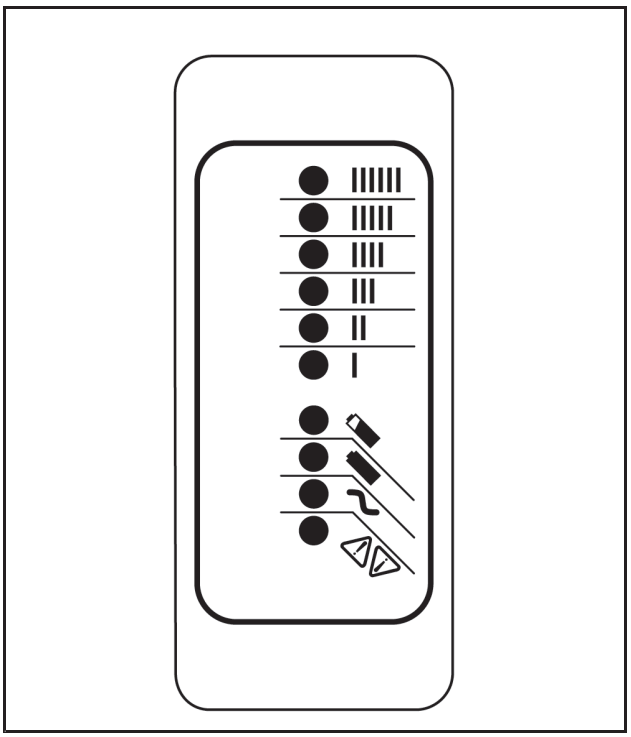

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Figure 15-3 10–LED Display on Charger

LED Color	Icon	Indication (following "Power-On Self Test")	STATUS EXPLANATION
Ammeter (Amber)		Solid:	Displays approximate scale of current output during bulk phase.
		Flashing:	High internal charger temperature. Output reduced. Also displays algorithm #1 through # 6 for 11 seconds if no battery is connected.
80% Charge (Amber)		Solid:	Bulk charge phase complete, 80% charged. In Absorption phase.
		Flashing:	1. With no battery connecte, indicates algorithm # selected by number of flashes. 2. With battery connected, indicates battery being charged.
100% Charge (Green)		Solid:	Charging is complete. Charger in Maintenance Mode.
		Flashing:	Absorption phase complete. In Finish phase
AC on (Amber)		Solid:	AC Power good
		Flashing:	Low AC Voltage. Check Voltage and power cord length (refer to guidelines) **See AC Power Connection on page 15-7.**
Fault (Red)		Flashing:	1. Solid Red = Charger Hardware Failure; requires charger to be replaced 2. Flashing Red = Charge Cycle Caution; AC Voltage, DC Voltage, Ambient Temperature, Charge Cycle Timers

AC POWER CONNECTION

CAUTION

- **Charger enclosure may be hot during charging. Use hand protection if handling the charger while charging.**

NOTE: *Make sure that the AC cord provided with your charger has the proper AC plug for your location. If it does not, contact your Club Car representative to obtain the proper cord or plug.*

Only use one charger on a single 15 amp circuit or the circuit may become overloaded.

To reduce the risk of electric shock, the battery charger must be grounded. The charger is equipped with an AC electric cord with an equipment-grounding conductor and a grounding type plug. The AC plug must be connected to an appropriate receptacle that is properly installed and grounded in accordance with the National Electric Code and all local codes and ordinances.

The AC power cord must be a three-conductor, no. 12 AWG (American Wire Gauge) or no. 14 SWG (British Standard Wire Gauge), heavy-duty cord with ground, properly wired and in good electrical condition. Keep it as short as possible (no more than 12 feet (3.7 m)). Place all cords so they will not be stepped on, tripped over, or otherwise subject to damage or stress.

CHARGING BATTERIES

NOTE: *Batteries should be put on charge even if they have been used for only a short time, i.e., 10 minutes. The 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 a local Club Car distributor/ dealer.*

New batteries will not deliver their full range until the vehicle has been driven and recharged from 20 to 50 times.

Vehicles should be restricted to 40 to 50 amp hours of discharge between charges until the batteries have been properly seasoned (20 to 50 charge cycles). For maximum battery life, Club Car recommends that electric vehicles always be recharged after 40 to 50 amp hours of discharge or each night in order to avoid deep discharging the batteries. Charging between uses will also extend battery life.

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, while cold batteries require more time to fully charge.

1. Insert the onboard charger AC plug into a dedicated and properly wired AC receptacle to begin a charge cycle. **See Battery Charger Algorithms, Section 15, Page 15-2.**

NOTE: *Only connect ONE charger to a single 15 amp circuit or the circuit may become overloaded.*

2. Place the charger AC cord so it will not be stepped on, tripped over, or otherwise subject to damage or stress.
3. Do not place items in the compartment where the battery charger is installed. Provide the charger with adequate ventilation.

After the charger is plugged in, the vehicle's control circuit is locked out, preventing operation of the vehicle, as well as the possibility of subsequent damage to the charger and vehicle.

Once the lockout is actuated, the charger turns on and performs a Power-On Self Test in which the LED lights on the charger flash ON in sequence, the Charger Indicator Light on the dash will flash three times and the reverse buzzer will simultaneously sound three times. If test is successful, charging will start and the ammeter will come on.

The charger monitors battery voltage, charge current and charge time to determine when the batteries are properly charged. The charger will shut off by itself and the green battery icon will stop flashing and remain on.

The vehicle's control circuit lockout remains activated until the charger AC plug is disconnected from the AC receptacle.

MAINTENANCE

See General Warnings on page 1-1.

To ensure trouble-free performance, it is very important to follow an established preventive maintenance program. Regular and consistent maintenance can prevent vehicle downtime and expensive repairs that can result from neglect. Any charger 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 Club Car distributor/dealer to perform all repairs and semiannual and annual periodic service

⚠ 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.**
- **Do not wear loose clothing or jewelry, such as rings, watches, chains, etc., when servicing the charger.**

- Do not expose charger to oil, dirt, mud or direct heavy water spray when cleaning vehicle.
- Keep all AC connections clean and dry.
- If the detachable input power supply cord set is damaged, replace with a cord that meets the following criteria:

For North America:	UL or CSA listed/approved detachable cord, 3 conductor, 16AWG minimum, and rated SJT; terminating in a grounding type IEC 60320 C14 plug rated 250V, 13A minimum.
For all other countries:	Safety approved detachable cord, 3 conductor, 1.5mm²; minimum, rated appropriately for industrial use. The cord set must be terminated on one end with a grounding type input connector appropriate for use in the country of destination and, on the other end, an output grounding type IEC 60320 C14 plug.

TROUBLESHOOTING

See General Warnings on page 1-1.

⚠ DANGER

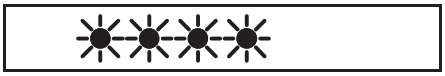
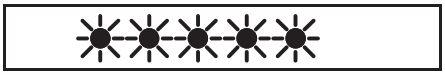
- **Do not touch any wire or component in the battery charger while AC power is present. Failure to heed this warning will result in an electric shock.**

⚠ WARNING

- **Knowledge of battery charger wiring and component terminology is required before attempting any repair (Figure 15-1, Page 15-3).**
- **Prior to servicing the charger, disconnect the AC power supply cord from the wall outlet and remove the battery charger from the vehicle. See Onboard Charger Removal And Installation on page 15-11.**

If a fault occurs, count the number of red flashes (on the charger or dash) between pauses and refer to the table below:

HIGH FREQUENCY BATTERY CHARGER TROUBLESHOOTING GUIDE

RED FLASHES	CAUSE	SOLUTION
	Battery High Voltage	Ensure battery set is rated 48 volts and composed of 24 cells. **See Battery Voltage Using Multimeter on page 15-10.** If not, replace with correct battery set. Reset charger (interrupt AC power for 15 seconds).
	Battery Low Voltage	Ensure battery set is rated 48 volts and composed of 24 cells. Also, check the voltage of each individual battery. **See Battery Voltage Using Multimeter on page 15-10.**If not, replace with correct battery set. Reset charger (interrupt AC power for 15 seconds).
	Charge Timeout caused by battery pack not reaching required voltage. Charger output was reduced due to high temperatures	Check for loose or corroded connections. Check for old or defective batteries. **See Test Procedures on page 15-10.** Operate charger at a lower ambient temperature.
	Check Battery: battery could not be trickle charged up to minimum voltage	Check for shorted or damaged cells. **See Battery Voltage Using Multimeter on page 15-10.**
	Over-Temperature: Charger shut down due to high internal temperature	Check for dirty, obstructed, or damaged cooling fins. Clean if necessary and ensure sufficient cooling air flow. Reset charger (interrupt AC power for 15 seconds).
	Charger Internal Fault	Reset charger (interrupt AC power for 15 seconds). Return to qualified service depot if fault persists.

TEST PROCEDURES

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

Index of Test Procedures

1 – Battery Voltage Using Multimeter
2 – Battery Condition Using Charger – All Batteries
3 – On-Charge Battery Voltage Using Charger And Multimeter
4 – AC Power and Continuity Test of AC Circuit
5 – Charger DC Circuit Continuity Test

TEST PROCEDURE 1 – Battery Voltage Using Multimeter

See General Warnings on page 1-1.

1. Check battery pack voltage. **See Measuring Voltage of Battery Set, Section 14, Page 14-2.**
2. Normal no-load voltage should be between 50 and 52 volts for a fully charged battery set. Normal no-load voltage of an individual battery should not be less than 0.5 volts of the other 7 batteries (for 8 x 6 volt battery set).

TEST PROCEDURE 2 – Battery Condition Using Charger – All Batteries

The easiest way to monitor the condition of a vehicle's batteries is simply to observe the charger display (usually found on the dash) at the end of the charge cycle. After a full charge, disconnect the charger AC plug, wait 30 seconds and reconnect the charger AC plug. The green battery icon will flash quickly and then flash slowly within 10 to 20 minutes, indicating sound, fully charged batteries.

NOTE: *Batteries near the end of their useful lives may not allow the battery charge current to taper and the green battery icon will continue to flash quickly.* ***See Batteries: IQ Plus Electric Vehicles on page 14-1.***

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. If the green battery icon does not change to a slow flash, the batteries should be tested further using the on-charge voltage test.

TEST PROCEDURE 3 – On-Charge Battery Voltage Using Charger And Multimeter

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. 8 (for 8 x 6 volt battery set). 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.

For 6 volt batteries: If individual batteries read above 7.0 volts and are within 0.5 volt of each other, go to the hydrometer test or discharge test. **See Battery Testing – 6 Volt, Section 14, Page 14-3.** If any battery reads below 7.0 volts and not within 0.5 volts of those batteries above 7.0 volts, replace battery. If readings are below 7.0 volts but within 0.5 volts of each other, the batteries are old.

TEST PROCEDURE 4 – AC Power and Continuity Test of AC Circuit

1. Disconnect AC cord from the wall outlet and DC plug from the vehicle receptacle.
2. Check the AC line fuse or circuit breaker in the storage facility.
3. With a multimeter set to 500 volts AC, check incoming AC voltage. Insert multimeter test probes into AC wall outlet; voltage should be between 85 and 270 volts. **See QuiQ Battery Charger Specifications, Section 2, Page 2-3.** If proper voltage is not present, have building wiring checked by a licensed electrical contractor.
4. If the charger will not power ON, check AC cord connections.
5. If the charger is connected correctly, check continuity of the AC cord wires.

TEST PROCEDURE 5 – Charger DC Circuit Continuity Test

1. Disconnect the AC cord from the wall outlet and the DC cord plug from the charger lead.
2. Check continuity of the DC cord wires from plug pin to large solenoid post (10-gauge red wire) and B- terminal of controller (10-gauge black wire). **See following NOTE.**

NOTE: *The 10-gauge red wire from the charger to the solenoid has an in-line 30-amp fuse.*

3. When finished, connect DC cord plug to the charger lead.

CHARGER REPAIRS

See General Warnings on page 1-1.

NOTE: *The high frequency charger offers no replacement parts. If necessary, the charger must be replaced.* ***See Onboard Charger Removal And Installation on page 15-11.***

ONBOARD CHARGER REMOVAL AND INSTALLATION

See General Warnings on page 1-1.

⚠ WARNING

- **Knowledge of battery charger wiring and component terminology is required before attempting any repair See Troubleshooting on page 15-9.**
- **Prior to servicing the charger, disconnect the AC power supply cord from the wall outlet and remove the battery charger from the vehicle.**

ONBOARD CHARGER REMOVAL

1. Disconnect the batteries and discharge the controller. **See Disconnecting the Batteries – Electric Vehicles, Section 1, Page 1-4.**
2. Remove the wire ties securing the connector to the charger P-clip.
3. Disconnect the all connectors from the charger AC and DC connector.
4. Remove four lock nuts (5) securing charger to charger mounting plate.

5. Remove charger from vehicle.

ONBOARD CHARGER INSTALLATION

1. Install charger onto vehicle.
2. Install the four lock nuts (5) securing charger to charger mounting plate. Tighten to 40 in·lb (5.4 N·m).
3. Connect the AC and DC connector.
4. Connect 8-pin grey connector.
5. Install wire ties to secure connectors to the charger P-clip.
6. Connect the batteries. **See Connecting the Batteries – Electric Vehicles on page 1-4.**

SECTION 16 — MOTOR (MODEL DA5-4006): ELECTRIC VEHICLES

16

⚠ DANGER

- **See General Warnings on page 1-1.**

⚠ WARNING

- **See General Warnings on page 1-1.**

GENERAL INFORMATION

The IQ Plus vehicle is equipped with a 48-volt DC, shunt-wound, reversible traction motor. This 3.7 horsepower motor is designed for use on IQ Plus vehicles only. Club Car recommends 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.

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.*

Index of Test Procedures

TEST PROCEDURE 1 – Internal Short Circuits

See General Warnings on page 1-1.

1. Disconnect the batteries and discharge the controller. **See Disconnecting the Batteries – Electric Vehicles, Section 1, Page 1-4.**
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. If readings are incorrect, motor will need to be removed from the vehicle and repaired by a qualified technician. **See Motor Removal on page 16-2.**

   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.
4. Connect the batteries. **See Connecting the Batteries – Electric Vehicles, Section 1, Page 1-4.**

TEST PROCEDURE 2 – Armature Circuit Open

See General Warnings on page 1-1.

1. Disconnect the batteries and discharge the controller. **See Disconnecting the Batteries – Electric Vehicles, Section 1, Page 1-4.**
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 16-2.**
3. Connect the batteries. **See Connecting the Batteries – Electric Vehicles, Section 1, Page 1-4.**

TEST PROCEDURE 3 – Field Circuit Open

See General Warnings on page 1-1.

1. Disconnect the batteries and discharge the controller. **See Disconnecting the Batteries – Electric Vehicles, Section 1, Page 1-4.**
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 16-2.**
3. Connect the batteries. **See Connecting the Batteries – Electric Vehicles, Section 1, Page 1-4.**

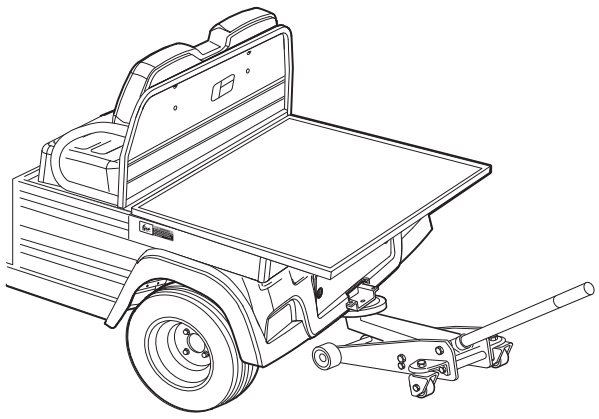
MOTOR REMOVAL

See General Warnings on page 1-1.

1. Disconnect the batteries and discharge the controller. **See Disconnecting the Batteries – Electric Vehicles, Section 1, Page 1-4.**
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 16-1, Page 16-3)** 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 16-2, Page 16-3)**. **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.**



1. Position floor jack under hitch bracket or frame.
2. Carryall 700 (shown)

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Figure 16-1 Lift Vehicle with Floor Jack

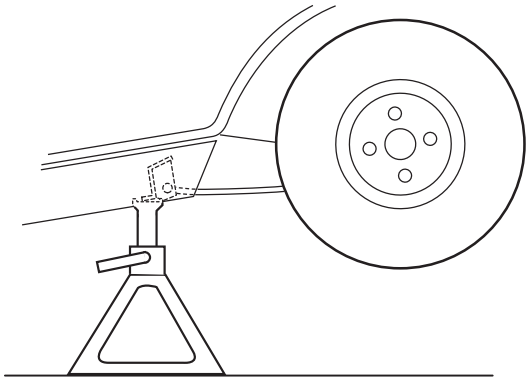


Figure 16-2 Vehicle Supported on Jack Stands

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 16-3, Page 16-3)**.
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 16-3, Page 16-3)**.

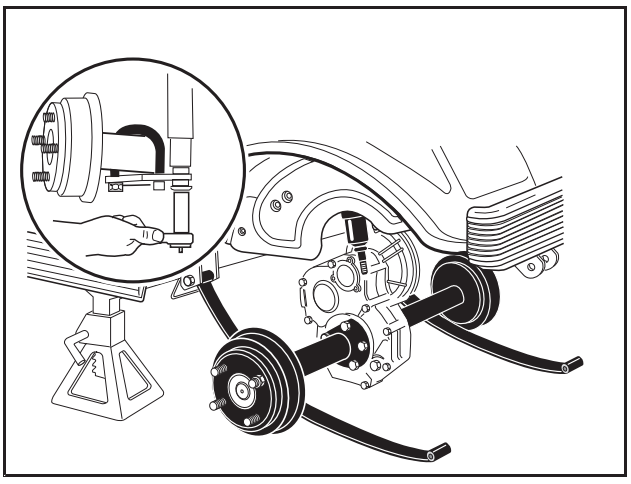


Figure 16-3 Lower Axle

9. Remove the four bolts that mount the motor to the transaxle **(Figure 16-21, Page 16-16)**. **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.

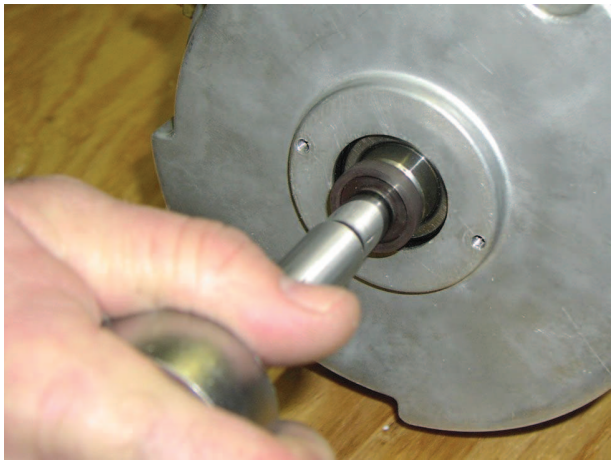


Figure 16-4 Speed Sensor Magnet

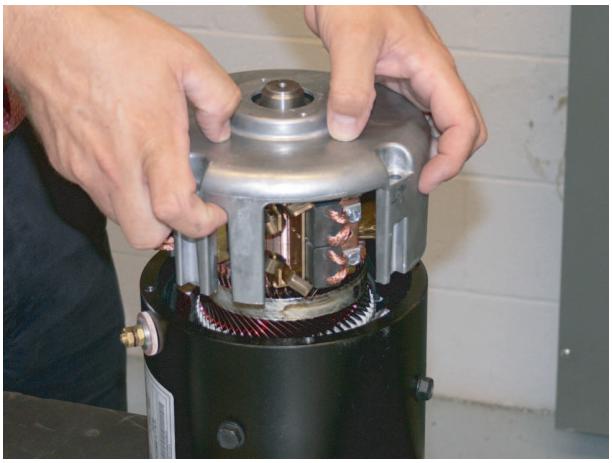


Figure 16-5 End Cap Removal

MOTOR DISASSEMBLY

1. Release the clasp and remove the headband assembly (21) from the motor. Visually inspect brushes and springs. **(Figure 16-13, Page 16-10)**.
2. Before continuing disassembly, place match marks on the motor end cap (20) and motor frame (14).
3. Remove speed sensor (10) and magnet (12).
   - 3.1. Remove the two screws (11) and clamp that secure the speed sensor (10) to the end cap (20).
   - 3.2. Remove the bolt (13) securing the magnet (12) to the armature shaft (15). Hold the back of the armature assembly to keep it from turning as you remove the bolt.
   - 3.3. Inspect the speed sensor magnet. **See Speed Sensor Magnet Inspection on page 16-9.**

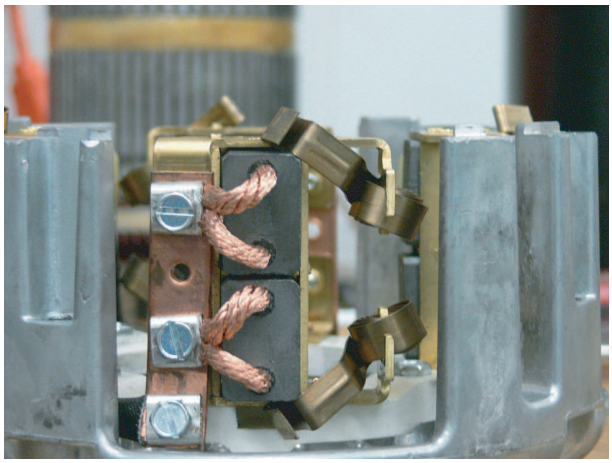


Figure 16-6 Brush Springs Positioning

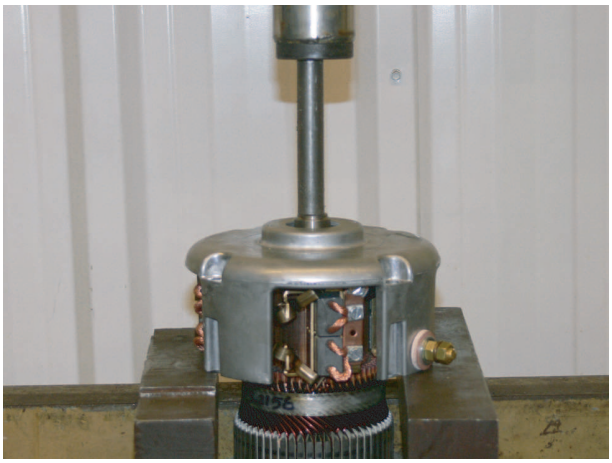


Figure 16-7 Armature Removal

4. Orient the motor so that the splined end of the armature is facing down.

5. Remove the four end cap bolts. The weight of the motor housing will cause it to drop when the bolts are removed. **See following CAUTION.**

⚠ CAUTION

- **The motor housing will drop when the bolts are removed. Do not put fingers under the motor housing when removing bolts.**

6. Remove the end cap and armature from the motor frame **(Figure 16-5, Page 16-4)**.
7. Inspect the brush springs for proper tension. **See Motor Brush, Spring, and Terminal Insulator Inspection on page 16-8.**
8. 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.*

8.1. Position the brush springs to reduce tension during removal of the armature. **(Figure 16-6, Page 16-4)**.
8.2. Place the end cap in a press with the armature facing down.
8.3. 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 16-7, Page 16-4)**.
8.4. Have an assistant support the armature while the press is activated.

9. Inspect the armature for wear and damage. **See Armature Inspection and Testing on page 16-7.**
10. Inspect the motor frame and field windings. **See Motor Frame and Field Windings Inspection on page 16-8.**
11. Remove the brush rigging.
    11.1. Mark the brush terminal posts (A1 and A2).
    11.2. Remove the two nuts securing the brush terminals (A1 and A2) to the end cap.
    11.3. Remove the four bolts and the brush rigging from the end cap **(Figure 16-8, Page 16-6)**.
12. Inspect the terminal insulators. **See Terminal Insulator Inspection on page 16-9.**
13. Remove the bearing from the end cap.
    13.1. Remove the retaining ring that secures the bearing in the end cap **(Figure 16-9, Page 16-6)**.
    13.2. Use an arbor press to remove the bearing from the end cap.
14. Inspect the bearing for wear and damage. **See Bearing Inspection on page 16-9.**

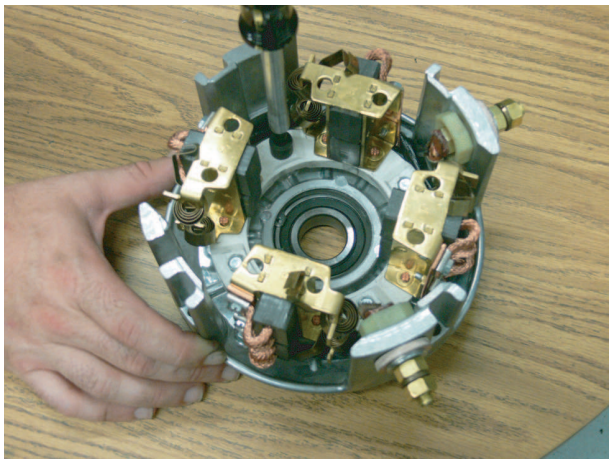


Figure 16-8 Brush Rigging Removal

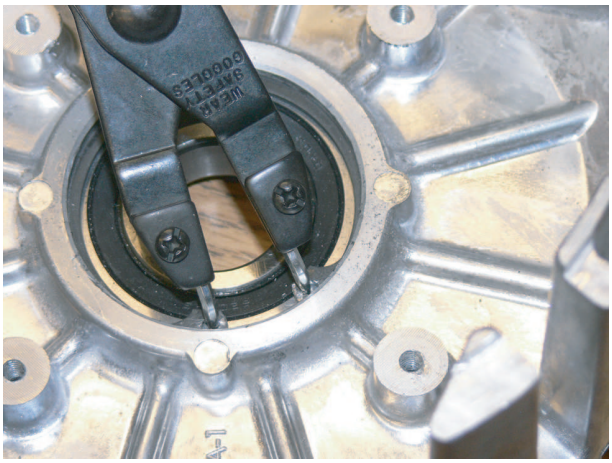


Figure 16-9 Retaining Ring Removal

MOTOR COMPONENT TESTING AND INSPECTION

See General Warnings on page 1-1.

ARMATURE INSPECTION AND TESTING

1. Remove the motor from the vehicle. **See Motor Removal, Section 16, Page 16-2.**
2. Remove the end cap and armature by performing steps 1 through 6 of Motor Disassembly on page 16-4.

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 (1) and the other on the armature core (2). The multimeter should indicate no continuity ***(Figure 16-10, Page 16-8)***. If the reading is incorrect, replace the armature.

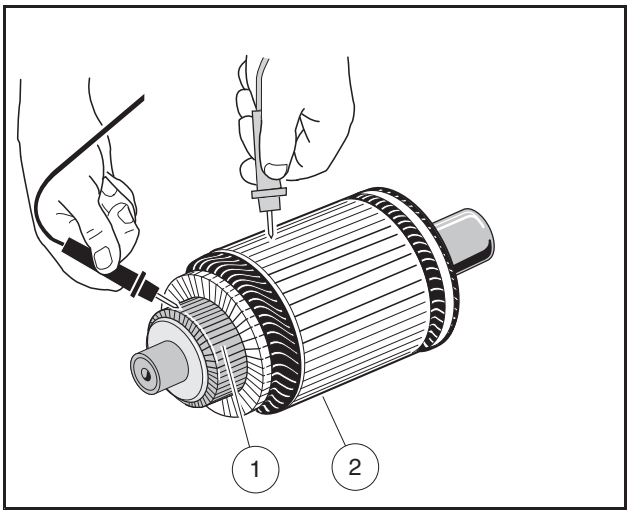


Figure 16-10 Armature Test

MOTOR FRAME AND FIELD WINDINGS INSPECTION

1. Remove the motor from the vehicle. **See Motor Removal, Section 16, Page 16-2.**
2. Remove the end cap and armature by performing steps 1 through 6 of Motor Disassembly on page 16-4.
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 16, Page 16-2.**
2. Release the clasp and remove the headband from the motor.
3. Inspect the brush springs (18) **(Figure 16-13, Page 16-10)**. 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 (1) on a scale (2).
   - 4.2. Place the end of the C-shaped plate (1) so that it is between the spring and the brush.
   - 4.3. Gently pull the scale (2) 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 ozf. (990 gf.) **(Figure 16-11, Page 16-9)**. **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 on page 16-11*** *for brush installation.*

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 16, Page 16-2.**
2. Release the clasp and remove the headband from the motor.
3. Inspect the brushes (16) for damage or excessive wear **(Figure 16-13, Page 16-10)**. 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 16, Page 16-2.**
2. Remove the terminal insulators by performing steps 1 through 11 of Motor Disassembly on page 16-4.
3. Inspect the insulators for cracks or other damage. 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 16, Page 16-2.**
2. Remove the bearing by performing steps 1 through 13 of Motor Disassembly on page 16-4.
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 16-12, Page 16-9)**.
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.

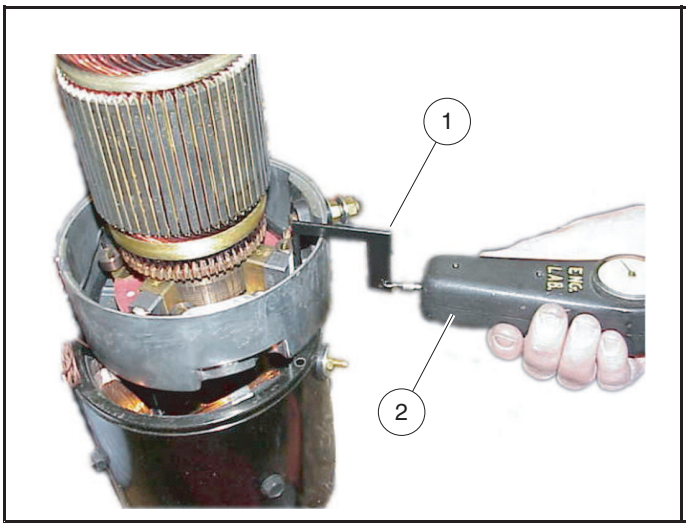


Figure 16-11 Brush Spring Tension Test

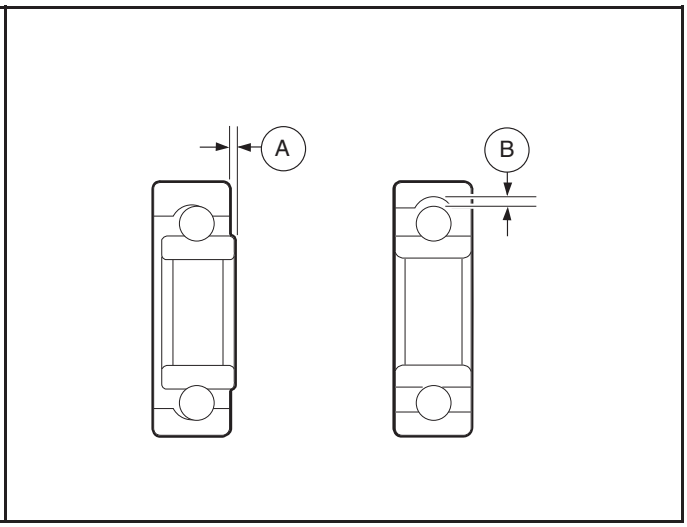


Figure 16-12 Bearing Inspection

Speed Sensor Magnet Inspection

Inspect the speed sensor magnet (12) for rust, wear, and cracks **(Figure 16-13, Page 16-10)**. Replace the magnet if necessary.

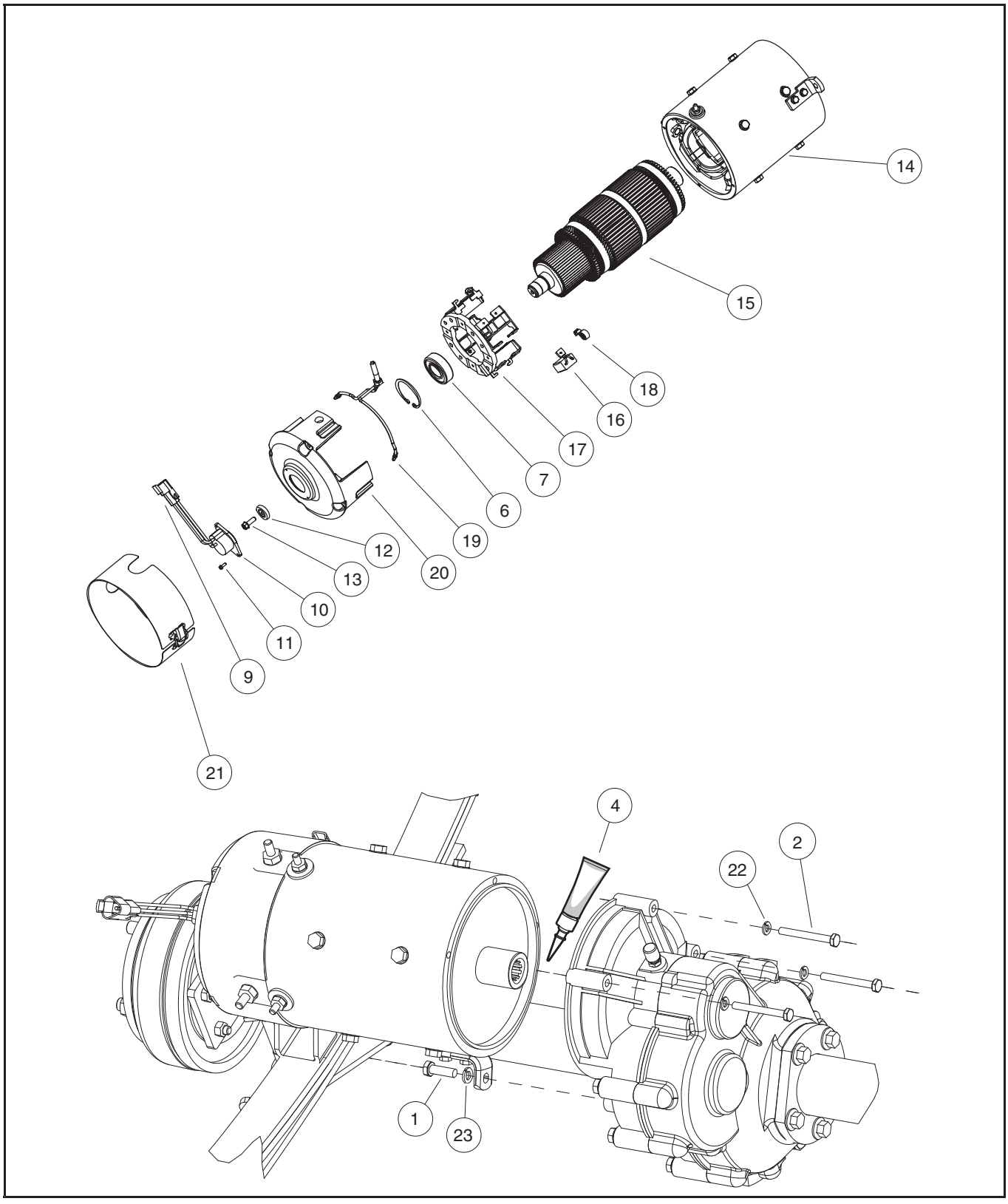


Figure 16-13 Motor

RECONDITIONING THE MOTOR

See General Warnings on 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)	0.014 ohms between bars 1 and 15
Field resistance at 75 °F (24 °C)	0.55 ohms

MOTOR ASSEMBLY

See General Warnings on 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.
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 eight brushes.

Install the brushes in the same rigging 180° apart from each other.

   2.1. Insert the brushes into the brush rigging as shown.
   2.2. Insert the two terminal posts through insulators in the end cap (20) wall at the A1 and A2 positions **(Figure 16-13, Page 16-10)**.
   2.3. Place external insulators and washers on each terminal post, and secure terminal with nuts. Tighten nuts to 100 in·lb (11.3 N·m). Ensure that the terminal posts do not rotate when tightening the nuts.
   2.4. Secure the brush rigging to the end cap with four bolts. Tighten the bolts to 25 in·lb (2.8 N·m).
   2.5. One at a time, push the brushes back until they are completely retracted into their mounting slots **(Figure 16-14, Page 16-12)**.

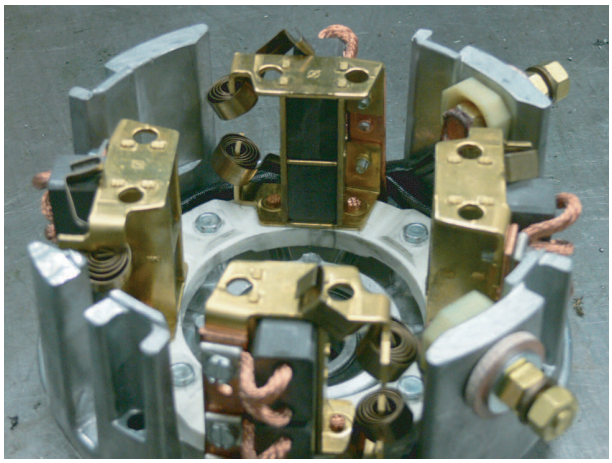


Figure 16-14 Retracted Brushes

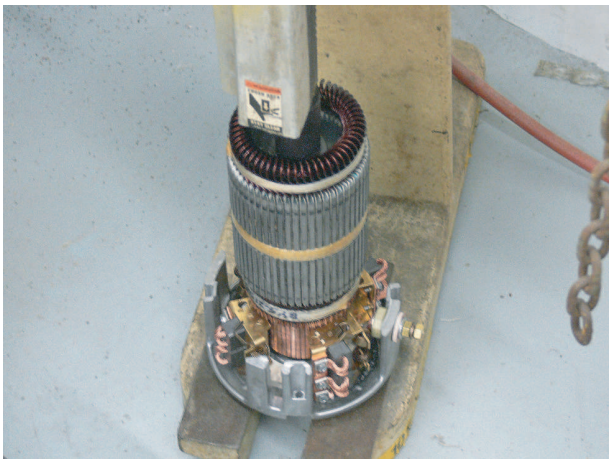


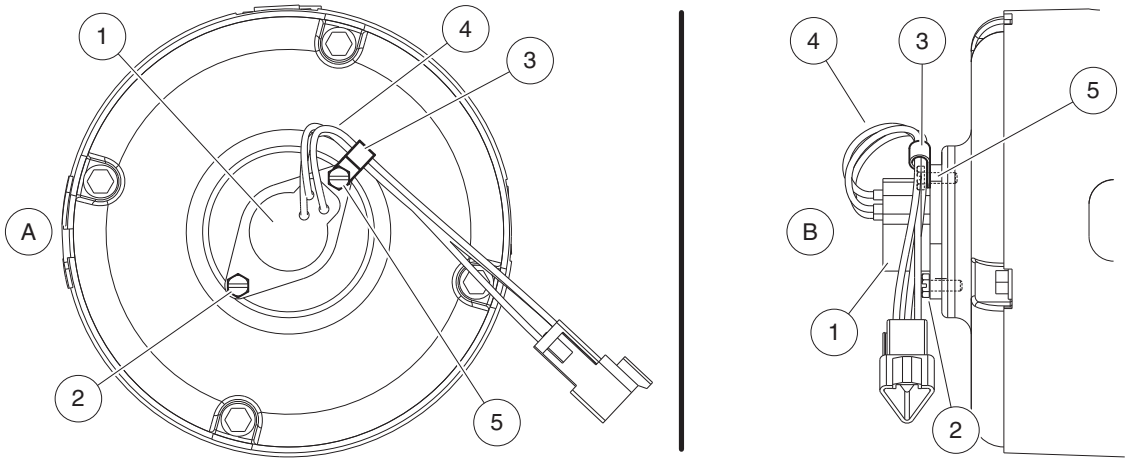
Figure 16-15 Armature Installation

3. With the brushes retracted, use an arbor press to press the armature shaft into the end cap bearing **(Figure 16-15, Page 16-12)**. **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. Move the springs back to their original position. Ensure that the spring rests on the end of each brush.
5. Align the match marks on the end cap (20) and the motor frame (14) and secure with four bolts **(Figure 16-13, Page 16-10)**. Tighten bolts to 130 in·lb (14.7 N·m).
6. Install the speed sensor magnet (12) with bolt (13). Tighten to 65 in·lb (7.3 N·m).
7. Install the speed sensor (1) with one screw (2) finger-tight **(Figure 16-16, Page 16-13)**.
8. Install clamp (3) onto sensor wires (4) and secure with other screw (5) finger-tight. Ensure clamp (3) and wires (4) are oriented as shown **(Figure 16-16, Page 16-13)**. Tighten both screws (2 and 5) to 20 in·lb (2.2 N·m).
9. Make sure the armature turns freely. If it does not turn freely, disassemble the motor to find the problem.



A. End View B. Side View

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Figure 16-16 Speed Sensor Clamp

MOTOR INSTALLATION

See General Warnings on 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 16-17, Page 16-14)**.
   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 16-18, Page 16-14)**.
   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.

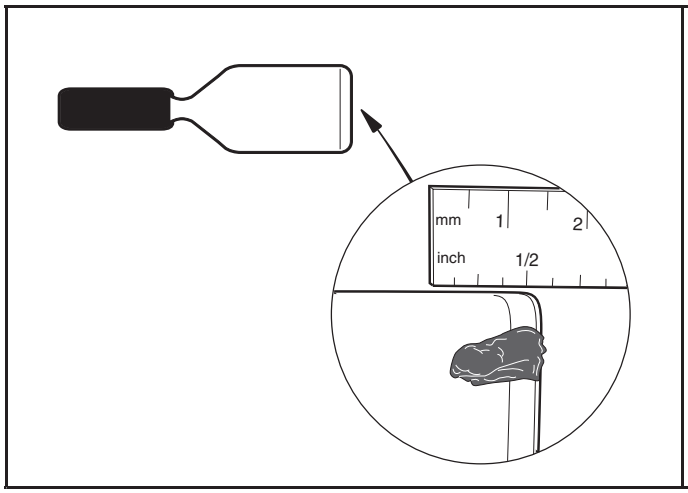


Figure 16-17 Grease on Putty Knife

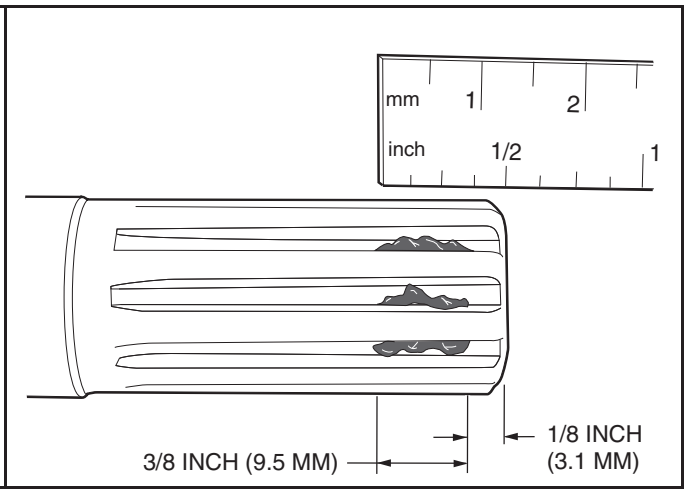


Figure 16-18 Application of grease to Input Shaft Grooves

2.6. Check the chamfer (1) and end (2) of the input shaft to ensure these areas are completely clean of grease as shown **(Figure 16-19, Page 16-15)**.

3. Install motor on transaxle.

3.1. 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. There will be approximately 1/16 inch (1.6 mm) gap between the motor adapter ring and transaxle housing as shown **(Figure 16-20, Page 16-15)**.*

3.2. Loosely install the four bolts that secure the motor to the transaxle. Do not tighten.

3.3. Begin finger-tightening the bolts (1 and 2) in the sequence indicated **(Figure 16-21, Page 16-16)**. 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.*

3.4. Tighten the right bolt (1) to 65 in·lb (7.3 N·m) **(Figure 16-21, Page 16-16)**.

3.5. Tighten the left bolt (2) to 65 in·lb (7.3 N·m) **(Figure 16-21, Page 16-16)**.

3.6. Tighten the center bolt (3) to 65 in·lb (7.3 N·m).

3.7. Tighten the bolt (4) inserted through the tab to 155 in·lb (17.5 N·m).

3.8. Install the motor wires, making sure they are connected to the correct motor terminals and that the terminal orientation is correct. **See Wiring Diagrams on page 12-4.** Tighten the terminal retaining nuts to 65 in·lb (7.3 N·m). Use a wrench on the bottom nuts to keep the terminals from moving.

3.9. 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.

3.10. Connect the three-pin speed sensor plug to the vehicle wire harness.

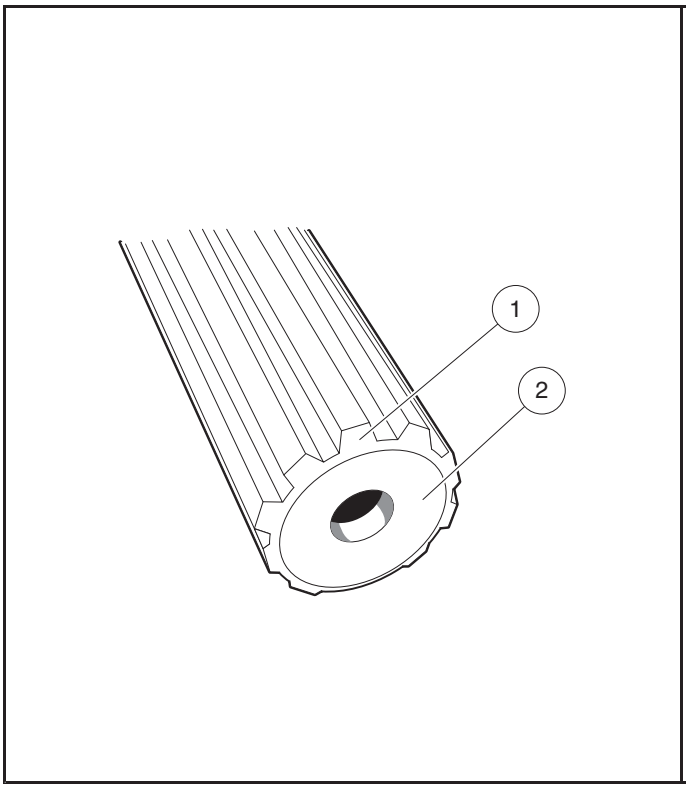


Figure 16-19 Clean Chamfer and Input Shaft End

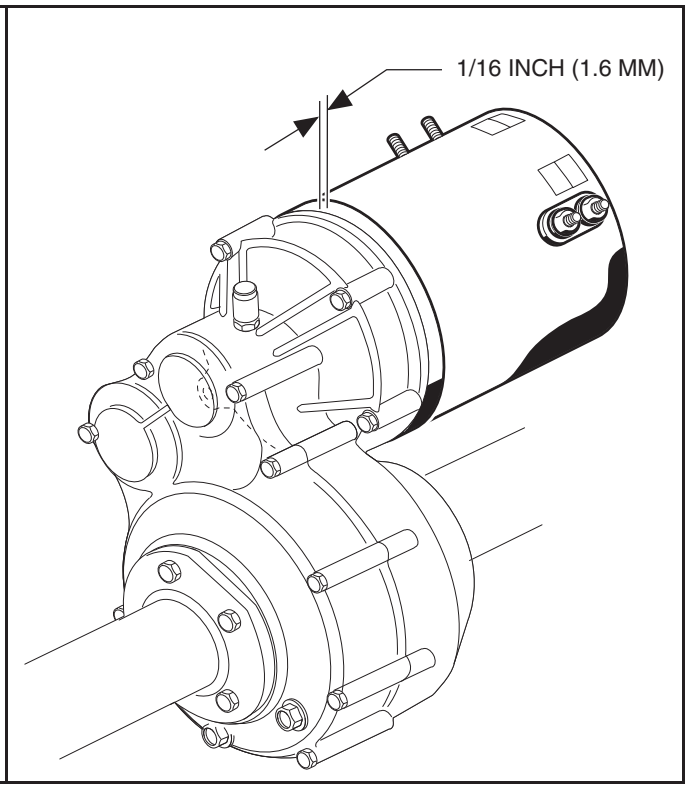


Figure 16-20 Gap at Motor and Transaxle

4. 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.
5. 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 Rear Suspension Section.**
6. Install the shock absorbers. Tighten nut until rubber bushing expands to the diameter of the cup washer.
7. If removed, install wheels and finger tighten the lug nuts.
8. Lift vehicle and remove jack stands. Lower vehicle to the floor and tighten lug nuts, using a crisscross pattern. **See Wheel Installation, Section 8, Page 8-1.**
9. Connect the batteries. **See Connecting the Batteries – Electric Vehicles, Section 1, Page 1-4.**
10. Place the Tow/Run switch in the RUN position.
11. 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.**

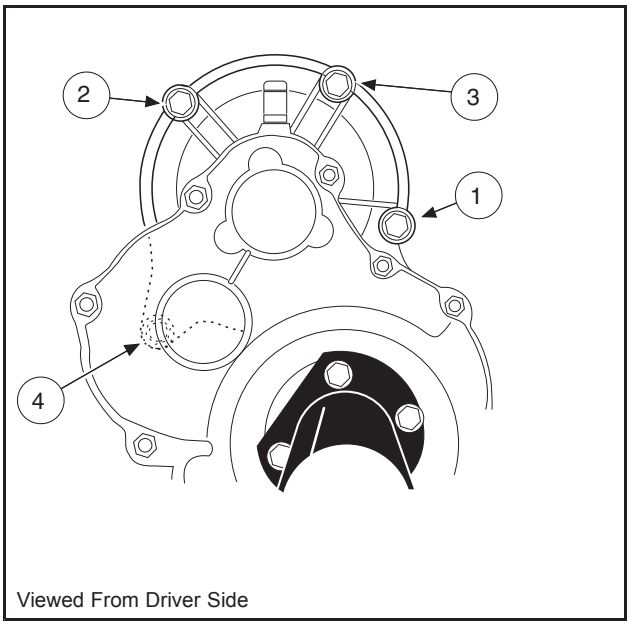


Figure 16-21 Motor Tightening Sequence

SECTION 17 — TRANSAXLE: ELECTRIC VEHICLES

⚠ DANGER

- **See General Warnings on page 1-1.**

⚠ WARNING

- **See General Warnings on page 1-1.**

LUBRICATION

See General Warnings on 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 17-5, Page 17-3)**. 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 installed 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 Warnings on page 1-1.

AXLE SHAFT

Axle Shaft and Oil Seal Removal

1. Disconnect the batteries and discharge the controller. **See Disconnecting the Batteries – Electric Vehicles, Section 1, Page 1-4.**
2. 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. **See WARNING "Lift only one end..." in General Warnings on page 1-1.**
3. Remove the rear wheel and brake drum. **See Wheel Brake Assemblies Section and Wheels and Tires Section.**
4. Use 90° internal snap ring pliers to remove the internal retaining ring (1) from the axle tube **(Figure 17-1, Page 17-2)**.
5. Remove the axle (2), retaining ring, and bearing assembly by pulling the axle straight out of the housing.
6. If necessary, remove the axle oil seal and adapter ring.
   6.1. Use a bearing puller (CC P/N 1016417) to remove the axle seal and adapter ring from the axle tube **(Figure 17-2, Page 17-2)**. **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.*

   6.2. Use a press to separate the axle oil seal (15) from the adapter ring (39) **(Figure 17-3, Page 17-2)**. Retain the adapter ring and discard the oil seal.

7. 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.
8. Inspect bearing (5) **(Figure 17-5, Page 17-3)**. If the bearing in a Type G transaxle is worn or damaged, the entire axle shaft assembly (1 or 2) must be replaced.

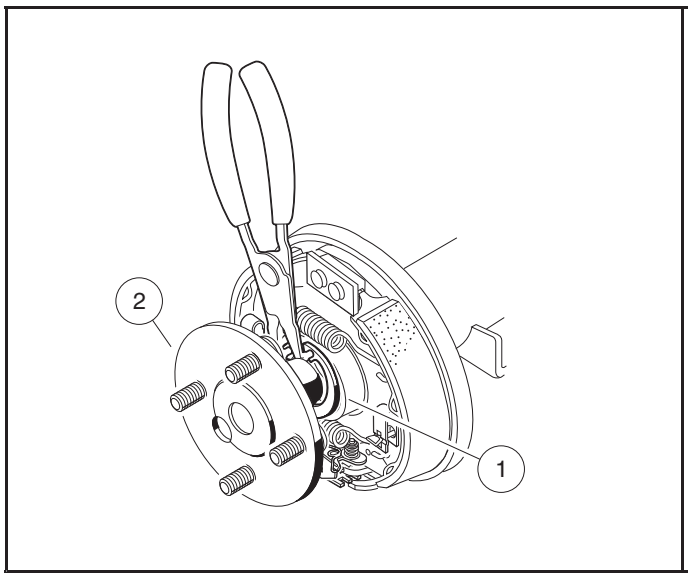


Figure 17-1 Remove Internal Retaining Ring

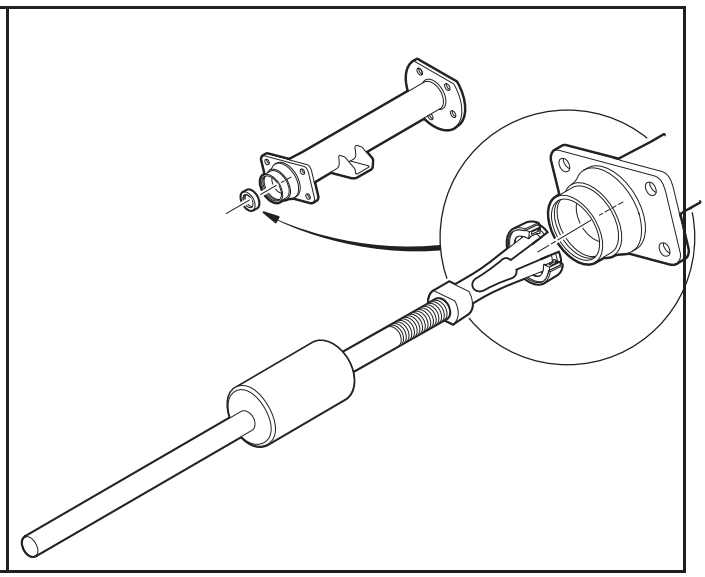
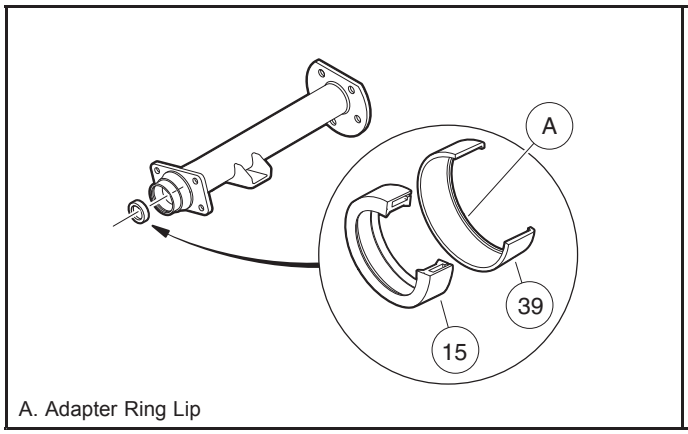


Figure 17-2 Axle Seal and Adapter Ring Removal



A. Adapter Ring Lip

Figure 17-3 Axle Seal and Adapter Ring

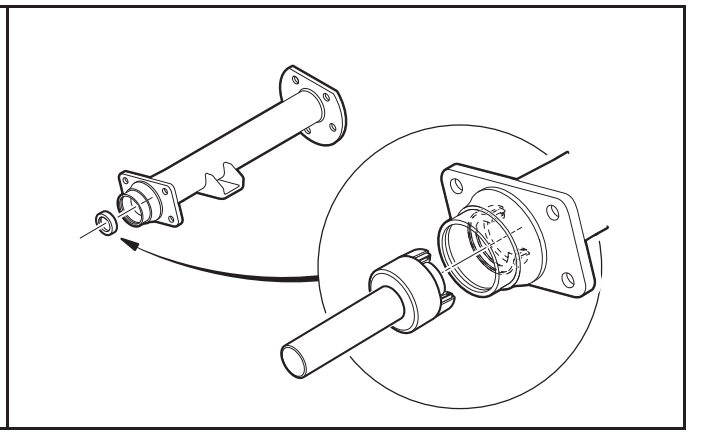


Figure 17-4 Axle Seal and Adapter Ring Installation

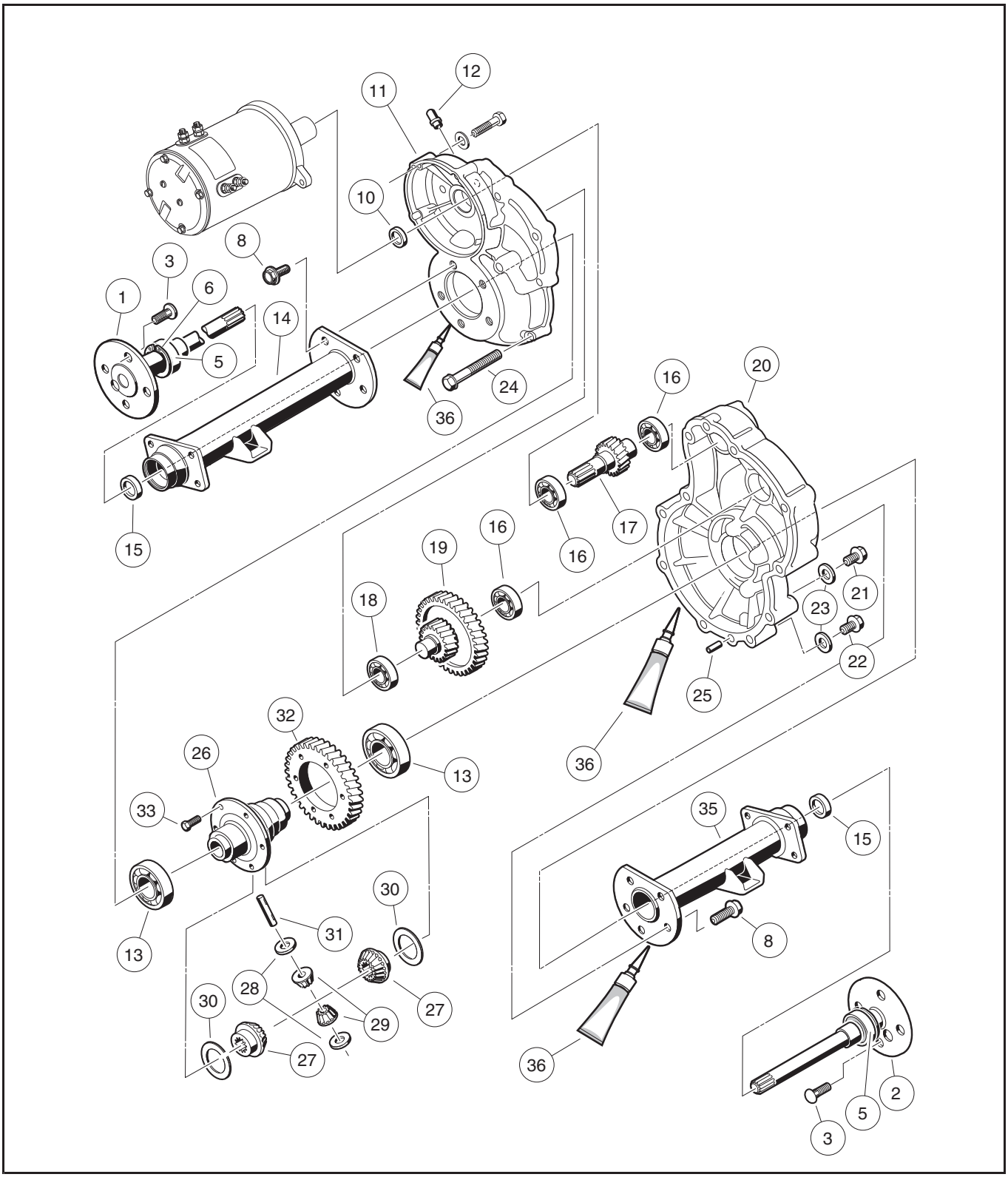


Figure 17-5 Transaxle – Type G

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 17-3, Page 17-2)**.
   1.2. Place a new seal (15) in the adapter ring with the seal lip facing toward the adapter ring lip **(Figure 17-3, Page 17-2)**. Use an axle seal tool (CC P/N 1014162) and mallet to tap it in until it seats firmly in position **(Figure 17-3, Page 17-2)**. 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 17-5, Page 17-3)**.
   1.4. Apply Loctite® 603 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 17-4, Page 17-2)**. Use an axle seal tool (CC 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 to prevent oil from coming in contact with brakes.**

2. Install the rear axle into the transaxle. **See following NOTE.**
   2.1. Insert the shaft, splined end first, through the seal and 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, then rotate it to align the shaft splines with the splined bore of the differential side gear (27) **(Figure 17-5, Page 17-3)**. Continue advancing the shaft until the bearing on the axle is firmly seated within the axle tube hub seat.
   2.2. Use a pair of snap ring pliers to install the retaining ring (6) inside 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 **(Figure 17-5, Page 17-3)**. **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 17-5, Page 17-3)**.*

   2.3. 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 or death.**

3. If a new oil seal was installed, allow 24 hours before operating the vehicle to allow the Loctite 603 to fully cure.
4. Connect the batteries. **See Connecting the Batteries – Electric Vehicles, Section 1, Page 1-4.**

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 17-5, Page 17-3)**.

TRANSAXLE

See General Warnings on page 1-1.

TRANSAXLE REMOVAL

1. Disconnect the batteries and discharge the controller. **See Disconnecting the Batteries – Electric Vehicles, Section 1, Page 1-4.**
2. Place chocks at the front wheels and slightly loosen lug nuts on both rear wheels.
3. 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 17-6, Page 17-5)**. **See WARNING "Lift only one end of the vehicle..." in General Warnings on page 1-1.**
4. 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.
5. Remove the bow tie pins (1), brake cable clevis pins (2), and cable retaining E-clips (3). Disconnect the brake cables (4) **(Figure 17-7, Page 17-5)**.

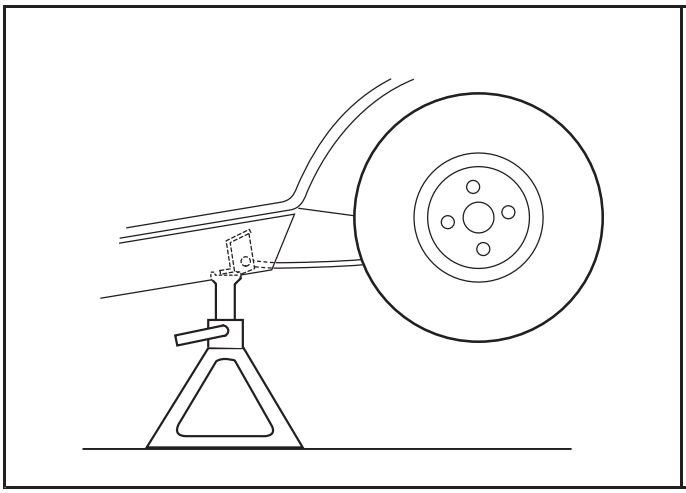


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Figure 17-6 Vehicle Supported on Jack Stands

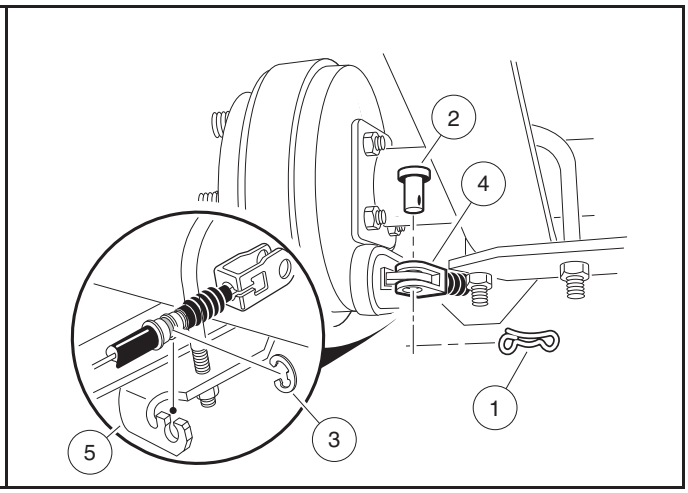

Figure 17-7 Brake Cables

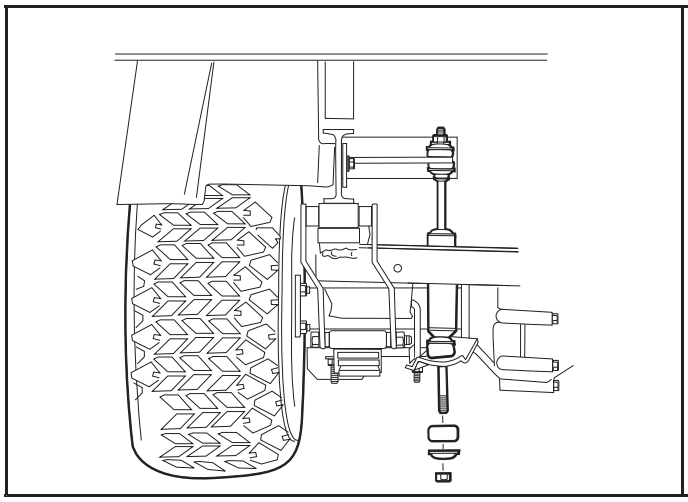

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Figure 17-8 Disconnect Shocks

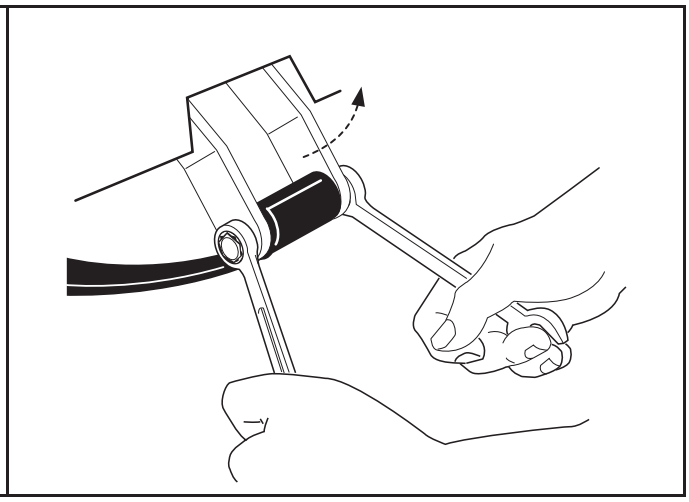

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Figure 17-9 Detach Spring From Shackles

6. Disconnect the shock absorbers from their lower mounts **(Figure 17-8, Page 17-6)**.
7. Disconnect the four motor wires. Use two wrenches to prevent the post from turning.
8. With a floor jack supporting the transaxle, remove lower spring shackle nuts and bolts. Rotate shackles up and away from springs **(Figure 17-9, Page 17-6)**.
9. 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.
10. Remove the three motor mounting bolts **(Figure 17-11, Page 17-7)** and the motor positioning bolt **(Figure 17-12, Page 17-7)** mounting the motor to the transaxle. **See following CAUTION.**

⚠ CAUTION

- **Do not position fingers under motor when sliding motor off of the input shaft. Fingers may get pinched when motor disengages.**

CAUTION CONTINUED ON NEXT PAGE

⚠ CAUTION

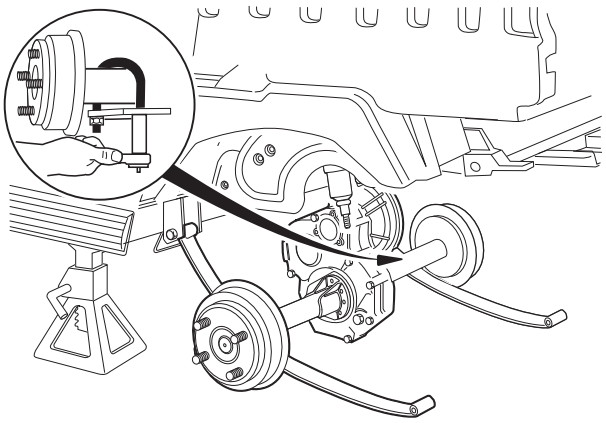

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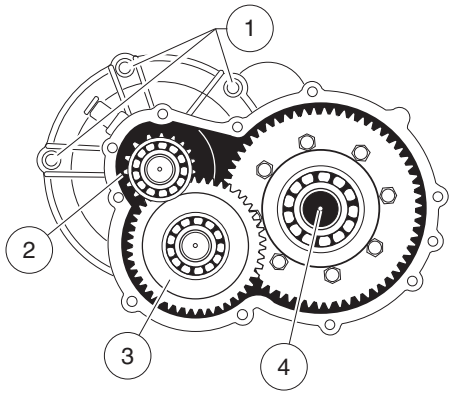
Figure 17-10 Detach Axle From Leaf Springs



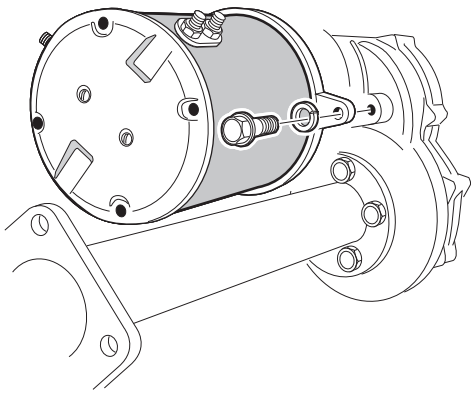
1. **Motor Mounting Bolts**
2. **Input Pinion Gear**
3. **Intermediate Gear Assembly**
4. **Differential Gear Case**

Figure 17-11 Motor Mounting Bolts and Gear Assembly

11. 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.**
12. If a floor jack was used, pull floor jack from beneath the transaxle and allow the springs to rest on the floor.
13. Remove the U-bolts attaching the transaxle to the leaf springs **(Figure 17-10, Page 17-7)**.
14. 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.
15. Drain the lubricant from the transaxle and remove the axle shafts. **See Axle Shaft and Oil Seal Removal on page 17-1. See following NOTE.**

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

16. Remove the brake assemblies if required. **See Wheel Brake Assemblies Section.**



Appearance of motor may be different from the motor shown above.

Figure 17-12 Motor Positioning Bolt

TRANSAXLE DISASSEMBLY, INSPECTION, AND ASSEMBLY

See General Warnings on page 1-1.

TRANSAXLE DISASSEMBLY AND INSPECTION

1. To detach axle tubes (14 and 35) from the transaxle housing, remove the bolts (8) **(Figure 17-5, Page 17-3)**.
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 unit out simultaneously **(Figure 17-5, Page 17-3)**. **See following CAUTION.**

CAUTION

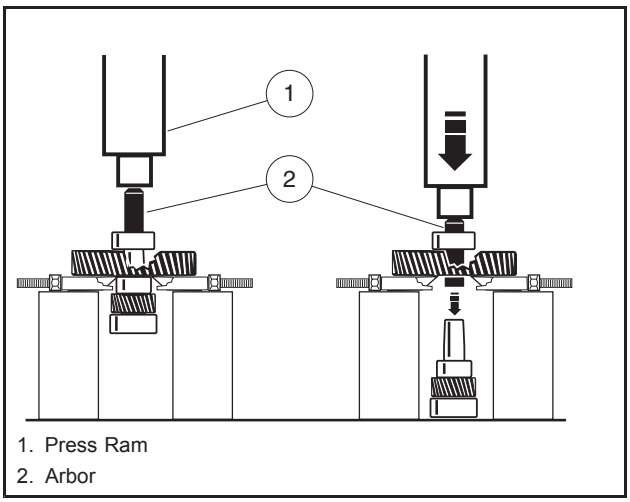
- **Do not damage gears. Use extreme care when handling them.**

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 17-5, Page 17-3)**. **See also Figure 17-13, Page 17-8. 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 17-5, Page 17-3)**. **See also Figure 17-13, Page 17-8.**
7. Press the bearing (18) off the intermediate gear assembly **(Figure 17-5, Page 17-3)**.



1. Press Ram
2. Arbor

Figure 17-13 Intermediate Gear Assembly

8. Disassemble the differential gear case:
   8.1. Remove the hex bolts (33) and the ring gear (32) from the differential case **(Figure 17-5, Page 17-3)**.
   8.2. Remove the ring gear.
   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 17-14, Page 17-9)**. Remove the two bolts.

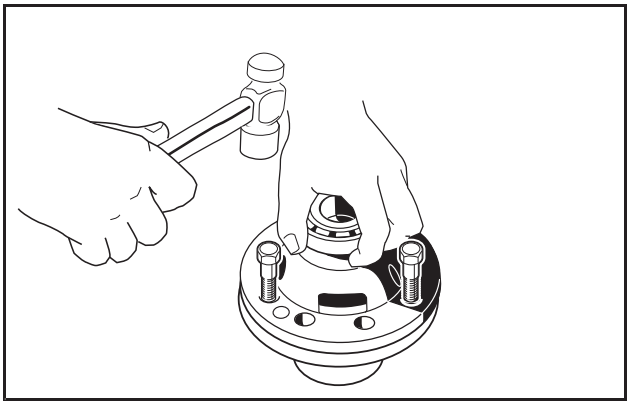


Figure 17-14 Separate Housing

   8.4. Remove the differential pin (31) by pushing pin through differential gear case from one side **(Figure 17-5, Page 17-3)**. **See also Figure 17-15, Page 17-9.**
   8.5. Remove the idler gears (1 and 2) and thrust plates (3 and 4) **(Figure 17-16, Page 17-9)**.

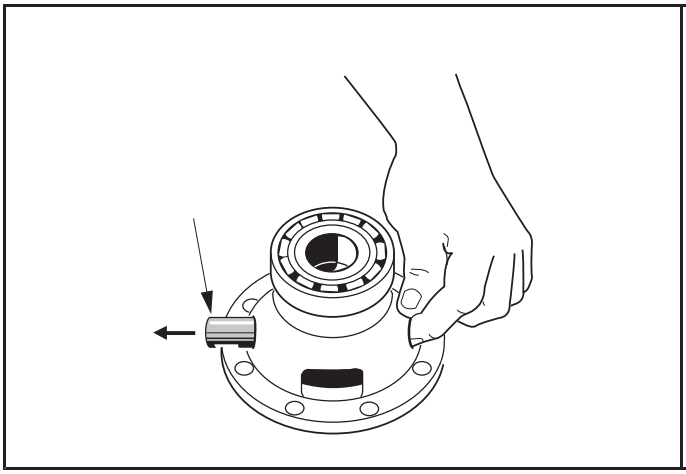


Figure 17-15 Differential Pin

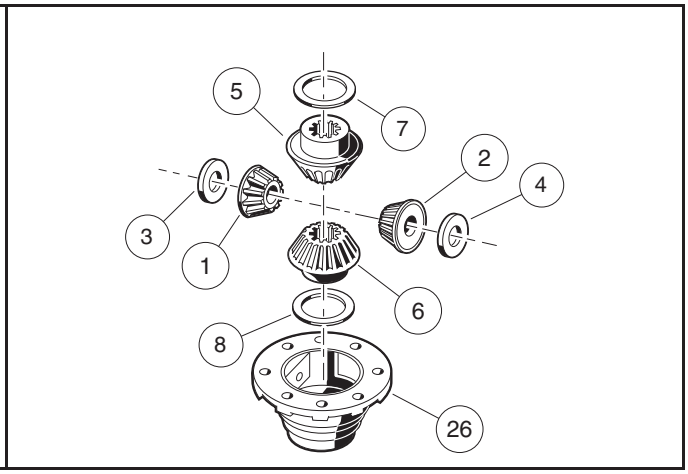


Figure 17-16 Left Differential

   8.6. Remove the differential gears (5 and 6) and thrust plates (7 and 8).
   8.7. Inspect the bearings (13) of the differential case (26) and replace them if they are damaged **(Figure 17-5, Page 17-3)**. 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 17-5, Page 17-3)**.
2. Assemble the differential gear case.
   2.1. Install the pin (31) **(Figure 17-5, Page 17-3)**. Apply a small amount of oil to all thrust plates and to both ends of the pin.
   2.2. Install the hex bolts (33) and output gear (32). Tighten bolts to 58 ft·lb (78.6 N·m).
3. Press a new bearing (18) onto the intermediate gear assembly **(Figure 17-5, Page 17-3)**.
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 (CC 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 17-11, Page 17-7)**.
7. Install both dowel pins (25) in the transaxle housing (20) **(Figure 17-5, Page 17-3)**.
8. Install left half of transaxle housing:
   8.1. Place a 1/8-inch (3 mm) bead of Three Bond liquid gasket on mating surface of housing.
   8.2. Install left half of transaxle housing (20) **(Figure 17-5, Page 17-3)**.
   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 bolts (8) **(Figure 17-5, Page 17-3)**. Tighten the bolts to 37 ft·lb (50.2 N·m).
9. Install the brake assemblies as instructed. **See Wheel Brake Assemblies Section.**
10. Apply a small amount of grease to the lip of the oil seal (15) **(Figure 17-5, Page 17-3)**. **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 to prevent oil from coming in contact with brakes.**

11. Install the rear axle onto the transaxle.
    11.1. 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 seat.
    11.2. Using 90° internal snap ring pliers (0.090 tip) (CC P/N 1012560), 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 **(Figure 17-5, Page 17-3)**.
    11.3. Place a 1/4 to 3/8-inch (6 to 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 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.**

12. 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 (21) to 23 ft·lb (31 N·m).

TRANSAXLE INSTALLATION

See General Warnings on 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.
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 (if required), and spacers, lockwashers, 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 Motor Installation on page 16-13.**
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 Diagrams, Section 12, Page 12-4.***

7. Insert bolts through the spring shackles and bushings in the leaf spring eyes. Secure bolts with locknuts. Tighten to 15 ft·lb (20.3 N·m).
8. Connect the brake cables using new bow tie pins (1) **(Figure 17-7, Page 17-5)**.
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. **See Wheel Installation, Section 8, Page 8-1.**
13. Connect the batteries. **See Connecting the Batteries – Electric Vehicles, Section 1, Page 1-4.**
14. Inspect the vehicle to check 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.**

SECTION 18 — TROUBLESHOOTING AND ELECTRICAL SYSTEM: PEDAL-START GAS VEHICLE

⚠ DANGER

- **See General Warnings on page 1-1.**

⚠ WARNING

- **See General Warnings on page 1-1.**

GENERAL INFORMATION

⚠ WARNING

- **To prevent damage to the ECU, never mix the black and gray connectors that attach to it. The black connector is tethered to the ECU mounting plate to help avoid installing it in the gray port.**

This section contains the information required to correctly troubleshoot the EFI gas vehicle. In addition to troubleshooting, this section contains general information on the electrical system and the circuits of the electrical system.

ACCESSORIES

For powered accessories that do not need to be controlled by the key switch, use the red/white and black/yellow wires with female, quick-disconnect terminals located behind the instrument panel.

LOW OIL WARNING LIGHT

NOTE: *When the key switch is placed in the ON position, the Low Oil Warning Light will illuminate for approximately 3 seconds as a bulb check function.*

If the Low Oil Warning Light comes ON due to low oil level, and oil is added to correct the issue, the Low Oil Warning Light will still remain ON. Cycle the key switch OFF and ON to reset the Low Oil Warning Light.

The gasoline vehicle is equipped with a low oil warning light (4), located at the top of the instrument panel. If the warning light comes on, oil should be checked and added to the engine as necessary before continuing to use the vehicle. **See following CAUTION.** The vehicle should never be driven when the low oil warning light remains on. If the warning light goes on and off, the vehicle may be driven, but oil should be added at the first opportunity. The light will flash repeatedly to indicate a possible problem with the electronic fuel injection (EFI) system. If the oil level is correct and the warning light stays on, have a trained technician check the vehicle.

CAUTION

- **Failure to add oil immediately when the low oil warning light stays on may result in permanent engine damage.**

GROUND LOCATIONS

Electrical grounds are located at the following areas:

- **Below the Battery:** The battery, starter/generator, voltage regulator and main wire harness are all grounded to the chassis on the frame rail below the battery.
- **In Front of Engine:** The engine is grounded to the chassis cross-member with an un-insulated, braided wire.

- **Top of Fuel Tank:** The fuel tank is grounded to the chassis through the main wire harness.

FEATURES OF THE ELECTRONIC FUEL INJECTION (EFI) SYSTEM

- Open-loop system (i.e. oxygen sensor not used)
- Controls fuel pump, fuel injector, oil lamp
- Inputs: Manifold Absolute Pressure (MAP), engine block temperature, ignition timing
- Blink fault codes through the Low Oil Warning Lamp
- Separate EFI wire harness
- The ECU and throttle body/fuel injector assembly are matched pairs

TROUBLESHOOTING GUIDE

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 the maintenance and service manual.

ECU ERROR CODES (DISPLAYED BY THE LOW OIL WARNING LIGHT)

Failure Mode Table – When Ignition Is Initially Switched ON

DISPLAY MODE	CONDITION	LAMP CONTROL
Blink Code	No Failure	Step 1: Lamp ON Two Seconds
		Step 2: Lamp OFF Four Seconds
		Step 3: Lamp OFF
	Detect Failure	Step 1: Lamp ON Two Seconds
		Step 2: Lamp OFF Four Seconds
		Step 3: Display Blink Code

Failure Mode Table – After Ignition Has Been In ON Position (i.e. During Use of Vehicle)

DISPLAY MODE	CONDITION	LAMP CONTROL
Blink Code	No Failure	Step 1: Lamp OFF
	Detect Failure	Step 1: Lamp OFF Four Seconds
		Step 2: Display Blink Code

Error Codes – ECU

BLINK CODE	CODE DESCRIPTION	CORRECTIVE ACTION
21	Low Battery Voltage	Check battery voltage. Charge/replace battery as necessary.
22	MAP Sensor: Open or Shorted Connection	Check connector at ECU & Throttle module. If connection is made and no corrosion is present, replace ECU and Throttle Module.
23	Temperature Sensor: Open or Shorted Connection	Check connector at ECU & Throttle module. If connection is made and no corrosion is present, replace ECU and Throttle Module.
31	Fuel Pump: Open Connection	Check fuel pump and fuel system. Check electrical connections at ECU, Throttle module and fuel pump.
41	Fuel Injector: Open Connection	Check connector at ECU & Throttle module. If connection is made and no corrosion is present, replace ECU and Throttle Module.
51	Ignition Pulse: Open Connection	Check spark plug, coil, ECU. Replace failed components.

NOTE: *If codes 22, 23, and 41 blink in-sequence, the gray plug is disconnected from the ECU.*

If no codes blink, the black plug is disconnected from the ECU.

GASOLINE POWERTRAIN

TROUBLESHOOTING GUIDE		
SYMPTOM	**POSSIBLE CAUSES**	**CORRECTIVE ACTION**
Engine does not start easily.	Spark plug is partially fouled or in poor condition	Clean or replace
	Spark plug is damaged or loose	Replace or tighten
	Incorrect spark plug gap	Adjust gap
	Spark plug wire is damaged or loose	Replace or reconnect
	Loose wire connection at ignition coil	Test Procedures 15 – *Ignition Spark* and 16 – *Ignition Coil*
	Intermittent ignition coil failure	Test Procedures 15 – *Ignition Spark* and 16 – *Ignition Coil*
	Low fuel level in fuel tank	Refill
	Fuel line pinched or clogged	Clean or replace
	Poor fuel quality or contaminated fuel	Replace
	Water or dirt in the fuel system and/or throttle body/fuel injector; dirty or clogged fuel filter	Section 23 — Fuel System: Gasoline Vehicles
	Throttle body dirty or improperly adjusted	Clean or adjust. Section 23 — Fuel System: Gasoline Vehicles
	Low cylinder compression	Section 22 — Engine (Subaru EX40)
	Cylinder head bolts not tighten properly	Check and retighten. Section 22 — Engine (Subaru EX40)
	Intake or exhaust valve not sealing	Repair. Section 22 — Engine (Subaru EX40)
	Incorrect valve clearance	Adjust. Section 22 — Engine (Subaru EX40)
	Vacuum leak	Retighten hardware or replace gasket(s)
	Starter/generator belt is slipping	Belt Tension Adjustment for EFI Engines on page 20-13
Engine starts but does not run smoothly.	Spark plug is fouled or in poor condition	Section 22 — Engine (Subaru EX40)
	Spark plug wire is damaged or loose	Section 22 — Engine (Subaru EX40)
	Intermittent ignition coil failure	Test Procedures 15 – *Ignition Spark* and 16 – *Ignition Coil*
	Water or dirt in the fuel system and/or throttle body/fuel injector; dirty or clogged fuel filter	Section 23 — Fuel System: Gasoline Vehicles
	Fuel pump malfunction; fuel pressure to throttle body too low	Section 23 — Fuel System: Gasoline Vehicles

TABLE CONTINUED ON NEXT PAGE

TROUBLESHOOTING GUIDE		
SYMPTOM	**POSSIBLE CAUSES**	**CORRECTIVE ACTION**
Engine turns but fails to start.	Fuel tank is empty	Section 23 — Fuel System: Gasoline Vehicles
	Fuel line or filter clogged	Section 23 — Fuel System: Gasoline Vehicles
	Fouled spark plug	Section 22 — Engine (Subaru EX40)
	Spark plug wire damaged or loose	Section 22 — Engine (Subaru EX40)
	Loose wire connection at ignition coil	Test Procedures 15 – *Ignition Spark* and 16 – *Ignition Coil*
	Ignition coil failed	Test Procedures 15 – *Ignition Spark* and 16 – *Ignition Coil*
	Kill circuit grounded	Test Procedures 14 – *Kill Limit Switch – Pedal-Start Vehicles Only* and 6 – *Key Switch (Engine Kill Circuit)*
	Fuel pump malfunction or failure	Section 23 — Fuel System: Gasoline Vehicles
Engine overheats.	Fan screen is partially blocked or plugged	Section 22 — Engine (Subaru EX40)
	Governor is improperly adjusted	Section 23 — Fuel System: Gasoline Vehicles
	Excessive back pressure in exhaust	Check and clean or replace
	Fuel/air mixture is too lean; check EFI	Section 23 — Fuel System: Gasoline Vehicles
	Overloading	Reduce to rated load
	Poor quality engine oil	Replace
Engine pre-ignites.	Excessive carbon deposits on piston head or in combustion chamber	Section 22 — Engine (Subaru EX40)
	Spark plug heat range is incorrect	Section 22 — Engine (Subaru EX40)
	Unsuitable or contaminated fuel	Section 23 — Fuel System: Gasoline Vehicles
Loss of engine power.	Exhaust valve is restricted with carbon deposit	Section 22 — Engine (Subaru EX40)
	Muffler or exhaust pipe restricted with carbon or other substance	Section 24 — Exhaust System: Gasoline Vehicles
	Ignition coil failed	Test Procedures 15 – *Ignition Spark* and 16 – *Ignition Coil*
	Air filter is dirty or clogged	Section 23 — Fuel System: Gasoline Vehicles
	Governor is improperly adjusted	Section 23 — Fuel System: Gasoline Vehicles
	Throttle linkage out of adjustment	Section 23 — Fuel System: Gasoline Vehicles
	Low cylinder compression	Section 22 — Engine (Subaru EX40)
	Spark plug failed	Section 22 — Engine (Subaru EX40)
	Restricted fuel flow	Section 23 — Fuel System: Gasoline Vehicles
	Torque converter is not backshifting properly	Section 25 — Clutches: Gasoline Vehicles

TABLE CONTINUED ON NEXT PAGE

TROUBLESHOOTING GUIDE		
SYMPTOM	**POSSIBLE CAUSES**	**CORRECTIVE ACTION**
Spark plug fouls repeatedly.	Incorrect plug	Section 22 — Engine (Subaru EX40)
	Spark plug wire is damaged	Section 22 — Engine (Subaru EX40)
	Unsuitable fuel, or incorrect (rich) fuel mixture	Section 23 — Fuel System: Gasoline Vehicles
	Ignition coil failed	Test Procedures 15 – *Ignition Spark* and 16 – *Ignition Coil*
	Dirt entering combustion chamber	Check intake system for leaks. Section 23 — Fuel System: Gasoline Vehicles
	Rings are heavily worn, low cylinder pressure	Section 22 — Engine (Subaru EX40)
Starter fails to operate.	Neutral lockout switch is in the MAINTENANCE position	Place switch in the OPERATE position.
	Fuse is blown	Test Procedure 2 – *Fuses*
	Battery is dead	Test Procedure 1 – *Battery*
	Starter control circuit is not operating	Test Procedure 5 – *Key Switch (Start Circuit)*
	Starter/generator failed	Test Procedure 12 – *Starter/Generator (Starter Function)*
	Starter solenoid failed	Test Procedure 8 – *Solenoid*
	Accelerator pedal limit switch failed	Test Procedure 7 – *Accelerator Pedal Limit Switch – Pedal-Start Vehicles Only*
	Key switch failed	Test Procedure 5 – *Key Switch (Start Circuit)*
	Neutral lockout limit switch failed	Test Procedure 10 – *Neutral Lockout Limit Switch – Pedal-Start Vehicles Only*
	Loose or broken wire in starter/generator circuit	Section 20 — Electrical Components: Pedal-Start Gas Vehicle Starter/Generator on page 20-1
	Cylinder and/or crankcase flooded with fuel	Section 23 — Fuel System: Gasoline Vehicles
Starter/generator does not charge battery.	Loose or broken wire in the starter/ generator circuit	Test Procedure 11 – *Starter/Generator (Generator Function)*
	Generator field coil is shorted	Test Procedure 11 – *Starter/Generator (Generator Function)*
	Brushes are worn or commutator is dirty	Section 20 — Electrical Components: Pedal-Start Gas Vehicle Starter/Generator on page 20-1
	Starter/generator belt is loose or slipping	Belt Tension Adjustment for EFI Engines on page 20-13
	Voltage regulator failed	Test Procedure 13 – *Voltage Regulator*
	Battery failed	Test Procedure 1 – *Battery*

TABLE CONTINUED ON NEXT PAGE

TROUBLESHOOTING GUIDE		
SYMPTOM	**POSSIBLE CAUSES**	**CORRECTIVE ACTION**
Transmission does not engage or disengage smoothly.	Transmission shifter linkage is binding or is out of adjustment	Section 26 — Transaxle (ED65): Gasoline Vehicles
	Insufficient (low) level of lubricant or wrong type of lubricant in transmission	Section 26 — Transaxle (ED65): Gasoline Vehicles
	Internal gears are damaged or worn	Section 26 — Transaxle (ED65): Gasoline Vehicles
	Dog clutch jammed or broken	Section 26 — Transaxle (ED65): Gasoline Vehicles
Excessive vehicle vibration.	Engine mounting nuts or bolts are loose	Section 22 — Engine (Subaru EX40)
	Snubber on frame is worn or damaged	Section 22 — Engine (Subaru EX40)
	Loose muffler mounting hardware	Section 24 — Exhaust System: Gasoline Vehicles
	Damaged drive belt or starter belt	Section 25 — Clutches: Gasoline Vehicles
	Damaged drive clutch	Section 25 — Clutches: Gasoline Vehicles
	Damaged starter/generator pulley	Section 20 — Electrical Components: Pedal-Start Gas Vehicle Starter/Generator on page 20-1
	RPM setting is incorrect	Section 23 — Fuel System: Gasoline Vehicles Engine RPM Adjustment on page 23-13
Clutches do not shift smoothly.	Drive belt is worn, cracked, glazed, or frayed	Section 25 — Clutches: Gasoline Vehicles
	Drive clutch malfunction	Section 25 — Clutches: Gasoline Vehicles
	Governor is sticking	Section 26 — Transaxle (ED65): Gasoline Vehicles
Engine won't stop running.	Kill circuit wire is disconnected from the ignition coil	Test Procedure 14 – *Kill Limit Switch – Pedal-Start Vehicles Only*
	Accelerator pedal linkage out of adjustment causing engine kill limit switch not to activate	Section 23 — Fuel System: Gasoline Vehicles
	Fuel mixture is too lean; check EFI	Section 23 — Fuel System: Gasoline Vehicles
	Throttle stop screw out of adjustment at governor arm	Section 23 — Fuel System: Gasoline Vehicles

WIRING DIAGRAMS

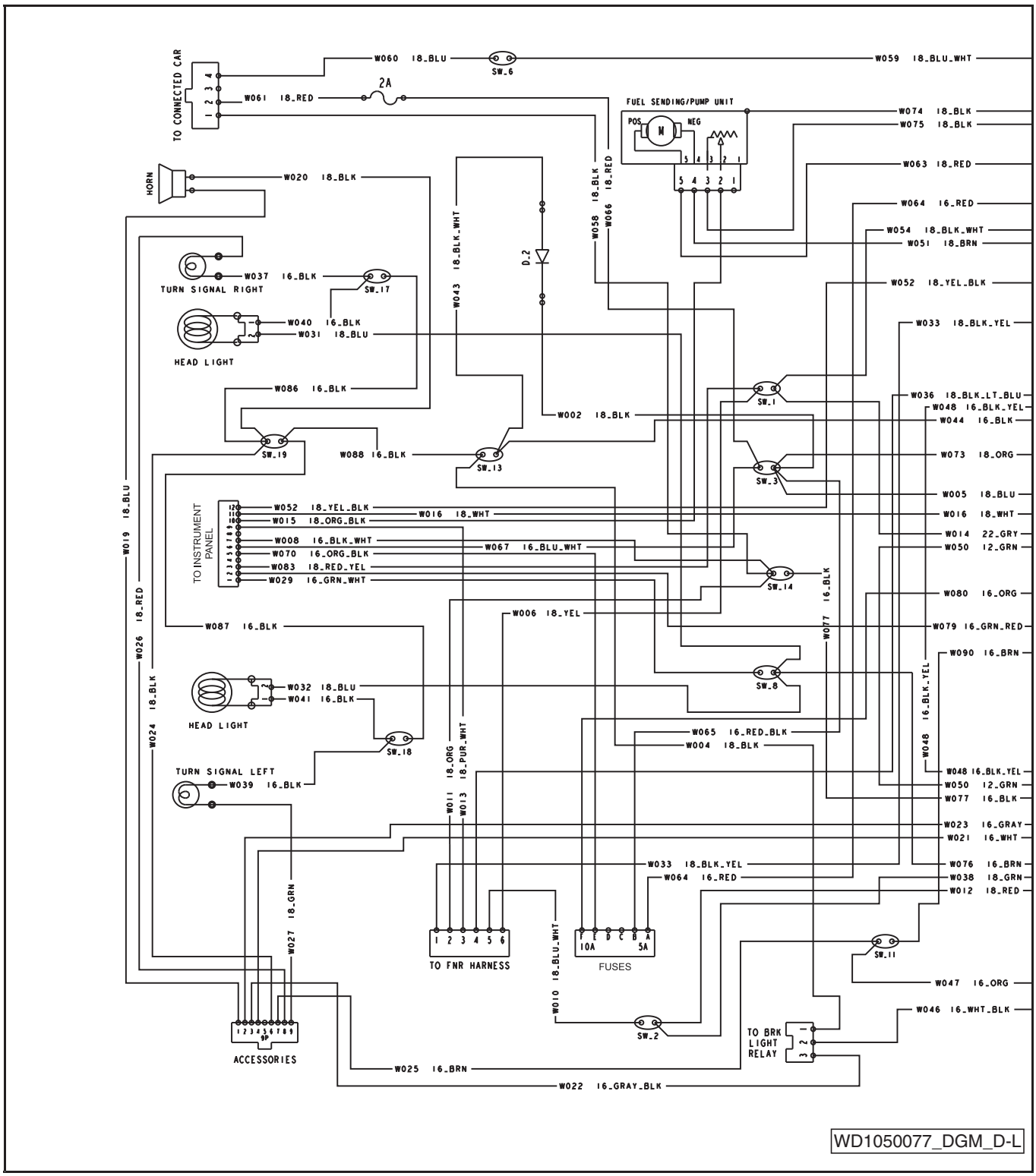


Figure 18-1 Wiring Diagram for Pedal-Start Gasoline Vehicle

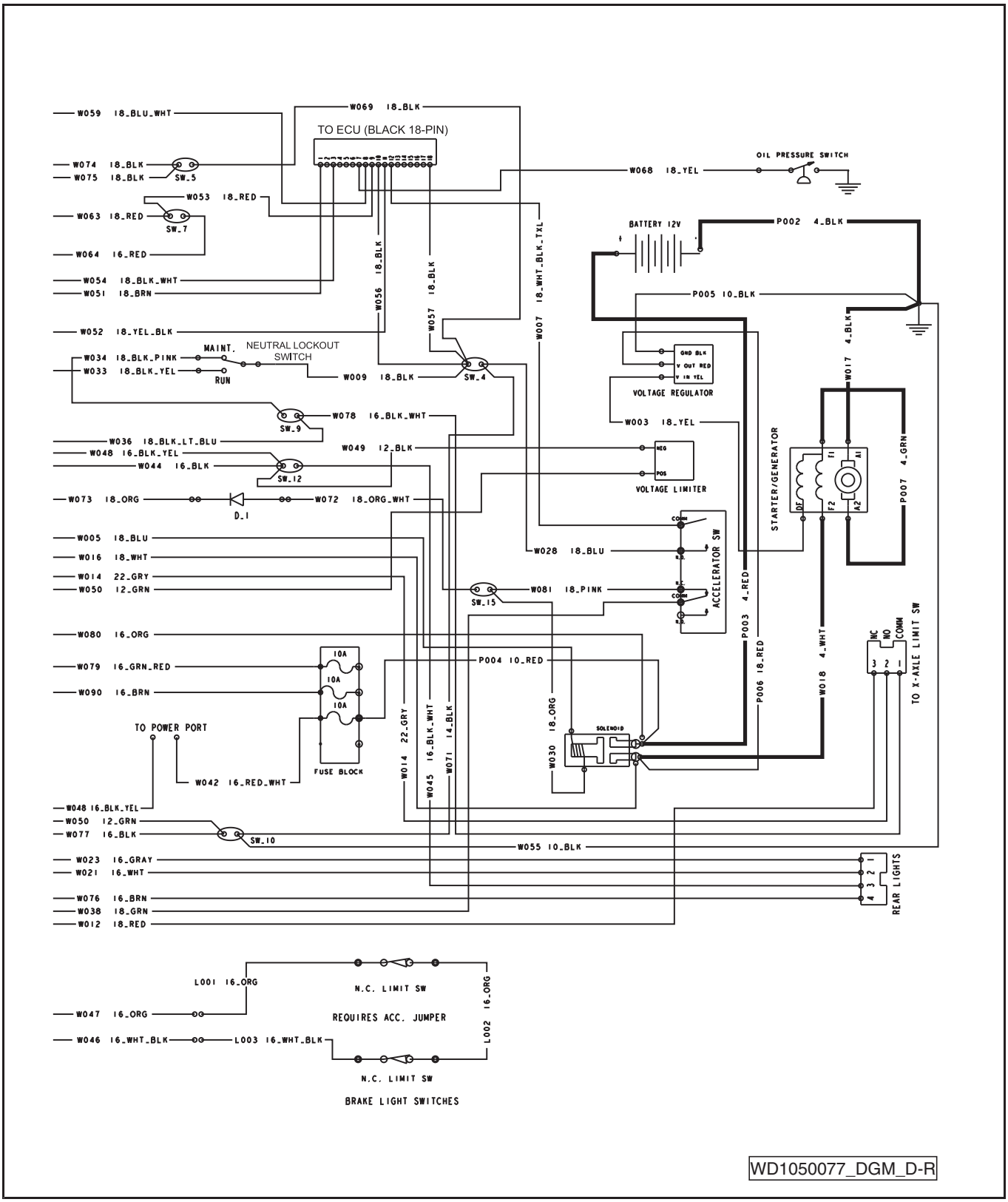


Figure 18-2 Wiring Diagram for Pedal-Start Gasoline Vehicle – Continued

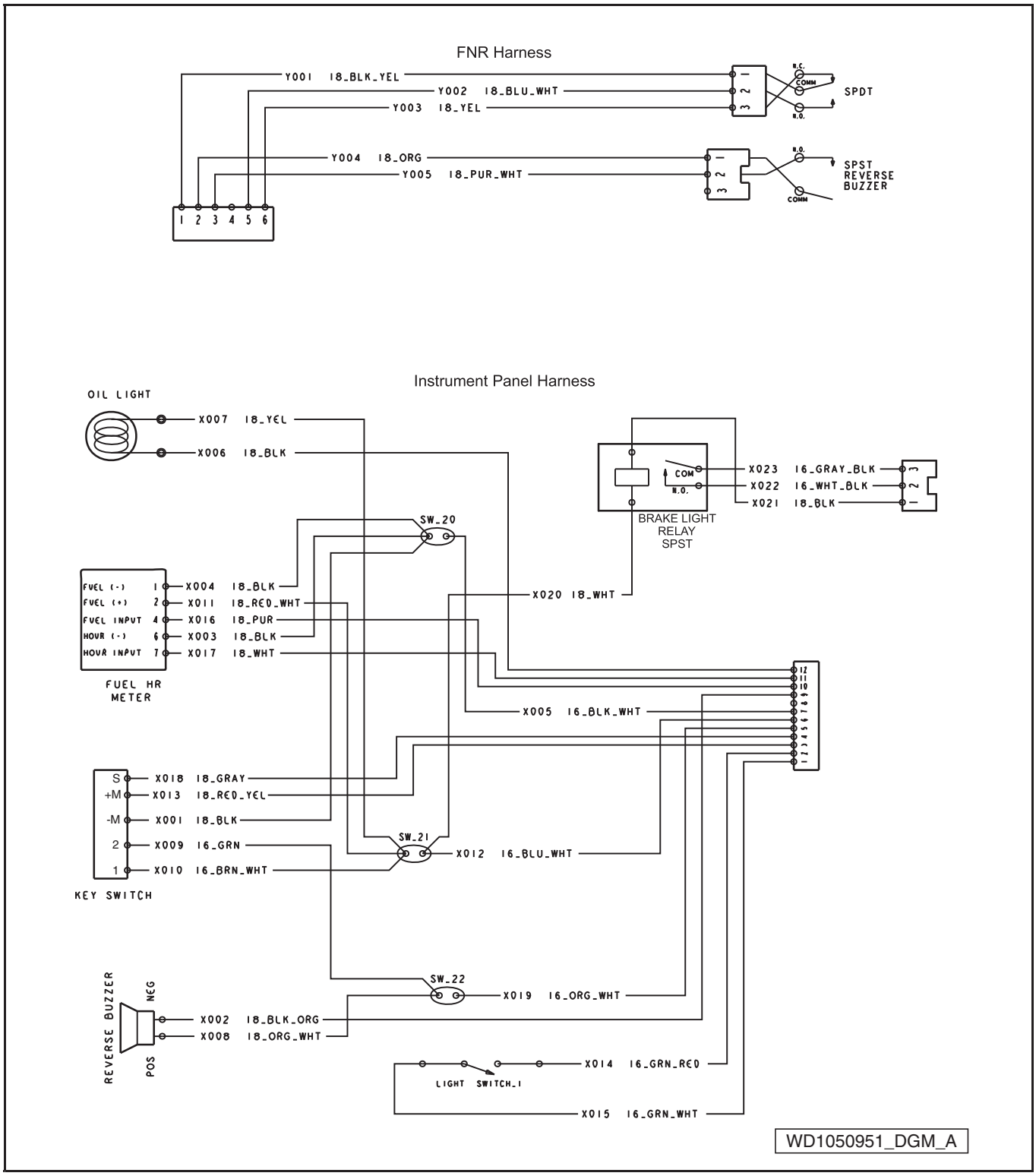


Figure 18-3 Wiring Diagram – Instrument Panel and FNR Shifter

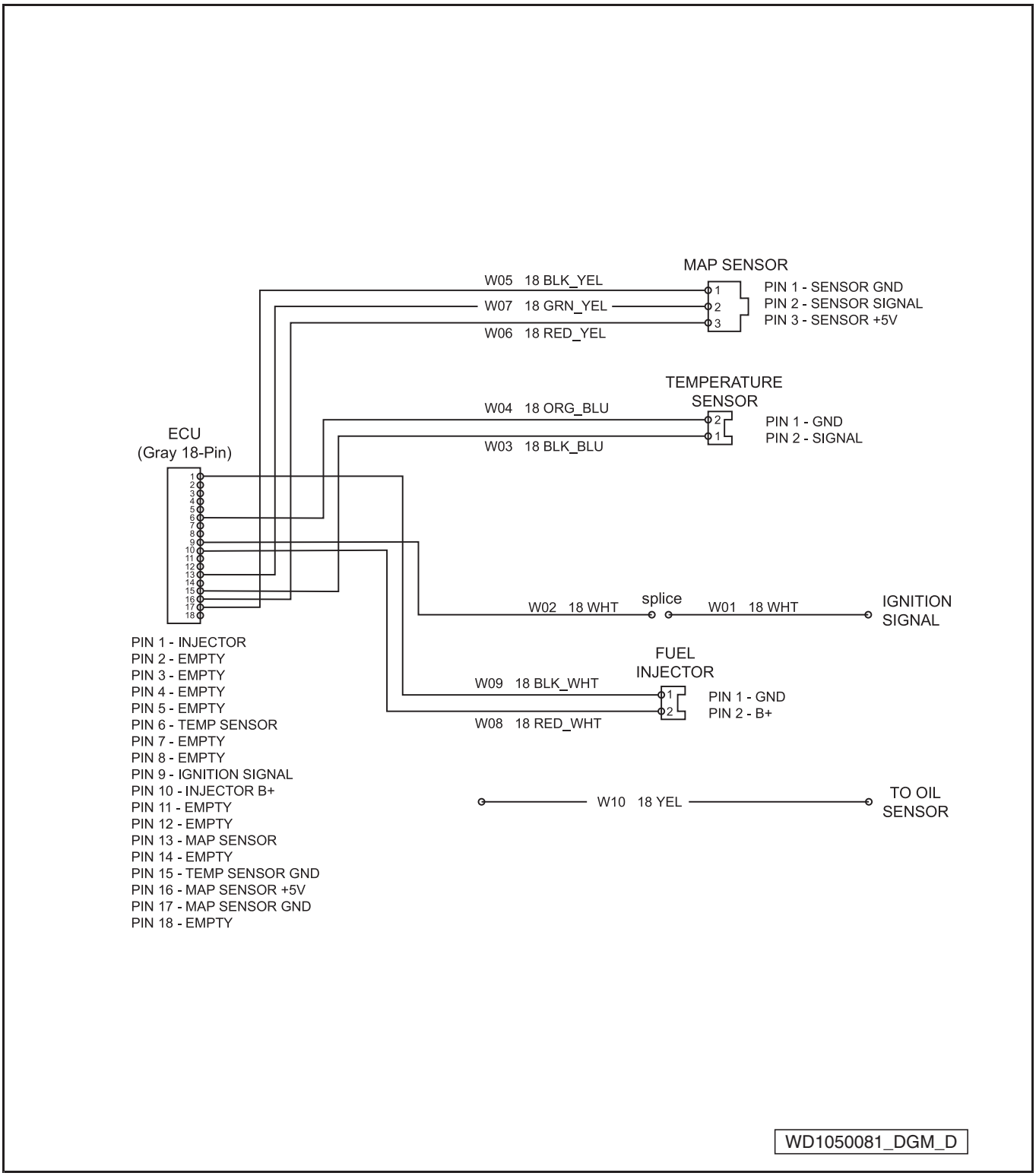


Figure 18-4 Wiring Diagram – EFI and Engine

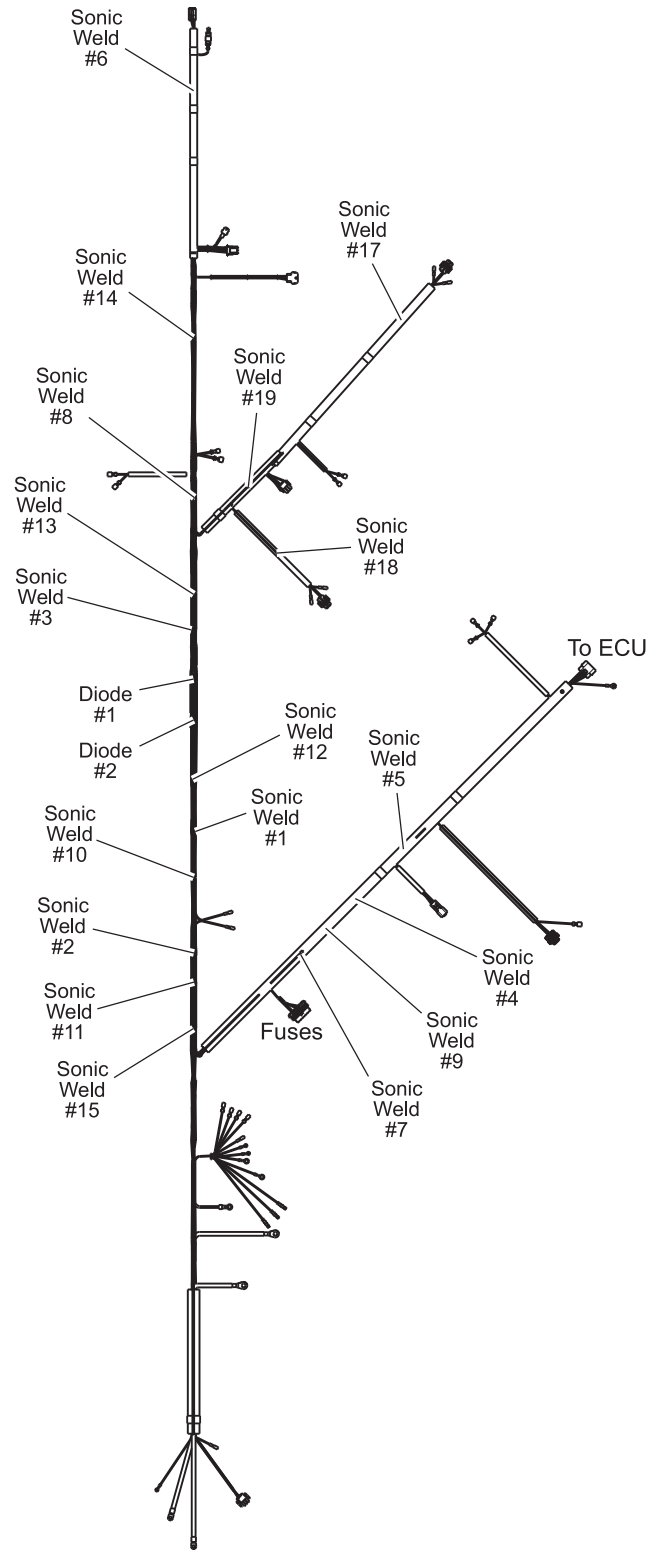


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Figure 18-5 Sonic Weld and Diode Locations (Approximate) – CA500/550/Cafe Express

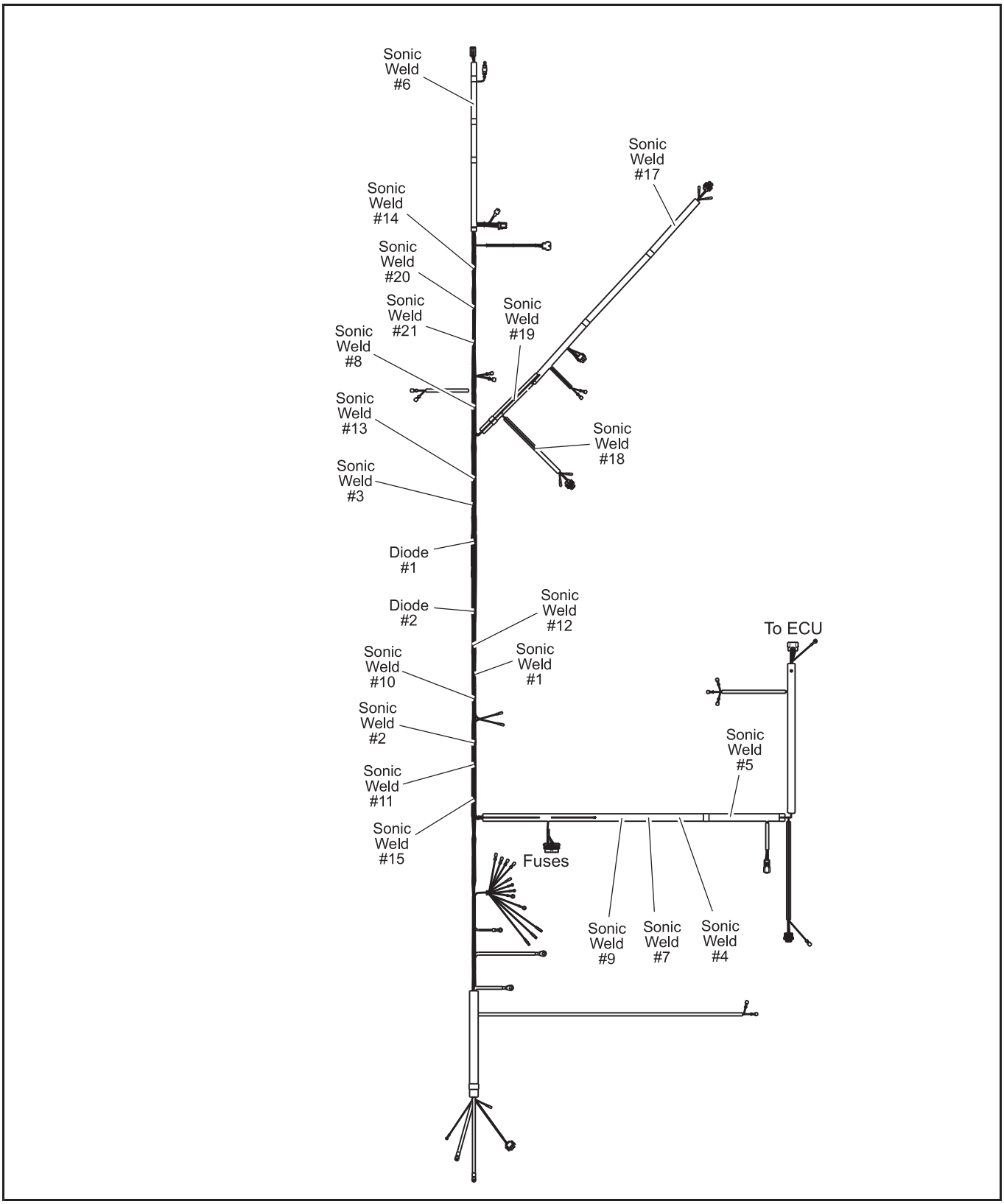

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Figure 18-6 Sonic Weld and Diode Locations (Approximate) – CA700

ELECTRICAL SYSTEM

The electrical system on the gasoline vehicle is 12 volts DC with negative (–) ground to frame, and consists of the following circuits that are easily identified:

- Starter Circuit
- Generator Circuit
- Electronic Fuel Injection Circuit
- Engine Ignition Circuit
- Engine Kill Circuit
- Reverse Buzzer Circuit
- Low Oil Warning Light Circuit
- Neutral Lockout Circuit
- Fuel Pump Circuit
- Fuel Gauge and Sending Unit Circuit
- Hour Meter Circuit
- Lighting Circuit

Recognizing and understanding the function of each of these circuits will help to quickly isolate the source of an electrical problem. Use the appropriate test procedure to correct the electrical problem. **See Test Procedures on page 18-15.**

For a complete wiring diagram, see Wiring Diagram for Pedal-Start Gasoline Vehicle on page 18-8 or Wiring Diagram for Key-Start Gasoline Vehicle on page 19-2.

TEST PROCEDURES

Using the following procedures, the entire electrical system can be tested without major disassembly of the vehicle.

⚠ WARNING

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

For some tests, the electrical component box cover must be removed to gain access to the various components that are mounted inside the component box. **See following WARNING.**

⚠ WARNING

- **Shorting of battery terminals can cause personal injury or death.**

After test procedures are completed, be sure to replace the cover. **See following CAUTION.**

CAUTION

- **Exposure to water and the elements may damage electrical components. Do not operate vehicle without the cover properly installed.**

TESTING BASICS

- Battery voltage will be referenced throughout the test procedures. Battery voltage is accessed in **Test Procedure 1 – Battery on page 18-17**.
- The MAINTENANCE/OPERATE switch, in the MAINTENANCE position, grounds and kills the ignition if the FNR shifter is placed in FORWARD or REVERSE.
- The key switch powers the ECU, fuel pump, solenoid, lights, and the connected car device.
- The 2-amp fuse is powered by the key switch via the 10-amp ATM fuse and carries battery voltage to the connected car device.
- The term “back-probe” refers to probing the side of a connector that the wire enters. This is usually done when the connector must remain connected to a device. An alternative method is to use an insulation-piercing probe. **See following CAUTION.**

CAUTION

- **Be careful not to damage the wire or terminal when back-probing.**

- When testing voltage, the battery must remain connected.
- When testing voltage, unless specifically directed to do otherwise in a procedure, connect the black (–) probe of the multimeter to chassis ground.
- When testing resistance or continuity, turn off power to the circuit being measured and discharge any capacitor(s). The presence of voltage can cause inaccurate readings.

Index of Test Procedures

2 – Fuses
3 – Ground Cables
4 – EFI System (ECU and Sensors)
5 – Key Switch (Start Circuit)
6 – Key Switch (Engine Kill Circuit)
7 – Accelerator Pedal Limit Switch – Pedal-Start Vehicles Only
8 – Solenoid
9 – Maintenance/Operate Switch – Pedal-Start Vehicles
10 – Neutral Lockout Limit Switch – Pedal-Start Vehicles Only
11 – Starter/Generator (Generator Function)
12 – Starter/Generator (Starter Function)
13 – Voltage Regulator
14 – Kill Limit Switch – Pedal-Start Vehicles Only
15 – Ignition Spark
16 – Ignition Coil
17 – Reverse Buzzer and Reverse Buzzer Limit Switch
18 – Low Oil Warning Light (LED)
19 – Oil Level Sensor
20 – Battery Test (Under Load)
21 – Fuel Pump
22 – Fuel Level Sending Unit
23 – Fuel Gauge
24 – Hour Meter
25 – Light Switch
26 – Voltage at Headlight Socket
27 – Voltage Limiter
28 – 4-Pin Connector (for Connected Car Device)

TEST PROCEDURE 1 – Battery

See General Warnings on page 1-1.

⚠ DANGER

- **Due to the danger of an exploding battery, wear a full face shield and rubber gloves when working near a battery.**
- **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.**

NOTE: *The battery must be properly maintained and fully charged in order to perform the following test procedures. Battery maintenance procedures can be found in section* ***Electrical Components: Pedal-Start Gas Vehicle on page 20-1*** *of this manual.* ***See Battery on page 20-33.***

1. Place the Forward/Reverse handle in the NEUTRAL position and the neutral lockout switch in the MAINTENANCE position. Chock the wheels.
2. Check for loose or corroded battery terminal connections. Remove the negative (–) cable first and clean, tighten, and replace connections as necessary.

Voltage Test

1. Take a voltage reading with a multimeter set to 20 VDC by placing the red (+) probe on the positive (+) battery post and the black (–) probe on the negative (–) battery post. If it shows less than 12.4 volts recharge the battery. If battery voltage is greater than 12.4 volts, the problem is not with the battery. If the battery does not reach 12.4 volts after charging, replace the battery. **See following NOTE.**

NOTE: *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 following table. Make sure you have the correct ambient temperature.

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

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.

TEST PROCEDURE 2 – Fuses

See General Warnings on page 1-1.

⚠ WARNING

- **Failure to use properly rated fuse can result in a fire hazard.**

NOTE: *These vehicles predominately use a combination of ATC-style and ATM-style blade fuses. A single ABC-style glass fuse is used for the Guardian/Visage 4-pin connector that is labeled "V3 circuit" on the harness.*

This is a voltage test. It can be performed relatively easily on ATC-style and ATM-style fuses. A voltage test can be performed on the ABC-style glass fuse if insulation-piercing probes are used. Otherwise, the ABC-style will have to be removed to visually inspect or check using a continuity test.

ATC-style blade fuses are located inside the electrical component box near the battery.

ATM-style blade fuses are located on the main wire harness in front of the engine.

The ABC-style glass fuse is located on the main wire harness underneath the front cowl.

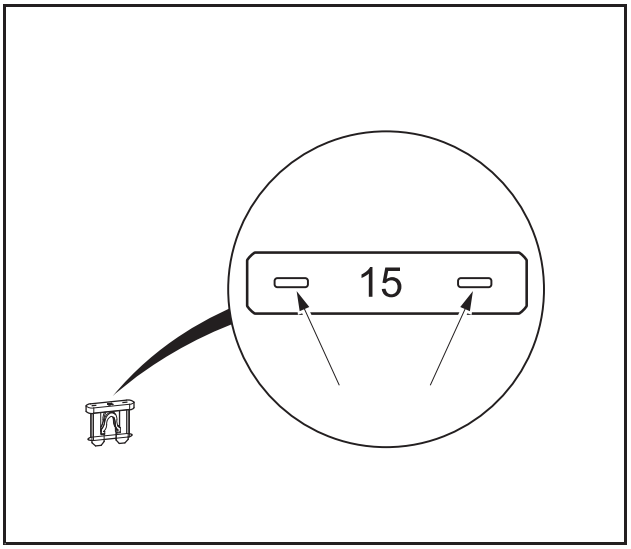

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Figure 18-7 Testing the ATC and ATM-style Blade Fuse

1. If necessary, see Testing Basics on page 18-15.
2. Access the fuse but do not remove it.
3. **10-amp ATC and ATM Fuses Only:** With the battery and solenoid connected:
   - 3.1. Probe the two, small metal contacts on the top of the fuse **(Figure 18-7, Page 18-19)**.
   - 3.2. Each contact should show battery voltage.
   - 3.3. If only one side shows battery voltage, replace fuse.
   - 3.4. If neither side of a fuse shows battery voltage, inspect the following locations:
     – Wire connections at the solenoid.

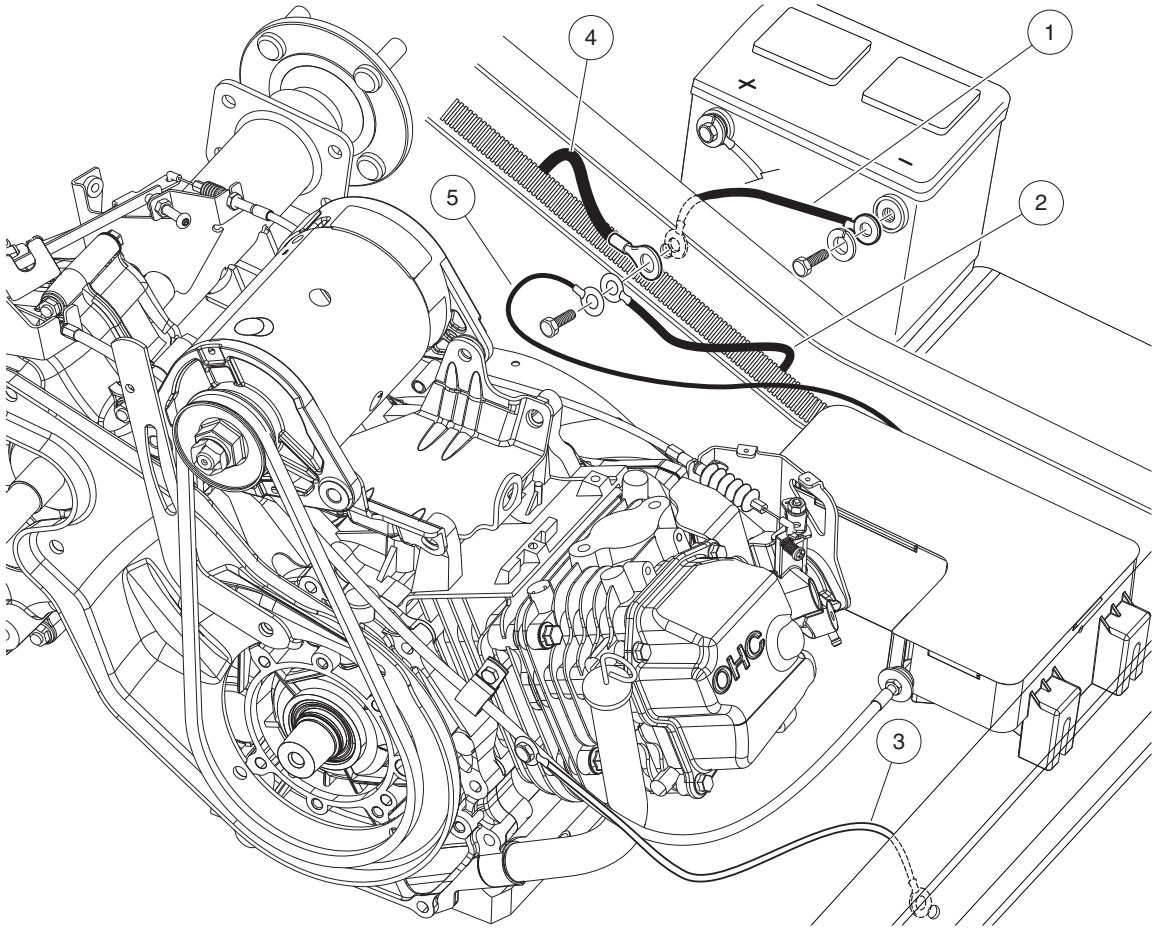
4. **5-amp ATM Fuse Only:** With the key switch in the ON position:
   4.1. Probe the two, small metal contacts on the top of the fuse **(Figure 18-7, Page 18-19)**.
   4.2. Each contact should show battery voltage.
   4.3. If only one side shows battery voltage, replace fuse.
   4.4. If neither side of a fuse shows battery voltage, inspect the following locations:
   – 12-pin dash wire harness connector, key switch and sonic weld 3.
5. **2-amp ABC Glass Fuse Only:** With the key switch in the ON position:
   5.1. Probe the wire on each side of the fuse with insulation-piercing probes.
   5.2. Each probe should show battery voltage.
   5.3. If only one side shows battery voltage, replace fuse.
   5.4. If neither side of a fuse shows battery voltage, inspect the following locations:
   – 5-amp ATM fuse, 12-pin dash wire harness connector, key switch and sonic weld 3.

TEST PROCEDURE 3 – Ground Cables

See General Warnings on page 1-1.

NOTE: *This is a continuity test for the main ground wire(s) of the vehicle. An additional ground wire is located on top of the fuel tank.*

1. If necessary, see Testing Basics on page 18-15.
2. Disconnect battery and spark plug wire(s). **See Disconnecting the Battery-Gasoline Vehicles on page 1-5.**
3. Check the following wires and cables for clean, tight connections and continuity **(Figure 18-8, Page 18-21)**:
   – Check the starter/generator ground cable (black wire) from A1 terminal to chassis.
   – Check the battery ground cable from the disconnected terminal to chassis.
   – Check the engine ground cable from engine block to chassis.
4. The reading should be continuity. If the reading is incorrect, clean and tighten cable connections. If the connections are good and the reading is incorrect, repair or replace the wire or cable.



1. Battery Ground 2. Main Wire Harness Ground 3. Engine Ground Cable 4. Starter/Generator Ground (from A1 Terminal) 5. Voltage Regulator Ground Wire (from electrical component box)

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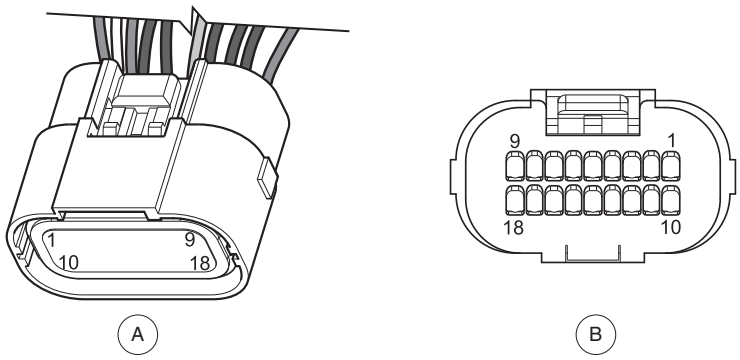
Figure 18-8 Ground Wires and Cables

TEST PROCEDURE 4 – EFI System (ECU and Sensors)

See General Warnings on page 1-1.

⚠ WARNING

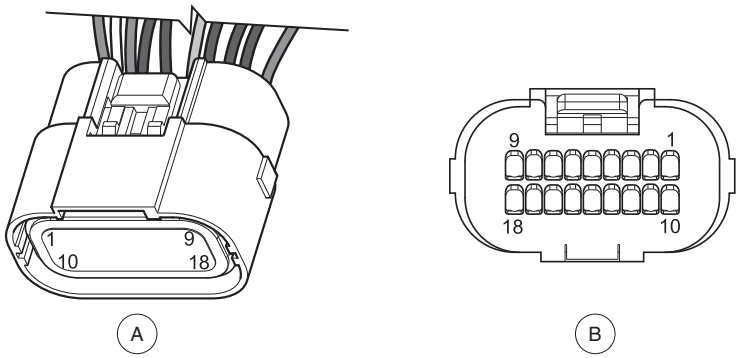
- **This procedure involves testing voltage, resistance and continuity. If necessary, see Testing Basics on page 18-15.**



18-PIN CONNECTOR (GRAY AND BLACK): A. ECU SIDE OF CONNECTOR B. WIRE ENTRY SIDE OF CONNECTOR

PIN I.D.	CONNECTOR COLOR	FUNCTION	TEST TYPE & PROBE BETWEEN LOCATIONS	TEST RESULT	CONDITION
1	Gray	Fuel Injector Control	**Resistance:** ECU Gray Pin 1 (Black/White) and ECU Gray Pin 10 (Red/White)	Approx. 12 ohms	Key OFF or ON
6	Gray	Engine Temperature Sensor Input	**Resistance:** ECU Gray Pin 6 (Orange/Blue) and ECU Gray Pin 15 (Black/Blue)	Approx. 11.5 kOhms @ 70 °F (21 °C) Resistance decreases as temperature rises.	Key OFF
9	Gray	Ignition Coil Input	**Resistance:** ECU Gray Pin 9 (White) and Ground	Approx. 10.1 kOhms	Key OFF
10	Gray	Fuel Injector Positive (+) Voltage from ECU	**Voltage:** ECU Gray Pin 10 (Red/White) and Ground	Battery Voltage	Plug connected to ECU and Key ON
13	Gray	MAP Sensor Input	**Voltage:** ECU Gray Pin 13 (Green/Yellow) and Ground	Approx. 3.9 volts @ sea level & engine OFF / 3.0 volts engine running. Voltage decreases as pressure decreases.	Key ON and engine running
15	Gray	Engine Temperature Sensor Ground	**Continuity:** ECU Gray Pin 15 (Black/Blue) and Ground	Meter should beep	Key OFF
16	Gray	MAP Sensor Reference Voltage (+5)	**Voltage:** ECU Gray Pin 16 (Red/Yellow) and ECU Gray Pin 17 (Black/Yellow)	Approx. 5 volts	Key ON
17	Gray	MAP Sensor Ground	**Continuity:** ECU Gray Pin 17 (Black/Yellow) and Ground	Meter should beep	Key OFF
			Voltage: ECU Gray Pin 17 (Black/Yellow) and Battery (+) Terminal	–Battery Voltage	Key OFF
1	Black	Fuel Pump Input	**Voltage:** ECU Black Pin 1 (Brown) and ECU Black Pin 10 (Black)	Battery Voltage (after pump stops running)	Key ON

TABLE CONTINUED ON NEXT PAGE



18-PIN CONNECTOR (GRAY AND BLACK): A. ECU SIDE OF CONNECTOR B. WIRE ENTRY SIDE OF CONNECTOR

PIN I.D.	CONNECTOR COLOR	FUNCTION	TEST TYPE & PROBE BETWEEN LOCATIONS	TEST RESULT	CONDITION
3	Black	Ignition OFF Input	**Continuity:** ECU Black Pin 3 (Black/White) and Ground	Meter should beep	Key OFF
				Meter should NOT beep	Key ON
7	Black	Low Oil Sensor Input	**Resistance:** ECU Black Pin 7 (Yellow) and Ground	Approx. 2.3 kOhms	Key OFF
8	Black	Connected Car Link	**Voltage:** ECU Black Pin 8 (Blue/White) and Ground	11.8 volts	Key ON
9	Black	B+ Input	**Voltage:** ECU Black Pin 9 (Red) and ECU Black Pin 10 (Black)	Battery Voltage	Key ON
10	Black	Ground for ECU Power	**Continuity:** ECU Black Pin 10 (Black) and Ground	Meter should beep	Key OFF
			Voltage: ECU Black Pin 10 (Black) and Battery (+) Terminal	–Battery Voltage	Key OFF
11	Black	Diagnosis (low oil) Lamp Control	**Voltage:** ECU Black Pin 11 (Yellow/Black) and Ground	Less than 1 Volt initially. 7 to 8 volts after lamp is OFF.	Key ON
12	Black	Foot Input	**Continuity:** ECU Black Pin 12 (White/Black) and Black Pin 18 (Black)		Key OFF with:
				Meter should beep	Accel. Pedal UP
				Infinity	Accel. Pedal DOWN
18	Black	Ground for ECU Housing	**Continuity:** ECU Black Pin 18 (Black) and Ground	Meter should beep	Key OFF
			Voltage: ECU Black Pin 18 (Black) and Battery (+) Terminal	–Battery Voltage	Key OFF

TEST PROCEDURE 5 – Key Switch (Start Circuit)

See General Warnings on page 1-1.

NOTE: *This is a voltage test.*

The key switch provides power and KEY INPUT to the ECU.

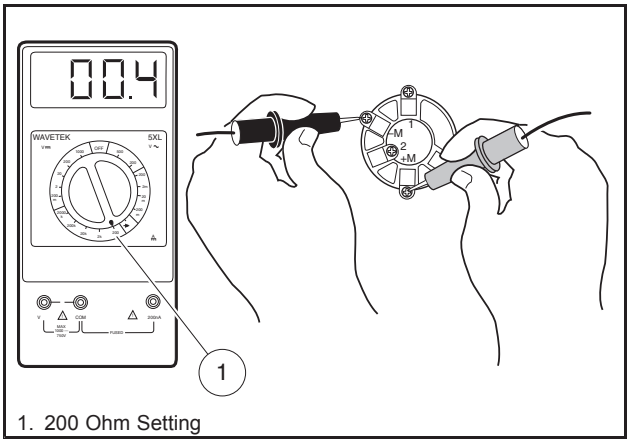
1. If necessary, see Testing Basics on page 18-15.
2. Remove instrument panel to access the back of the key switch but do not disconnect wires. **See Instrument Panel Removal on page 4-10.**
3. With the key switch in the OFF position:
   – The green wire should show battery voltage coming to the switch.
   – The brown/white wire should show zero (0) volts. If it shows battery voltage, the switch has failed CLOSED and must be replaced.
4. With the key switch in the ON position:
   – The brown/white wire should show battery voltage passing through the key switch to sonic weld 3, the 5-amp fuse, the solenoid, and the 4-pin connected car plug. If it does not show battery voltage, the switch has failed OPEN and must be replaced.

TEST PROCEDURE 6 – Key Switch (Engine Kill Circuit)

See General Warnings on page 1-1.

NOTE: *This is a continuity test.*

1. If necessary, see Testing Basics on page 18-15.
2. Disconnect battery and spark plug wire(s). **See Disconnecting the Battery-Gasoline Vehicles on page 1-5.**
3. Remove the instrument panel. **See Instrument Panel Removal on page 4-10.**
4. Disconnect wires from the (+M) and (–M) terminals of the key switch **(Figure 18-9, Page 18-26)**.
5. Place the red (+) probe on the (+M) terminal and the black (–) probe on the (–M) terminal. With the key switch OFF, the reading should be continuity. With the key switch ON, the reading should be no continuity. If either reading is incorrect, replace the key switch.
6. Connect wires to the key switch. Make sure wires are connected correctly and are tight. If they are not, rewire or tighten as necessary.
7. Install dash panel in reverse order of removal.



1. 200 Ohm Setting

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Figure 18-9 Key Switch Test – Engine Kill Circuit

TEST PROCEDURE 7 – Accelerator Pedal Limit Switch – Pedal-Start Vehicles Only

See General Warnings on page 1-1.

NOTE: *This is a continuity test.*

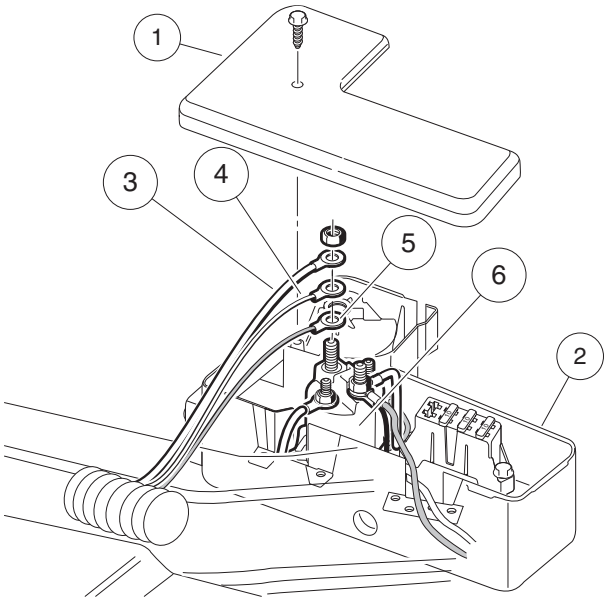
The accelerator pedal limit switch is the top switch located in the electrical component box. There is a green wire and a pink wire connected to this limit switch.

1. If necessary, see Testing Basics on page 18-15.
2. Disconnect battery and spark plug wire(s). **See Disconnecting the Battery-Gasoline Vehicles on page 1-5.**
3. Check for proper wiring and tight connections **(Figure 18-1, Page 18-8)**.
4. Set the multimeter to 200 ohms. Place the red (+) probe on the common (COM) terminal (green wire) of the limit switch and place the black (–) probe on the normally closed (NC) terminal (pink wire) of the limit switch.
5. Make sure the battery is disconnected. With the key switch in the OFF position, the Forward/Reverse handle in NEUTRAL, and the accelerator pedal in the UP position, the reading should be no continuity. With the accelerator pedal pressed, the reading should be continuity. If readings are incorrect, replace the switch.

TEST PROCEDURE 8 – Solenoid

See General Warnings on page 1-1.

NOTE: *This is a resistance and voltage test.*



1. Cover 2. Electrical Component Box 3. 6 Ga. White Wire 4. 18 Ga. White Wire 5. 18 Ga. Red Wire 6. Solenoid

3025

Figure 18-10 Solenoid Wire Removal

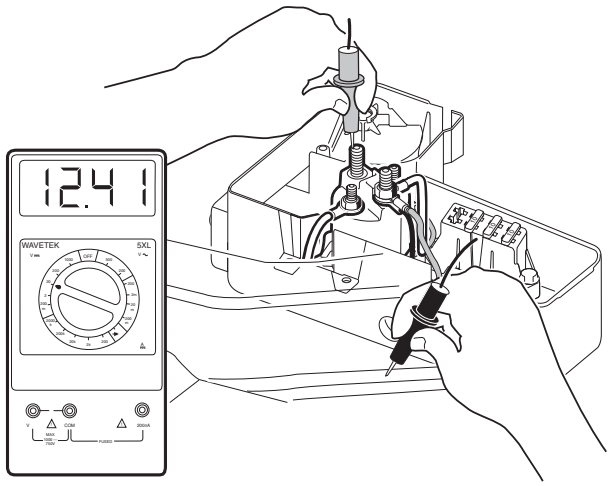


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Figure 18-11 Solenoid Voltage Test

1. If necessary, see Testing Basics on page 18-15.
2. Remove the electrical component box cover.
3. Ensure that the wires are connected correctly and are tight. If they are not, rewire or tighten as necessary.
4. **Coil Side:** Check resistance across the small posts of the solenoid. The reading should be 14 to 16 ohms. If the reading is not within limits, replace the solenoid.
5. **Contact Side:** Remove the 6-gauge white wire, the 16-gauge red wire, and 16-gauge white wire from the large post of the solenoid. Do not allow the wires to touch the frame or other components of the vehicle **(Figure 18-10, Page 18-27)**. Cover the other large post.
   5.1. Place Forward/Reverse handle in the NEUTRAL position, neutral lockout switch in the MAINTENANCE position, and key switch in the ON position.
   5.2. Check voltage between the empty large post and ground **(Figure 18-11, Page 18-27)**.
   – **With accelerator pedal in the UP position:** The meter should read no voltage.
   – **With accelerator pedal pressed:** The solenoid should click and the meter should read battery voltage.
   5.3. If the readings are incorrect, replace solenoid. **See Solenoid Removal, Section 20, Page 20-20.**

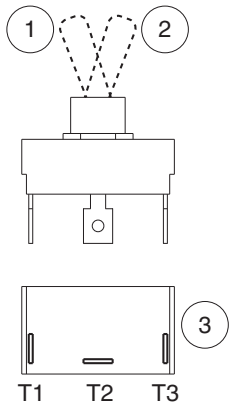
TEST PROCEDURE 9 – Maintenance/Operate Switch – Pedal-Start Vehicles

See General Warnings on page 1-1.

NOTE: *This is a continuity test.*

The Maintenance/Operate Switch is also known as the Neutral Lockout Switch.

1. If necessary, see Testing Basics on page 18-15.
2. Remove wires from switch **(Figure 18-12, Page 18-28)**.
3. With switch in position 1 (MAINTENANCE):
   3.1. Check for no continuity between terminals T1 and T2.
   3.2. Check for continuity between terminals T2 and T3.
4. With switch in position 2 (OPERATE):
   4.1. Check for no continuity between terminals T2 and T3.
   4.2. Check for continuity between terminals T1 and T2.



Toggle Position Operates:	1. Position 1 (MAINT.) closes T2 to T3
	2. Position 2 (OP.) closes T1 to T2
3. T1 – Black/Pink Stripe, T2 – Black, T3 – Black/Yellow Stripe	

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Figure 18-12 Maintenance/Operate Switch Test – for Pedal-Start Vehicles

5. If switch:
   5.1. does not work as stated in previous steps, replace switch.
   5.2. does work as stated and the MAINTENANCE/OPERATE modes still do not work:
   – Check the limit switches.
   – Check continuity of the wires involved.

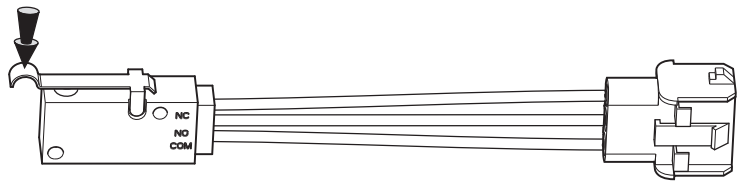
TEST PROCEDURE 10 – Neutral Lockout Limit Switch – Pedal-Start Vehicles Only

See General Warnings on page 1-1.

NOTE: *This is a continuity test.*

This switch is located on the transaxle. A black/white wire, a gray wire, and a red wire are connected to this limit switch with a 3-pin connector.

1. If necessary, see Testing Basics on page 18-15.
2. Disconnect battery and spark plug wire(s). **See Disconnecting the Battery-Gasoline Vehicles on page 1-5.**
3. At transaxle, disconnect neutral lockout limit switch three-wire lead from main wire harness.
4. Check to be sure the cam lobe on the shift lever is pressing the neutral lockout limit switch as the Forward/Reverse shifter is being shifted. The limit switch should make an audible click as it is pressed. If it does not, check for wear on the cam lobe and replace shift lever if necessary.
5. Check the following terminals for no continuity with the lever released and continuity with the lever engaged **(Figure 18-13, Page 18-29)**:



PROBE BETWEEN LOCATIONS	TEST RESULT
Between terminal 1 “COM” (black/white wire) and terminal 2 “NO” (gray wire)	**With lever released:** No continuity
	With lever pressed: Continuity
Between terminal 1 “COM” (black/white wire) and terminal 3 “NC” (red wire)	**With lever released:** Continuity
	With lever pressed: No continuity

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Figure 18-13 Neutral Lockout Limit Switch Test

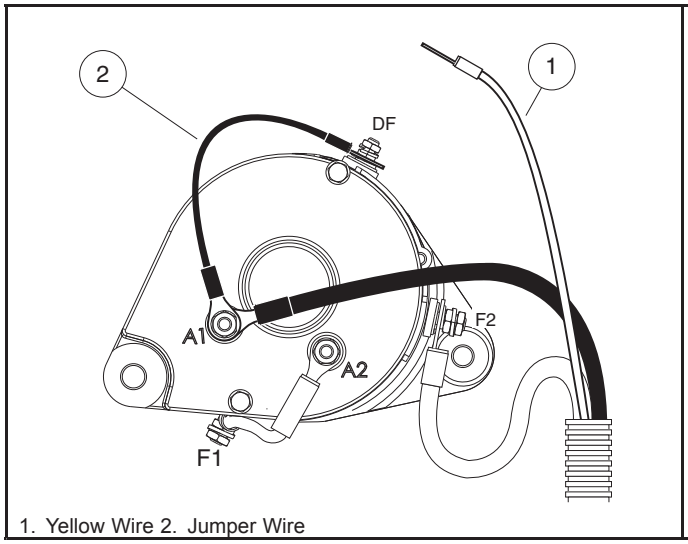
6. If switch does not work as stated in previous step, replace switch. **See Neutral Lockout Limit Switch Removal, Section 20, Page 20-19.**

TEST PROCEDURE 11 – Starter/Generator (Generator Function)

See General Warnings on page 1-1.

NOTE: *This is a voltage test.*

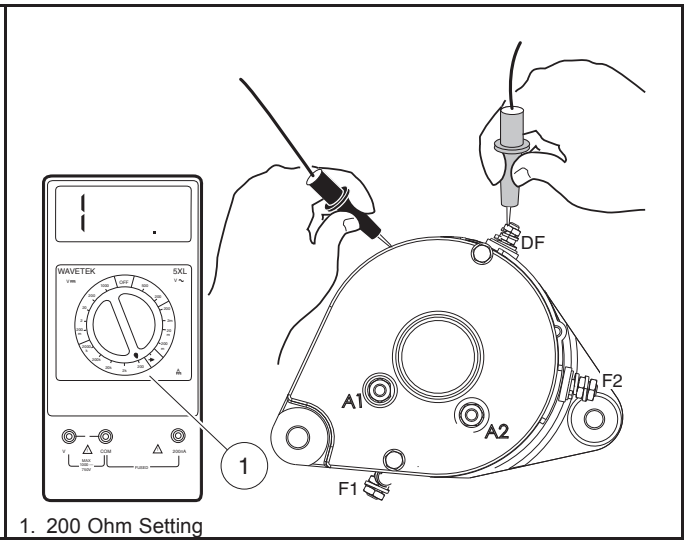
1. If necessary, see Testing Basics on page 18-15.
2. Place the Forward/Reverse handle in the NEUTRAL position and the neutral lockout switch in the MAINTENANCE position. Chock the wheels.
3. Ensure that the wires are connected correctly and are tight. If they are not, rewire or tighten as necessary.
4. Disconnect yellow wire from DF terminal on starter/generator. Cover terminal on yellow wire to make sure it will not short to ground. Then, using a jumper wire, ground DF terminal to A1 terminal **(Figure 18-14, Page 18-30)**.
5. Using a multimeter set to 20 volts DC, place the red (+) probe on the positive (+) post 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 above 15.3 volts DC, test the voltage regulator. **See Voltage Regulator on page 18-32.** If the voltage does not rise, a tear-down inspection of the starter/generator will be necessary. **See Starter/Generator Removal on page 20-1.**
6. Remove jumper wire.
7. Reconnect yellow wire to DF terminal on starter/generator.



1. Yellow Wire 2. Jumper Wire

3029

Figure 18-14 Jumper Wire Ground – DF to A1



1. 200 Ohm Setting

3030

Figure 18-15 Check Starter Terminal Continuity

TEST PROCEDURE 12 – Starter/Generator (Starter Function)

See General Warnings on page 1-1.

NOTE: *Observe the following before testing the starter/generator:*

- *This is only testing continuity.*
- *Tag the starter/generator wires for identification before disconnecting.*
- *Remove starter/generator wire from one of the "A" terminals and one of the "F" terminals if testing while starter/generator is in vehicle.*

- *When disconnecting wires from starter/generator terminals, use a second wrench on the lower nut of the terminal post to hold post steady.*
- *Scrape a small amount of paint from starter/generator housing (ground) and use this location when testing motor terminals to electrical ground.*

MOTOR TERMINALS	CONTINUITY TEST RESULT
A1 to A2 F1 to F2	Continuity
A1 to F1 A1 to F2	No Continuity
A2 to F1 A2 to F2	No Continuity
A1 to Ground A2 to Ground	No Continuity
F1 to Ground F2 to Ground	No Continuity

1. If necessary, see Testing Basics on page 18-15.
2. Disconnect battery and spark plug wire(s). **See Disconnecting the Battery-Gasoline Vehicles on page 1-5.**
3. Disconnect the wires from all the terminals on the starter/generator. Then place the black (–) probe of a multimeter, set to 200 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 18-15, Page 18-30)**. 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 on page 20-1.**
   – 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.
4. 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 on page 20-1.**
5. 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 on page 20-1.**
6. 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 on page 20-1.**

   Ensure that wires are connected correctly and are tight. If they are not, rewire or tighten as necessary.

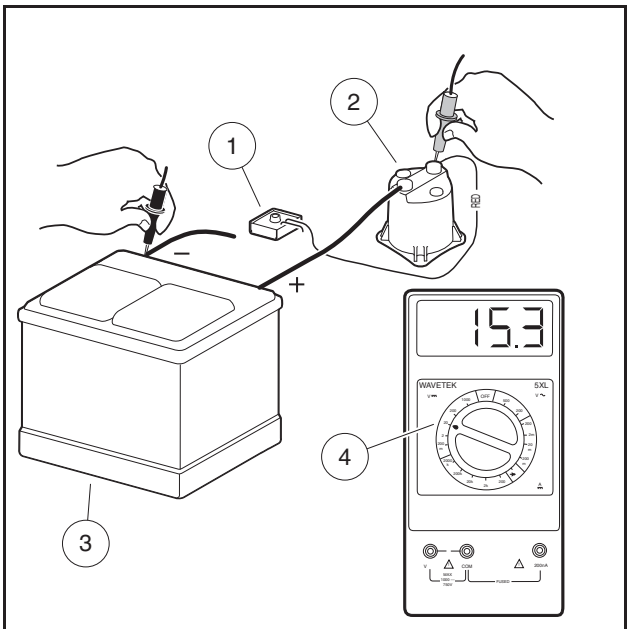
TEST PROCEDURE 13 – Voltage Regulator

See General Warnings on page 1-1.

NOTE: *This is a voltage test.*

Keep the battery connected while performing this test procedure.

1. If necessary, see Testing Basics on page 18-15.
2. Place the Forward/Reverse handle in the NEUTRAL position and the neutral lockout switch in the MAINTENANCE position. Chock the wheels.
3. Ensure that the wires are connected correctly and are tight. If they are not, rewire or tighten as necessary.
4. Check the engine RPM setting to ensure that it is adjusted correctly. **See Engine RPM Adjustment on page 23-13.**
5. With the battery in good condition and fully charged, run the engine for several minutes to bring the voltage regulator to operating temperature.
6. 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 18-16, Page 18-32)**. Turn the key switch to the ON position. Press the accelerator to start the engine and run it 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 Battery on page 18-17.** 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 on page 20-15.**



1. Voltage Regulator 2. Solenoid 3. Battery 4. 20 VDC Setting

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Figure 18-16 Voltage Regulator Test

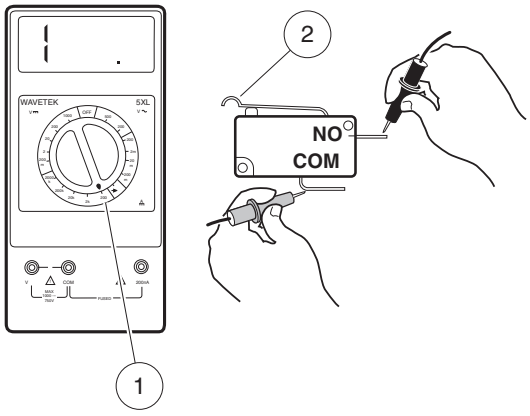
TEST PROCEDURE 14 – Kill Limit Switch – Pedal-Start Vehicles Only

See General Warnings on page 1-1.

NOTE: *This is a continuity test.*

The kill limit switch is the lower of the two limit switches located in the electrical component box. There is a white/black wire and a blue wire connected to this limit switch.

1. If necessary, see Testing Basics on page 18-15.
2. Disconnect battery and spark plug wire(s). **See Disconnecting the Battery-Gasoline Vehicles on page 1-5.**
3. Remove the electrical component box cover.
4. Check for proper wiring and tight connections. **See Wiring Diagrams on page 18-8.**
5. Disconnect the wires from the lower of the two limit switches and test the limit switch for continuity.
   – Place the red (+) probe of the multimeter on the common (COM) terminal (white/black wire) of the limit switch. Place the black (–) probe on the normally open (NO) terminal (blue wire) 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 the limit switch **(Figure 18-17, Page 18-33)**.
6. Reconnect wires to limit switch.



1. 200 Ohm Setting 2. Lever Up

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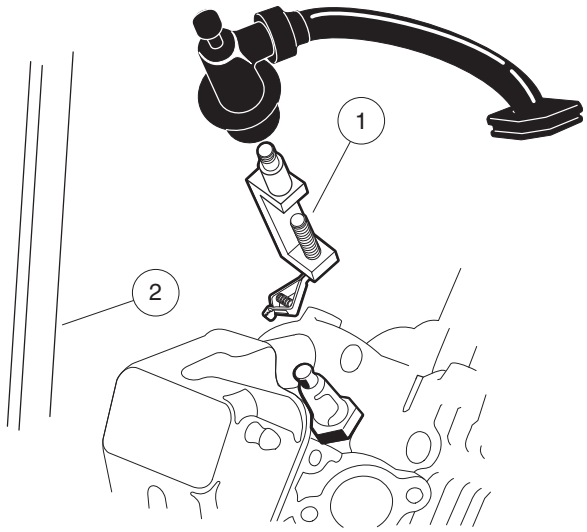
Figure 18-17 Kill Limit Switch Test

TEST PROCEDURE 15 – Ignition Spark

See General Warnings on page 1-1.

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

1. If necessary, see Testing Basics on page 18-15.
2. Place the Forward/Reverse handle in the NEUTRAL position and the neutral lockout switch in the MAINTENANCE position. Chock the wheels.
3. Remove the plug wire from the spark plug. Using an ignition spark gap test tool (Thexton 404® or equivalent), check for correct spark **(Figure 18-18, Page 18-34)**.
   - 3.1. Adjust the tester probes to approximately 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.
   - 3.2. 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. **See Ignition Coil on page 18-35.**
4. 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 0.024 to 0.028 in. (0.6 to 0.7 mm). If the gap is correct, replace the spark plug with a new part and test the engine for proper operation.



1. Ignition Gap Test Tool 2. Chassis

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Figure 18-18 Ignition Spark Test

TEST PROCEDURE 16 – Ignition Coil

See General Warnings on page 1-1.

NOTE: *This is a resistance test.*

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.

NOTE: *Resistance value ranges given in these tests reflect a tolerance of ±40%.*

Please note that these values are rough standard and it is impossible to reach an exact conclusion with the resistance reading.

1. If necessary, see Testing Basics on page 18-15.
2. Disconnect battery and spark plug wire(s). **See Disconnecting the Battery-Gasoline Vehicles on page 1-5.**
3. At engine, access white wire in ECU wire harness that connects to ignition coil lead at back of engine.
4. Using a multimeter set to 200k ohms, measure resistance between the following locations listed in table below.

IGNITION COIL TERMINALS	TEST RESULT
White Signal Wire to Ground	9 to 11 kOhms
White Signal Wire to Spark Plug Cap	17 to 20 kOhms
Spark Plug Cap to Ground	8 to 13 kOhms

TEST PROCEDURE 17 – Reverse Buzzer and Reverse Buzzer Limit Switch

See General Warnings on page 1-1.

NOTE: Reverse Buzzer: *This is a voltage test.*

Reverse Buzzer Limit Switch: *This is a continuity test.*

A reverse buzzer is mounted on the back side of the instrument panel. On some models, another reverse buzzer is also mounted on a bracket at the left rear of the vehicle. The reverse buzzer is powered by the 10-amp ATM fuse located on the main wire harness in front of the engine.

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

1. If necessary, see Testing Basics on page 18-15.
2. To test the front reverse buzzer, remove instrument panel. **See Instrument Panel Removal on page 4-10.**
3. Check for proper wiring and tight connections.
4. Check that battery voltage is present in the orange/white wire at buzzer.
5. Place the Forward/Reverse handle in the REVERSE position. The buzzer should sound. If not, check limit switch in the next steps.
6. Disconnect black/orange wire from buzzer.
7. With Forward/Reverse handle still in the REVERSE position, there should be continuity between the black/orange wire and ground. With Forward/Reverse handle still in the FORWARD position, there should be no continuity. If either reading is incorrect, replace limit switch. **See Reverse Buzzer Limit Switch Removal on page 20-25.**
8. If limit switch is operating properly, replace buzzer. **See Reverse Warning Buzzer Removal, Section 20, Page 20-23.**

TEST PROCEDURE 18 – Low Oil Warning Light (LED)

See General Warnings on page 1-1.

NOTE: *This is a voltage test.*

When the key switch is placed in the ON position, the Low Oil Warning Light will illuminate for approximately 3 seconds as a bulb check function.

1. If low oil warning light does not illuminate for approximately 3 seconds when the key switch is placed in the ON position, proceed with the steps below.
2. If necessary, see Testing Basics on page 18-15.
3. Remove the instrument panel. **See Instrument Panel Removal on page 4-10.**
4. Ensure that the wires are connected correctly and are tight. If they are not, rewire or tighten as necessary. **See Wiring Diagrams on page 18-8.**
5. With key switch in ON position, test for battery voltage at yellow wire to low oil warning light. If no voltage, check key switch. **See Key Switch (Start Circuit) on page 18-25.**
6. If battery voltage is present, use a test lead to ground the black wire terminal of low oil warning light. Light should illuminate. If not, replace low oil warning light.

TEST PROCEDURE 19 – Oil Level Sensor

See General Warnings on page 1-1.

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

This procedure requires the oil to be drained from the engine.

1. If necessary, see Testing Basics on page 18-15.
2. Place the Forward/Reverse handle in the NEUTRAL position, the neutral lockout switch in the MAINTENANCE position, turn the key switch to the OFF position, disconnect the spark plug wire, and chock the wheels.
3. Ensure that the low oil warning light and all connecting wires are functioning correctly. **See Low Oil Warning Light (LED) on page 18-36.**
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 low oil warning light should illuminate. If the low oil warning light does not illuminate, the oil level sensor needs to be replaced. **See Oil Level Sensor Removal on page 22-12.**
6. Fill the engine with new oil before returning the vehicle to service. **See Engine Oil – Gasoline Vehicle on page 22-2.**

TEST PROCEDURE 20 – Battery Test (Under Load)

See General Warnings on page 1-1.

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

1. If necessary, see Testing Basics on page 18-15.
2. Place the Forward/Reverse handle in the NEUTRAL position and the neutral lockout switch in the MAINTENANCE position. Chock the wheels.
3. Set a multimeter to 20 volts DC and place the red (+) probe on the F2 (white wire) terminal on the starter/generator. Place the black (–) probe on the negative (–) battery post.
4. Turn the key switch to the ON position, leave the Forward/Reverse shifter in the NEUTRAL position and press the accelerator pedal (with the accelerator pedal pressed, the battery is under load).
   4.1. If the voltage reading is over 9.6 volts, with an electrolyte temperature of 70 °F (21 °C), check the starter/generator. **See following NOTE.**

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

5. If the reading is below 9.6 volts, with an electrolyte temperature of 70 °F (21 °C), check the battery. **See Battery on page 18-17.**
   5.1. If the reading is zero, there may be no continuity across the large posts of the solenoid. **See Solenoid on page 18-27.**
6. 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 Starter/Generator (Starter Function) on page 18-30.**

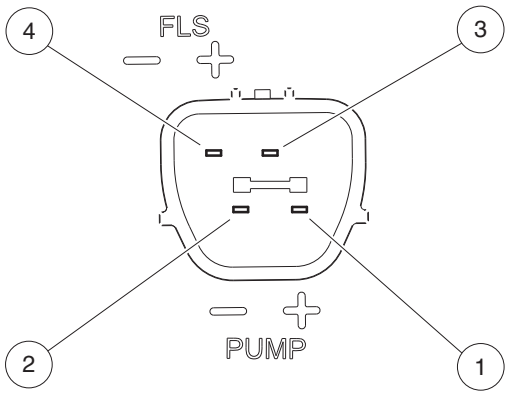
TEST PROCEDURE 21 – Fuel Pump

See General Warnings on 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.**

NOTE: *This is a voltage and resistance test.*



WIRE FUNCTION	WIRE COLOR
1. Fuel Pump Positive (+)	Red Wire
2. Fuel Pump Negative (–)	Brown Wire
3. Sending Unit Positive (+)	Orange/Black Wire
4. Sending Unit Negative (–) Black Wire	Black Wire

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Figure 18-19 Fuel Pump Module Terminals

Voltage to Pump

1. If necessary, see Testing Basics on page 18-15.
2. Disconnect the 5-pin connector from the top of the fuel pump module.
3. Check that battery voltage is present between ground and the red wire of the 5-pin connector immediately after the key switch is placed in the ON position.

NOTE: *The fuel pump and low oil warning light operate for a few seconds when key switch is turned to the ON position; it stops if no engine RPM is detected by the ECU.*

4. If no voltage, check key switch. **See Key Switch (Start Circuit) on page 18-25.**

Pump

1. If necessary, see Testing Basics on page 18-15.
2. Disconnect battery. **See Disconnecting the Battery-Gasoline Vehicles on page 1-5.**
3. Disconnect the 5-pin connector from the top of the fuel pump module.

4. Probe between pin (1) and pin (2) terminals in module **(Figure 18-19, Page 18-38)**.
   4.1. The reading should be approximately 2 to 5 ohms. If the reading indicates no resistance, the fuel pump has failed and the fuel pump module must be replaced. **See Fuel Pump Module Removal on page 23-18.**
   4.2. If the reading is correct and the fuel pump does not function correctly, check the continuity of the red wire from the fuel pump to the red wire of the black 18-pin ECU connector. This red wire contains sonic weld 7. Leave the battery disconnected while checking continuity. Also, check the continuity of the brown wire from the fuel pump to the brown wire of the black 18-pin ECU connector. **See Fuel Gauge/Hour Meter Removal on page 20-27.**

TEST PROCEDURE 22 – Fuel Level Sending Unit

See General Warnings on 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.**

NOTE: *This is a resistance test.*

1. If necessary, see Testing Basics on page 18-15.
2. Disconnect battery. **See Disconnecting the Battery-Gasoline Vehicles on page 1-5.**
3. Disconnect the 5-pin connector from the top of the fuel pump module.
4. Probe between pin (3) and pin (4) terminals in module **(Figure 18-19, Page 18-38)**.
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.

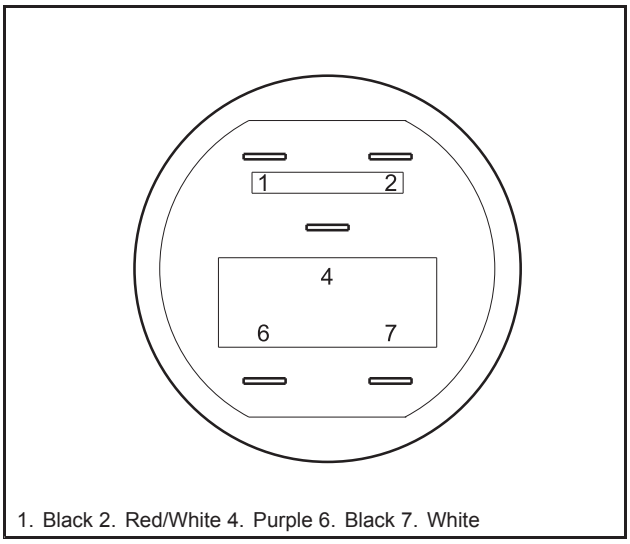
FLOAT POSITION	RESISTANCE READING	FUEL GAUGE READINGS
Lower position (tank empty)	250 ohms (±10)	Empty
Center position (tank half full)	141 ohms (±8)	Half full
Upper position (tank full)	33.3 ohms (±6)	Full

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 pump module must be replaced. **See Fuel Pump Module Removal on page 23-18.**
7. If the readings are correct and the fuel gauge does not function correctly, check the continuity of the orange/black wire from the fuel level sending unit to the purple wire on the fuel gauge/hour meter. Leave the battery disconnected while checking continuity. Also check the continuity of the red/white wire from the fuel gauge/hour meter to the brown/white wire on 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 on page 20-27.**
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 Fuel Gauge on page 18-40.**

TEST PROCEDURE 23 – Fuel Gauge

See General Warnings on page 1-1.

NOTE: *This is a voltage test.*



1. Black 2. Red/White 4. Purple 6. Black 7. White

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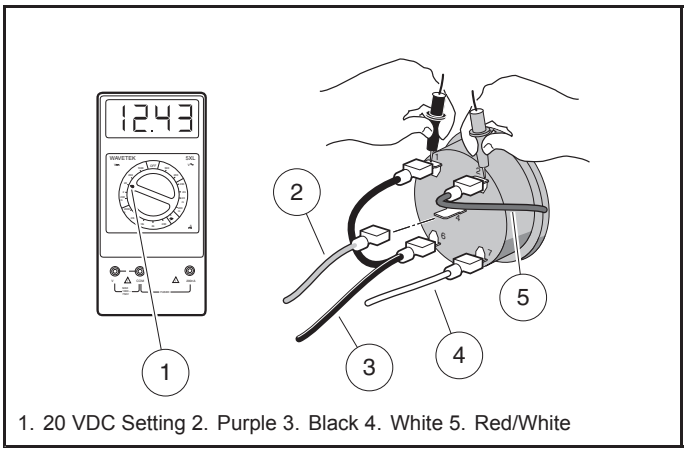
Figure 18-20 Fuel Gauge/Hour Meter

1. If necessary, see Testing Basics on page 18-15.
2. Turn the key switch OFF and remove the key. Place the Forward/Reverse handle in the NEUTRAL position. Chock the wheels.
3. Remove the instrument panel to gain access to the back of the fuel gauge/hour meter. **See Instrument Panel Removal on page 4-10.**
4. 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.
5. Disconnect the purple wire from the fuel gauge/hour meter.
6. 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.
7. Set a multimeter to 20 volts DC and place the red (+) probe on the (2) terminal of the fuel gauge/hour meter with the red/white wire is connected. Place the black (–) probe on the (1) terminal of the fuel gauge/hour meter with the black wire **(Figure 18-21, Page 18-41)**.
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 red/white and black wires **(Figure 18-21, Page 18-41)**.
9. The purple wire should remain disconnected for this step. Place the black probe of the multimeter on the (1) terminal of the fuel gauge/hour meter and place the red (+) probe on the (4) terminal of the fuel gauge/hour meter **(Figure 18-22, Page 18-41)**. The voltage reading should be approximately 4.94 volts. If the reading is incorrect, replace the fuel gauge/hour meter.



1. 20 VDC Setting 2. Purple 3. Black 4. White 5. Red/White

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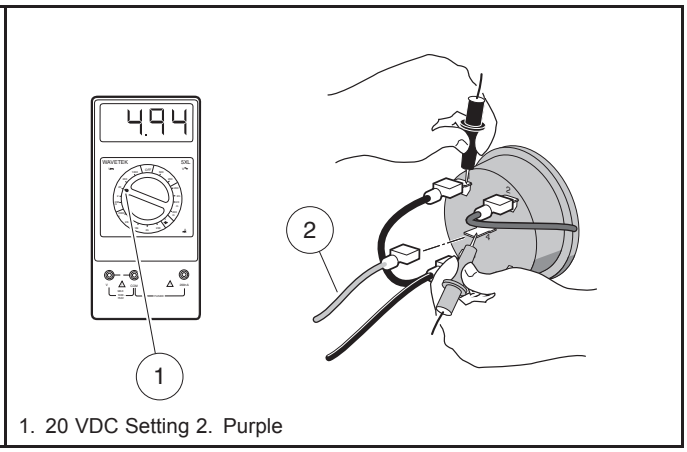
Figure 18-21 Fuel Gauge Voltage Test - Terminal 2



1. 20 VDC Setting 2. Purple

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Figure 18-22 Fuel Gauge Voltage Test - Terminal 4

TEST PROCEDURE 24 – Hour Meter

See General Warnings on page 1-1.

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

1. If necessary, see Testing Basics on page 18-15.
2. Place the Forward/Reverse handle in NEUTRAL. Chock the wheels.
3. With the key switch OFF, check the hour meter display. It is powered by an internal battery and should always be on, even with the engine off and the key removed.
4. Start the engine and let it idle. **See following DANGER.**

⚠ DANGER

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

5. With engine idling, the "hour glass" icon should flash. If not, check the low oil warning light and the oil pressure switch. **See following NOTE. See also Test Procedure 18 – Low Oil Warning Light (LED) on page 18-36.**

NOTE: *The hour meter is designed to record actual engine running time and will not start adding increments until the engine is running and the oil pressure switch has opened.*

6. If the hour meter still does not function after the low oil warning light, oil pressure switch, and all of the appropriate wires have been checked for continuity, replace the fuel gauge/hour meter.

TEST PROCEDURE 25 – Light Switch

See General Warnings on page 1-1.

NOTE: *The headlight circuit is protected by the 20-amp fuse. Check the fuse before this procedure is performed.* ***See Test Procedure 2 – Fuses on page 18-19.***

This is a voltage test.

1. If necessary, see Testing Basics on page 18-15.
2. Remove instrument panel. **See Instrument Panel Removal on page 4-10.**
3. Use a multimeter set to 20 volts DC and place alligator clips on the multimeter probes. Connect the red (+) probe to the light switch terminal where the green/white wire is connected.
4. Connect the black (–) probe of the multimeter to ground.
5. With the light switch in the OFF position, the reading should indicate 0 volts. With the light in the ON position, the reading should indicate battery voltage. If there is no voltage reading, check associated wiring and 10-amp fuse (located in electrical component box). **See Test Procedure 2 – Fuses on page 18-19.** If the wires and fuse show continuity and the readings are still incorrect, replace the switch. **See Headlight Switch Removal, Section 20, Page 20-30.**

TEST PROCEDURE 26 – Voltage at Headlight Socket

See General Warnings on page 1-1.

NOTE: *This is a voltage test.*

1. If necessary, see Testing Basics on page 18-15.
2. Inspect the wires at the light bulb socket. Make sure the wires are securely fastened to the contacts inside the socket and that wires are oriented correctly - black to black and blue to blue.
3. Remove the wire harness connector from the headlight bulb **(Figure 18-23, Page 18-42)**.
4. With the light switch in the ON position, probe across the two terminals in the connector. If battery voltage is shown, check/replace the headlight bulb.

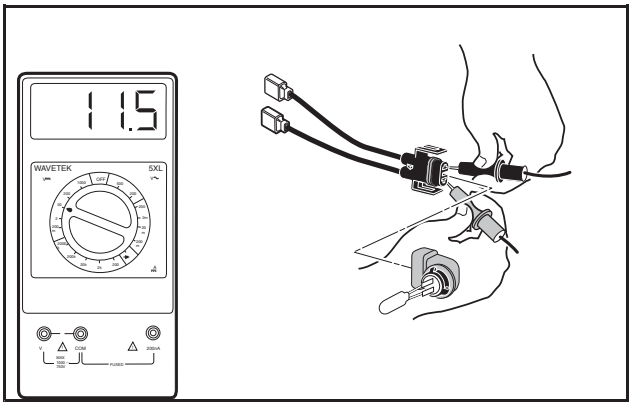

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Figure 18-23 Voltage Measurement at Headlight Socket

5. If there is no voltage reading, check associated wiring, light switch and 10-amp fuse (located in electrical component box). **See Test Procedure 2 – Fuses on page 18-19. See Test Procedure 25 – Light Switch on page 18-42.**

TEST PROCEDURE 27 – Voltage Limiter

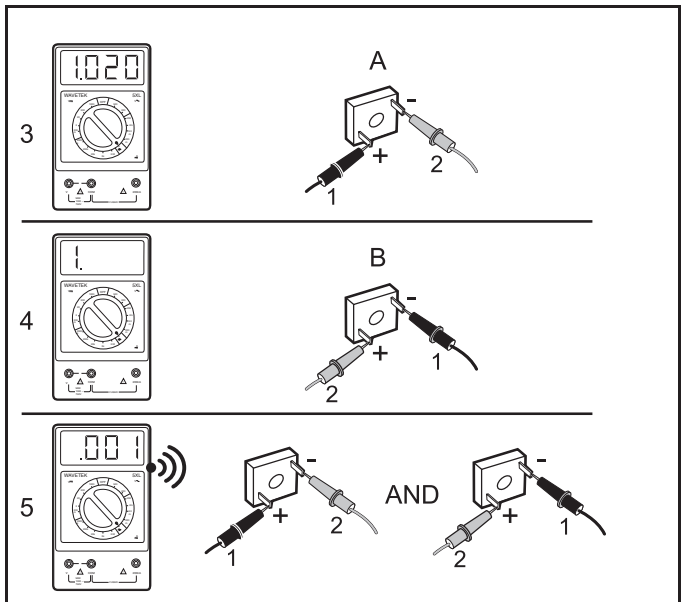
See General Warnings on page 1-1.

NOTE: *This is a diode test.*

The voltage limiter is a diode. Diodes are designed to conduct current in one direction only. **See following NOTE.**

NOTE: *If the voltage limiter conducts current in both directions, the diode has failed closed. If the voltage limiter will not conduct current in either direction, the diode has failed open.*

1. If necessary, see Testing Basics on page 18-15.
2. Turn the key switch OFF and remove the key. Place the Forward/Reverse handle in the NEUTRAL position. Chock the wheels.
3. Remove the cowl. **See Cowl Removal, Section 4, Page 4-5.**
4. Disconnect green wire from positive (+) terminal of voltage limiter and black wire from negative (-) terminal.
5. Using a multimeter on diode setting, test voltage limiter as shown **(Figure 18-24, Page 18-43)**.



1. Black Lead 2. Red Lead 3. Good Diode (Probe Scenario A) - Conducts Current and Shows Continuity 4. Good Diode (Probe Scenario B) - No Continuity (Infinite) 5. Bad Diode - Meter Beeps In Either Direction (Probe Scenarios A and B)

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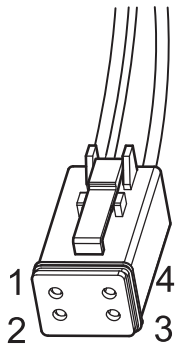
Figure 18-24 Voltage Limiter Test

TEST PROCEDURE 28 – 4-Pin Connector (for Connected Car Device)

See General Warnings on page 1-1.

NOTE: *This is a voltage and continuity test.*

The Connected Car Device 4-pin connector is used for Guardian/Visage and is labeled "V3 circuit" on the main wire harness.



Pin 1 – Black	Pin 4 – Blue
Pin 2 – Red	Pin 3 – Open (No wire)

2786

Figure 18-25 4-Pin Connector

1. If necessary, see Testing Basics on page 18-15.
2. Check for continuity between pin 1 (black wire) **(Figure 18-25, Page 18-44)** and pin 18 (black wire) of the black 18-pin connector on the ECU. It should indicate continuity. If not, check sonic welds no. 4, 10, and 14.
3. Probe pin 2 (red wire). It should show battery voltage with the key switch in the ON position. If not, check 2-amp fuse near 4-pin connector. **See following NOTE.**

NOTE: *The red wire only has battery voltage with the key switch in the ON position.*

4. Probe pin 4 (blue wire). It should show approximately 11.8 volts supplied by pin 8 (blue/white wire) of the black 18-pin connector on the ECU. If not, check wiring and then ECU. **See following NOTE.**

NOTE: *The blue wire only has voltage with the key switch in the ON position.*

If pin 4 has no voltage, the ECU LIN (Local Interconnect bus) may have failed. The vehicle can be driven if it is not used with Guardian or Visage and will not show any symptoms. Otherwise, Guardian or Visage will disable the vehicle until communication is restored.

SECTION 19 — TROUBLESHOOTING AND ELECTRICAL SYSTEM: KEY-START GAS VEHICLE

19

⚠ DANGER

- **See General Warnings on page 1-1.**

⚠ WARNING

- **See General Warnings on page 1-1.**

GENERAL INFORMATION

⚠ WARNING

- **To prevent damage to the ECU, never mix the black and gray connectors that attach to it. The black connector is tethered to the ECU mounting plate to help prevent accidentally installing it in the gray port.**

This section covers only the components that make troubleshooting the key-start gasoline vehicle different from the pedal-start gasoline vehicle. Use this information in addition to the **Troubleshooting and Electrical System: Pedal-Start Gas Vehicle** section. Most components are shared between the two systems except for the following items unique to the key-start vehicle:

- **Key Switch:** Only way to start and shut off the engine.
- **Accelerator Pedal:** Is not linked to the accelerator pedal limit switch and kill limit switch in the electrical component box because these switches are omitted for key-start applications.
- **Charging Diode:** Is connected to the solenoid in the electrical component box.
- **Forward/Reverse Shifter:** Is not linked to the neutral lockout limit switch on the transaxle because this switch is omitted for key-start applications.

In addition to troubleshooting, this section contains general information on the key-start electrical system and the circuits of the key-start electrical system.

WIRING DIAGRAMS

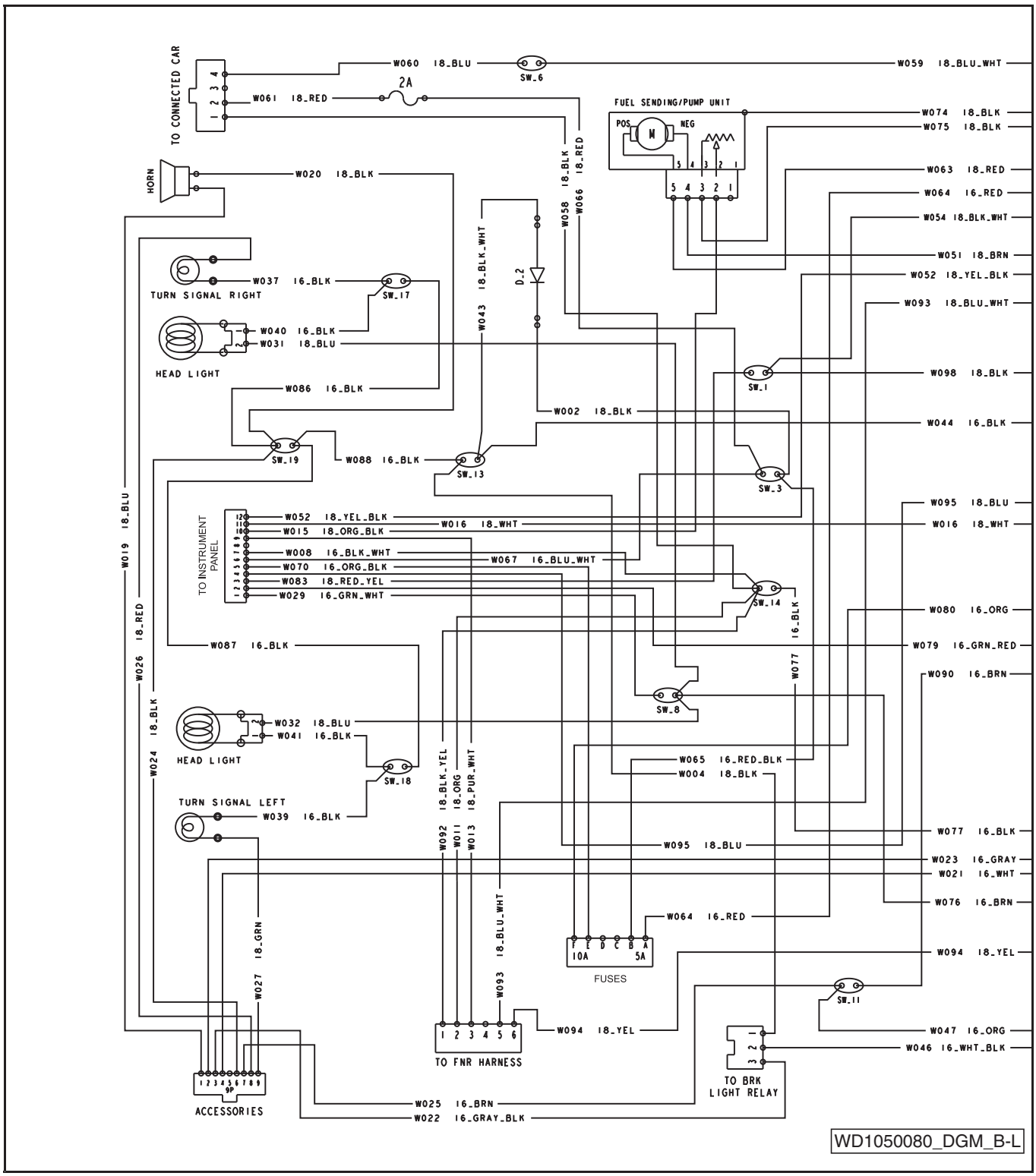


Figure 19-1 Wiring Diagram for Key-Start Gasoline Vehicle

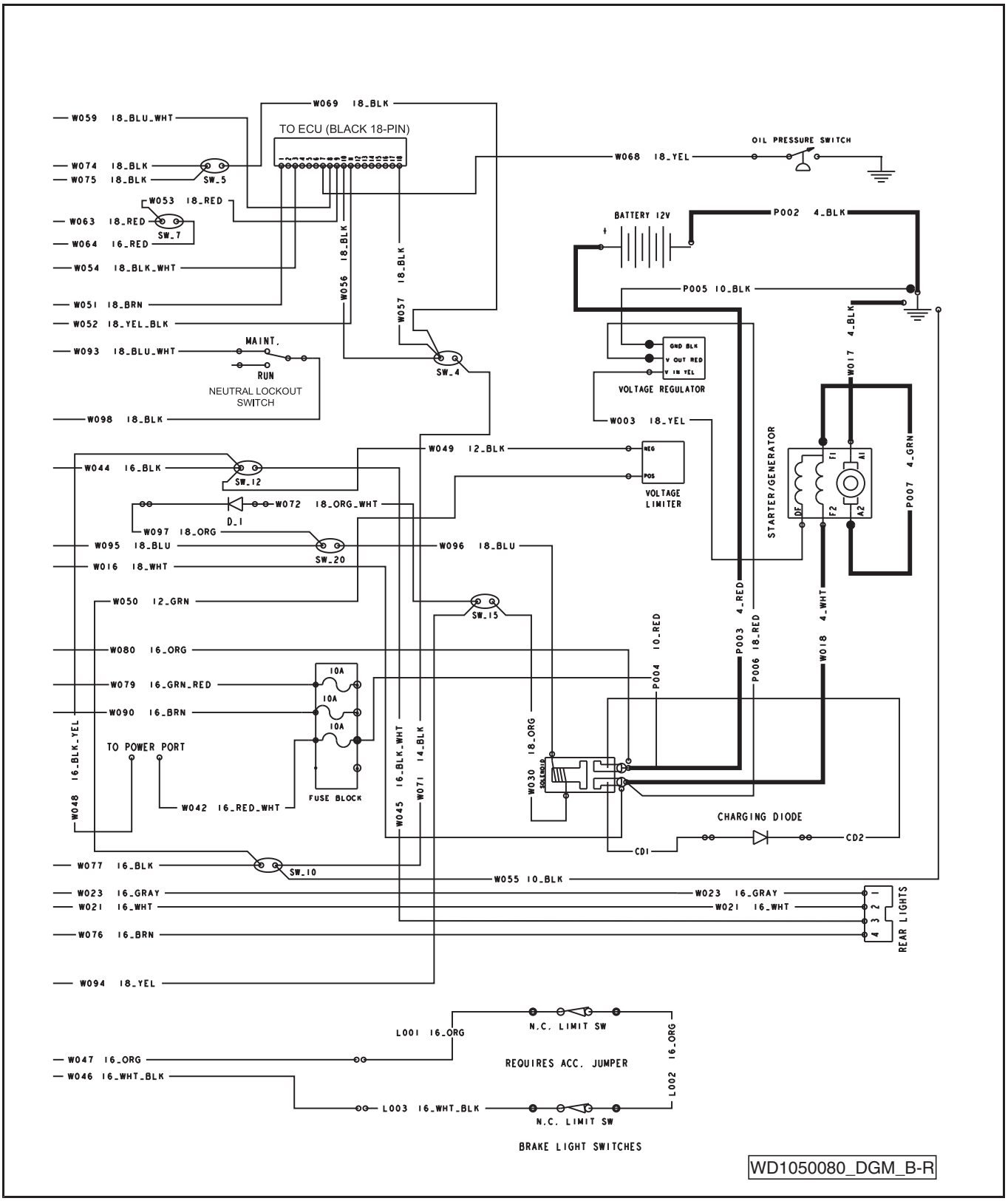


Figure 19-2 Wiring Diagram for Key-Start Gasoline Vehicle – Continued

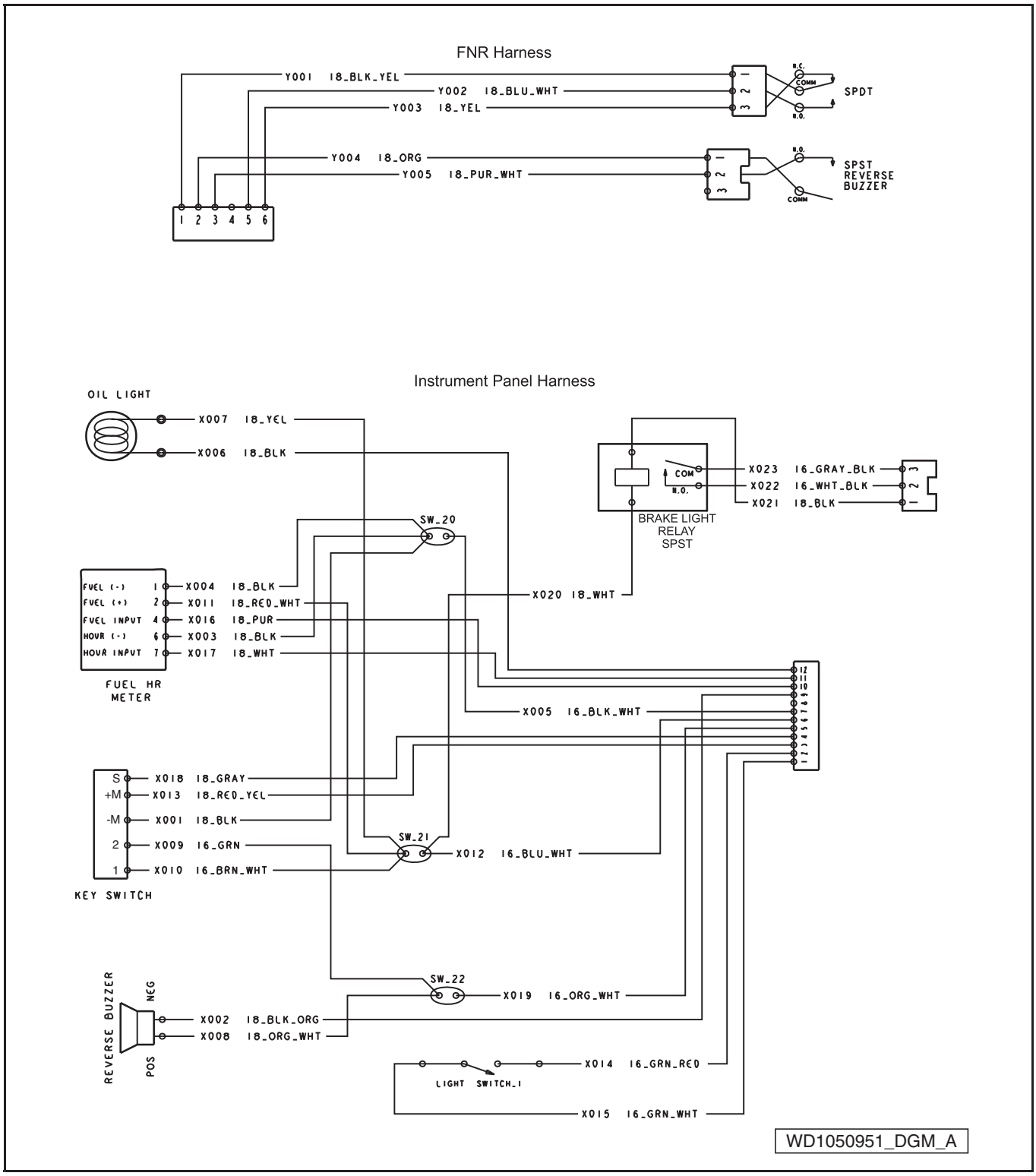


Figure 19-3 Wiring Diagram – Instrument Panel and FNR Shifter

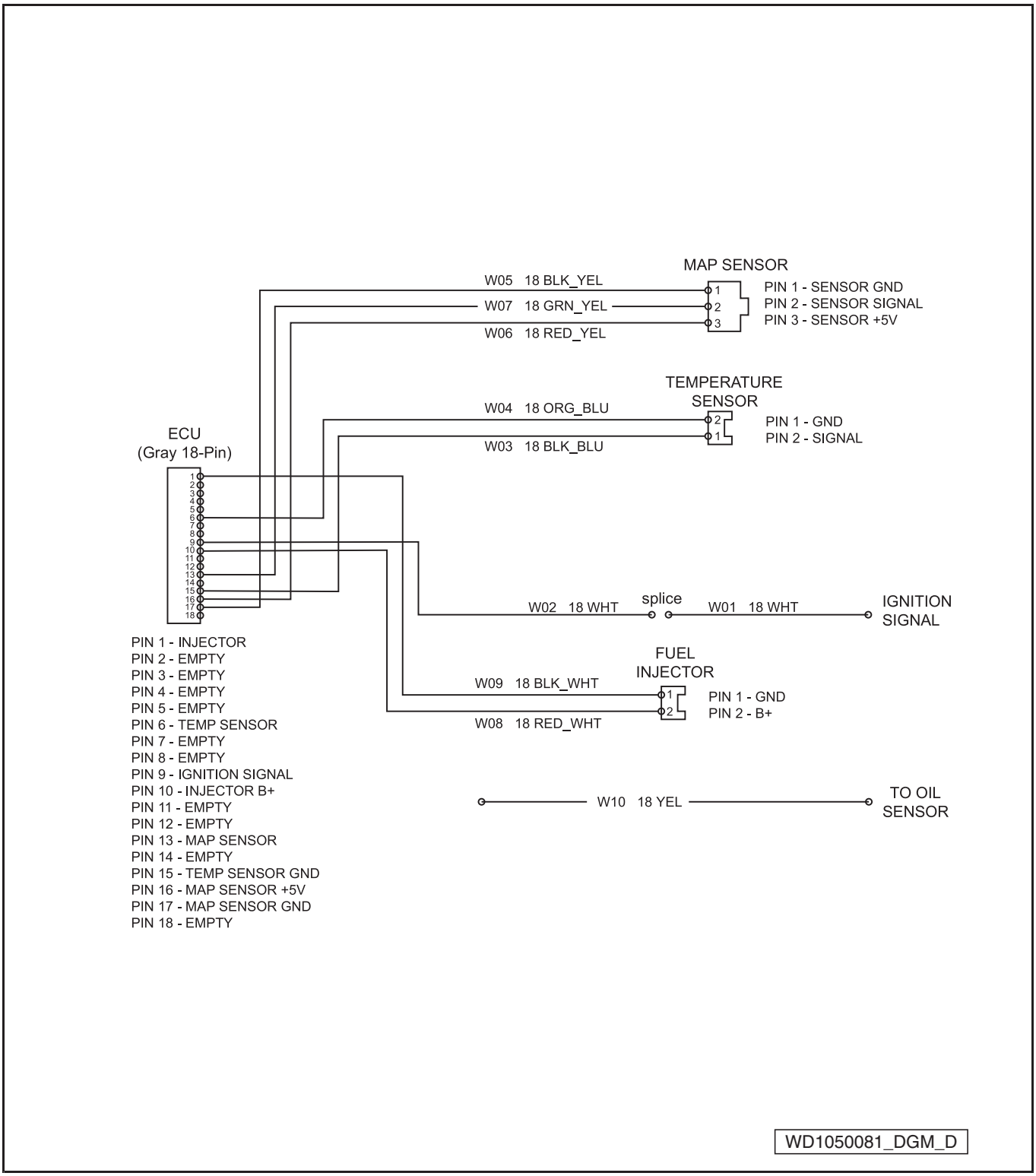


Figure 19-4 Wiring Diagram – EFI and Engine

TEST PROCEDURES

Using the following procedures, the entire electrical system can be tested without major disassembly of the vehicle.

⚠ WARNING

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

For some tests, the electrical component box cover must be removed to gain access to the various components that are mounted inside the component box. **See following WARNING.**

⚠ WARNING

- **Shorting of battery terminals can cause personal injury or death.**

After test procedures are completed, be sure to replace the cover. **See following CAUTION.**

CAUTION

- **Exposure to water and the elements may damage electrical components. Do not operate vehicle without the cover properly installed.**

Index of Test Procedures

TEST PROCEDURE 1 – EFI System (ECU and Sensors)

See General Warnings on page 1-1.

⚠ WARNING

- **This procedure involves testing voltage, resistance and continuity. If necessary, see Testing Basics on page 18-15.**

In key-start vehicles, pin 12 of the ECU black 18-pin connector is not used. Pin 12 provides Foot Input to the ECU in pedal-start applications only. See Test Procedure 4 – EFI System (ECU and Sensors) on page 18-22 for all other ECU testing.

TEST PROCEDURE 2 – Key Switch (ON Position)

See General Warnings on page 1-1.

NOTE: *This is a voltage test.*

The key switch ON position provides power and KEY INPUT to the ECU.

1. If necessary, see Testing Basics on page 18-15.
2. Remove instrument panel to access the back of the key switch but do not disconnect wires. **See Instrument Panel Removal on page 4-10.**
3. With the key switch in the OFF position:
   – The green wire should show battery voltage coming to the switch.
   – The brown/white wire should show zero (0) volts. If it shows battery voltage, the switch has failed CLOSED and must be replaced.
4. With the key switch in the ON position:
   – The brown/white wire should show battery voltage passing through the key switch to sonic weld 3, the 5-amp fuse, the solenoid, and the 4-pin connected car plug. If it does not show battery voltage, the switch has failed OPEN and must be replaced.

TEST PROCEDURE 3 – Key Switch (START Position)

See General Warnings on page 1-1.

NOTE: *This is a voltage test.*

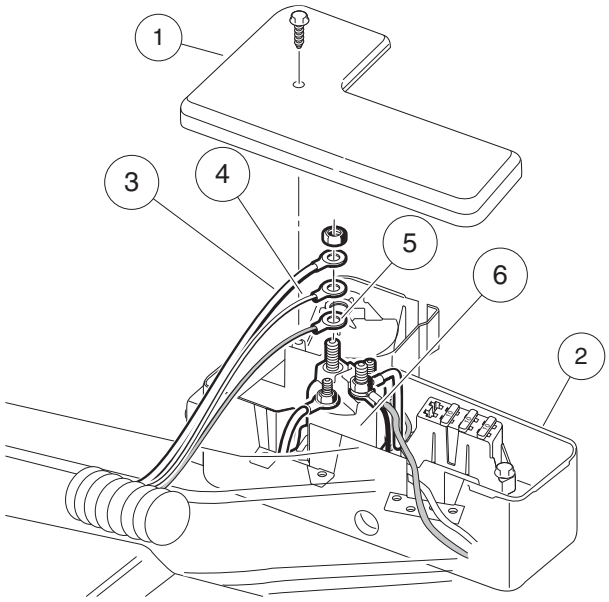
The key switch START position provides power to the starter/generator.

1. If necessary, see Testing Basics on page 18-15.
2. Remove instrument panel to access the back of the key switch but do not disconnect wires. **See Instrument Panel Removal on page 4-10.**
3. With the key switch in the OFF position:
   – The green wire should show battery voltage coming to the switch.
   – The gray wire should show zero (0) volts. If it shows battery voltage, the switch has failed CLOSED and must be replaced.
4. With the key switch in the START position:
   – The gray wire should show battery voltage passing through the key switch to sonic weld 20 and the solenoid coil. If it does not show battery voltage, the switch has failed OPEN and must be replaced.

TEST PROCEDURE 4 – Solenoid

See General Warnings on page 1-1.

NOTE: *This is a resistance and voltage test.*



1. Cover 2. Electrical Component Box 3. 6 Ga. White Wire 4. 18 Ga. White Wire 5. 18 Ga. Red Wire 6. Solenoid

3025

Figure 19-5 Solenoid Wire Removal

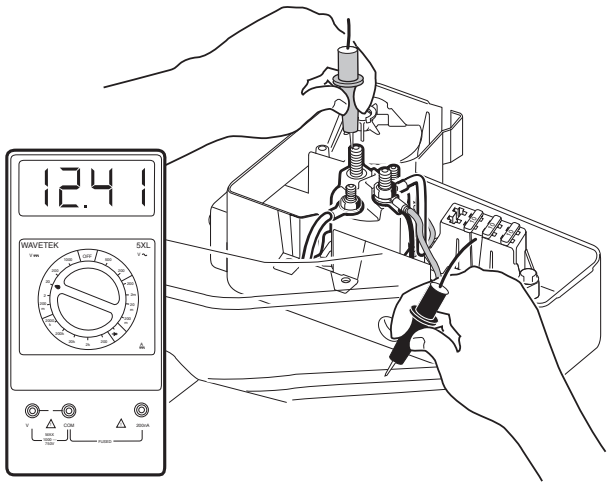


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Figure 19-6 Solenoid Voltage Test

1. If necessary, see Testing Basics on page 18-15.
2. Remove the electrical component box cover.
3. Ensure that the wires are connected correctly and are tight. If they are not, rewire or tighten as necessary.
4. **Coil Side:** Check resistance across the small posts of the solenoid. The reading should be 14 to 16 ohms. If the reading is not within limits, replace the solenoid.
5. **Contact Side:** Remove the 4-gauge white wire, the 10-gauge white wire, the 18-gauge red wire, and 18-gauge white wire from the large post of the solenoid. Do not allow the wires to touch the frame or other components of the vehicle **(Figure 19-5, Page 19-8)**. Cover the other large post.
   5.1. Place Forward/Reverse handle in the NEUTRAL position and neutral lockout switch in the MAINTENANCE position.
   5.2. Check voltage between the empty large post and ground **(Figure 19-6, Page 19-8)**.
   – **With key switch in the OFF and ON positions:** The meter should read no voltage.
   – **With key switch in the START position:** The solenoid should click and the meter should read battery voltage.
   5.3. If the readings are incorrect, replace solenoid. **See Solenoid Removal, Section 21, Page 21-3.**

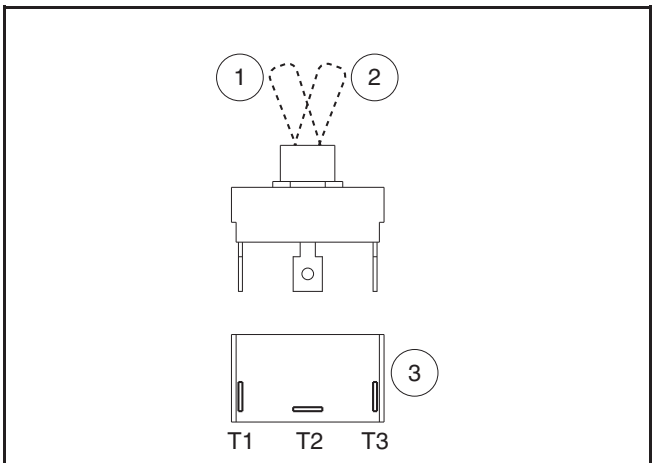
TEST PROCEDURE 5 – Maintenance/Operate Switch – Key-Start Vehicles

See General Warnings on page 1-1.

NOTE: *This is a continuity test.*

The Maintenance/Operate Switch is also known as the Neutral Lockout Switch.

1. If necessary, see Testing Basics on page 18-15.
2. Remove wires from switch **(Figure 18-12, Page 18-28)**.
3. With switch in position 1 (MAINTENANCE):
   3.1. Check for no continuity between terminals T1 and T2.
   3.2. Check for continuity between terminals T2 and T3.
4. With switch in position 2 (OPERATE):
   4.1. Check for no continuity between terminals T2 and T3.
   4.2. Check for continuity between terminals T1 and T2.



Toggle Position Operates:	1. Position 1 (MAINT.) closes T2 to T3
	2. Position 2 (OP.) closes T1 to T2
3. T1 – Blue/White Stripe; T2 – Black	

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Figure 19-7 Maintenance/Operate Switch Test – for Key-Start Vehicles

5. If switch:
   5.1. does not work as stated in previous steps, replace switch.
   5.2. does work as stated and the MAINTENANCE/OPERATE modes still do not work:
   – Check the fuse.
   – Check the limit switches.
   – Check continuity of the wires involved.

TEST PROCEDURE 6 – Charging Diode (Generator Circuit) – Key-Start Vehicles Only

See General Warnings on page 1-1.

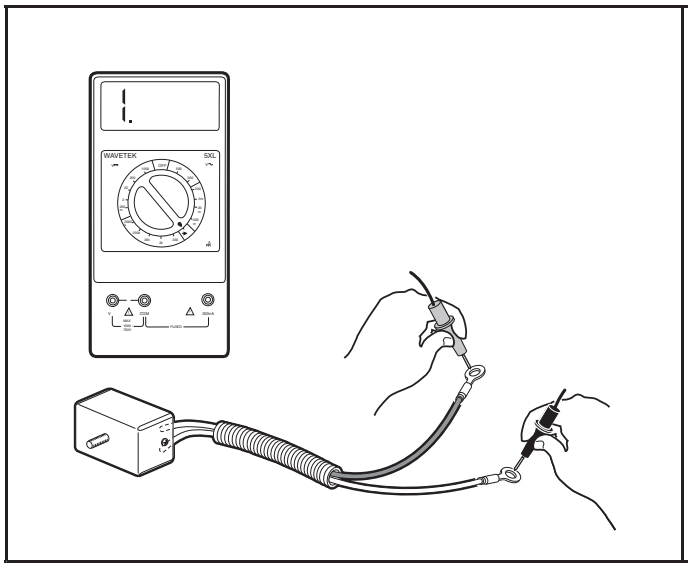

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Figure 19-8 Diode Test

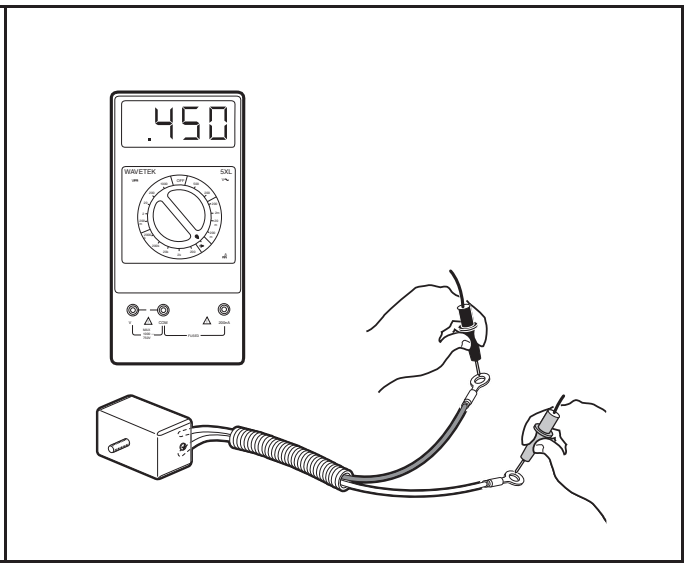

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Figure 19-9 Diode Test – Probes Reversed

1. Turn the key switch OFF and remove the key. Place the Forward/Reverse handle in the NEUTRAL position. Chock the wheels.
2. Disconnect battery and spark plug wire(s). **See Disconnecting the Battery-Gasoline Vehicles on page 1-5.**
3. Disconnect the 10-gauge red wire and 10-gauge white wire of the diode assembly from the solenoid posts, located within the electrical component box.
   3.1. Remove the cover retaining screw (1) and electrical component box cover (2) **(Figure 21-2, Page 21-5)**.
   3.2. Remove the locknuts (3) 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 19-8, Page 19-10)**. 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 Charging Diode Removal, Section 21, Page 21-4.**
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 from 400 to 500 mV is acceptable **(Figure 19-9, Page 19-10)**.
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 Charging Diode Removal, Section 21, Page 21-4.**
7. If the diode tests good, reconnect the diode leads. **See Charging Diode Installation, Section 21, Page 21-5. See also following WARNING.**

⚠ WARNING

- **Incorrect wiring could result in severe injury or death.**

WARNING CONTINUED ON NEXT PAGE

⚠ WARNING

- **Diode and solenoid connections must have correct polarity.**
- **Keep all persons clear of engine belts when making final connections.**

Pagination Page

SECTION 20 — ELECTRICAL COMPONENTS: PEDAL-START GAS VEHICLE

⚠ DANGER

- **See General Warnings on page 1-1.**

⚠ WARNING

- **See General Warnings on page 1-1.**

STARTER/GENERATOR

See General Warnings on page 1-1.

TESTING THE STARTER/GENERATOR

See Test Procedure 12 – Starter/Generator (Starter Function) on page 18-30.

See Test Procedure 11 – Starter/Generator (Generator Function) on page 18-30.

STARTER/GENERATOR REMOVAL

1. Disconnect battery and spark plug wire(s). **See Disconnecting the Battery-Gasoline Vehicles on page 1-5.**
2. Place the neutral lockout switch in the MAINTENANCE position. Access the engine compartment by removing the seat or raising the cargo bed.
3. Disconnect the wires from the starter/generator (1) **(Figure 20-14, Page 20-13)**.
4. Loosen the pivot nuts (7) and bolts (5) **(Figure 20-13, Page 20-12)**.
5. Remove the adjustment nut (4), washer (6) and adjustment bolt (1) **(Figure 20-13, Page 20-12)**. Lower the starter/generator and remove the belt (2) from the pulley.
6. Support the starter/generator so that when the pivot bolts (5) are removed the starter/generator will not fall. Remove the two pivot nuts (7) and bolts (5) from the mounting bracket.
7. Remove the starter/generator.

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 20-1, Page 20-2)**. **See following NOTE.**

NOTE: *If the brushes are not removed, contact between the brushes and commutator as the commutator end cover is being removed or installed could damage the brushes. 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 rest on the sides of the brushes and help prevent them from sliding towards the center of the cover* ***(Figure 20-5, Page 20-4)****.*

2. Remove brush covers (29 and 30), terminal hardware (25), brush springs (28), and brushes (27) **(Figure 20-2, Page 20-2)**. **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 20-4****.*

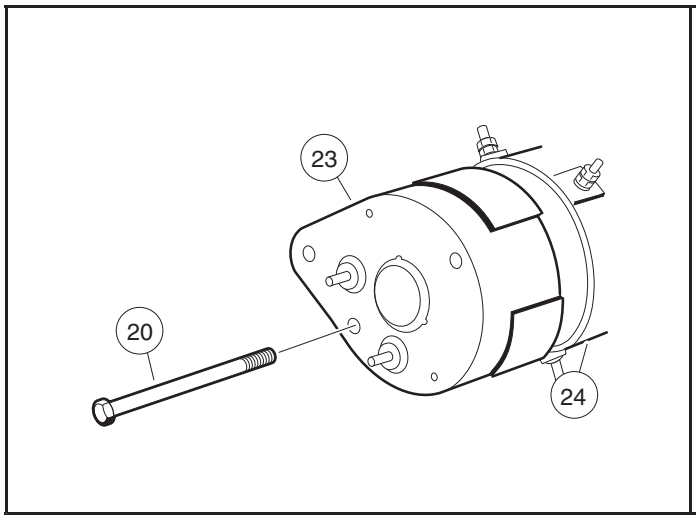

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Figure 20-1 Commutator End Cover

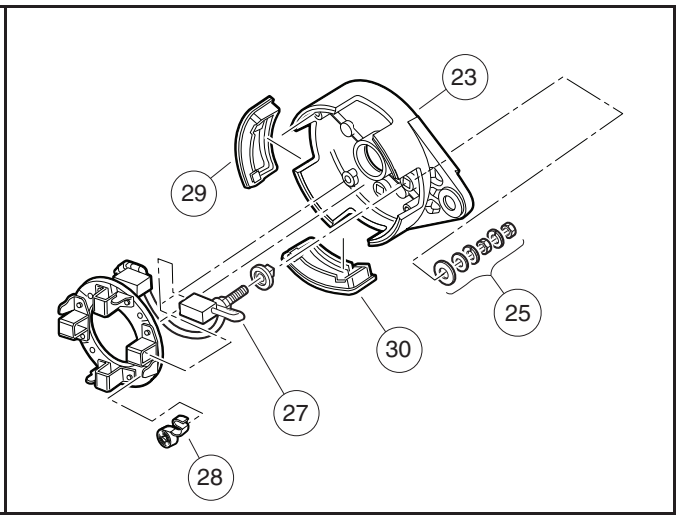

Figure 20-2 Brush Covers and Brushes

BRUSH INSPECTION AND REPLACEMENT

1. Visually inspect brushes. Replace brushes that are cracked or severely chipped.
2. Measure the length of each brush. Replace the brush set if a brush is less than 0.375 inch (9.5 mm) **(Figure 20-3, Page 20-2)**.

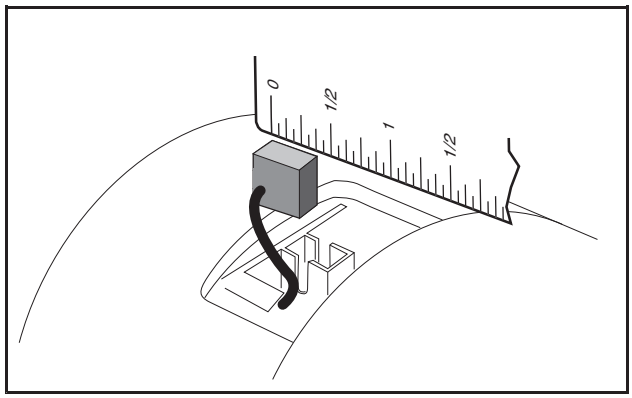

Figure 20-3 Inspect Brushes and Measure Length

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 20-2, Page 20-2)**. Using a spring scale, test brush spring tension. If any spring has a tension less than 24 ozf (0.68 kgf), replace all four springs **(Figure 20-4, Page 20-3)**. **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.**

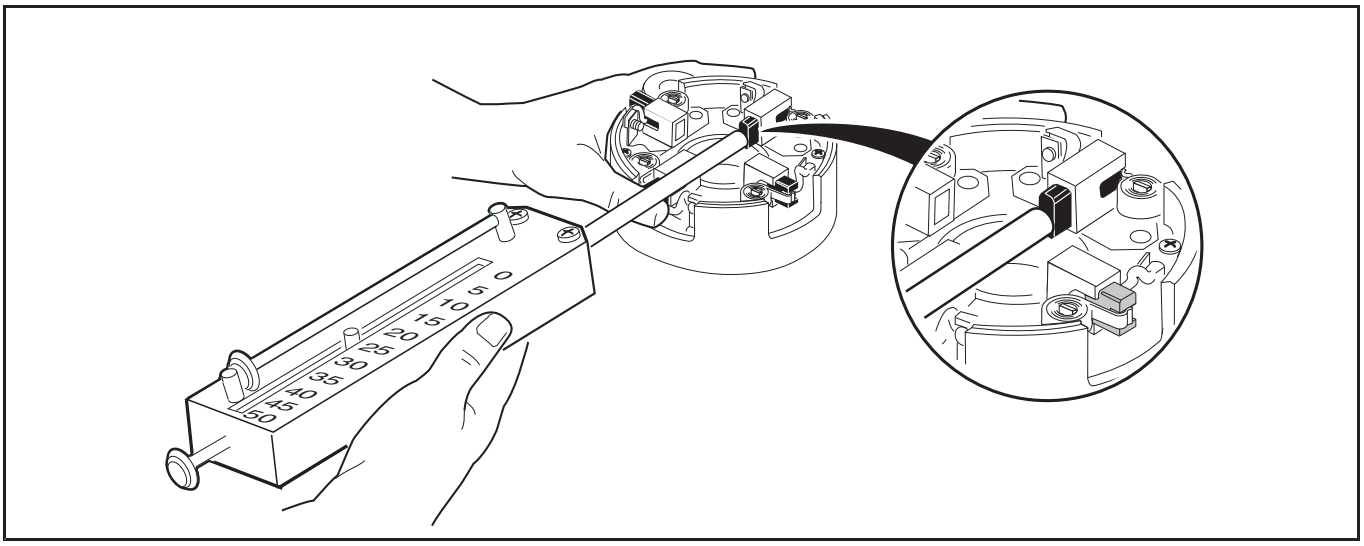

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Figure 20-4 Brush Spring Tension Test

STARTER/GENERATOR ASSEMBLY

1. Install the brushes (27) into the holders. Install the terminal hardware (25) **(Figure 20-2, Page 20-2)**.
2. To prevent contact between the brushes and commutator as the commutator is installed, and possible damage to the brushes, lift the brush springs and pull the brushes back from the center of the commutator end cover. The springs will rest on the sides of the brushes and help prevent them from sliding towards the center of the cover **(Figure 20-5, Page 20-4)**.
3. Install the commutator end cover (23) onto the armature shaft. Align the locating pin with the pin hole in the cover. Install two M6 x 180 mm bolts (20) and tighten to 100 in·lb (11.3 N·m) **(Figure 20-1, Page 20-2)**.
4. Push the brushes down into the holders. Position springs on the end of 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) in the openings in the commutator end cover (23) **(Figure 20-2, Page 20-2)**.

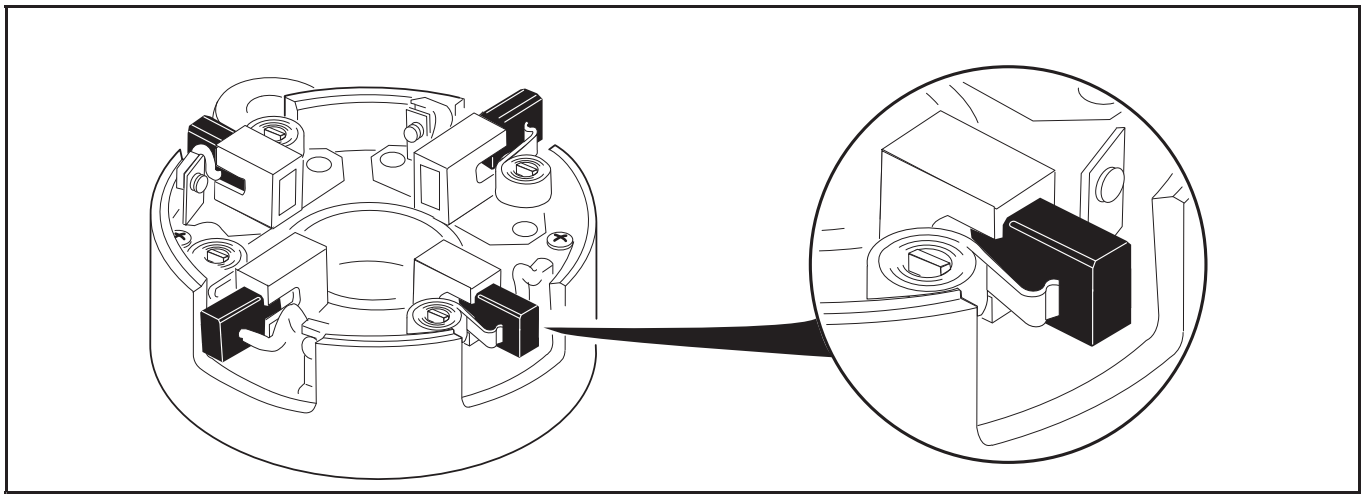

Figure 20-5 Pull Brushes Away From Center of the Commutator End Cover

DISASSEMBLY OF THE STARTER/GENERATOR TO SERVICE THE ARMATURE/COMMUTATOR

1. Remove the commutator end cover to prevent damage to the brushes and armature. **See Disassembly of the Starter/Generator to Service the Brushes on page 20-1.**
2. To separate armature and output end cover assembly from the field coil housing, first remove the two securing bolts (43). Carefully remove armature and output end cover assembly from the field coil housing so components are not damaged.
3. To separate armature (33) from output end cover (36), remove nut (41), lock washer (40), pulley (39). It may be necessary to use the wedge attachment tool (P/N 1012812) to remove the pulley from the shaft.
4. Remove the internal retaining ring (32) to release the bearing (35) and armature (33) from the output end cover (36). **(Figure 20-6, Page 20-5)**.

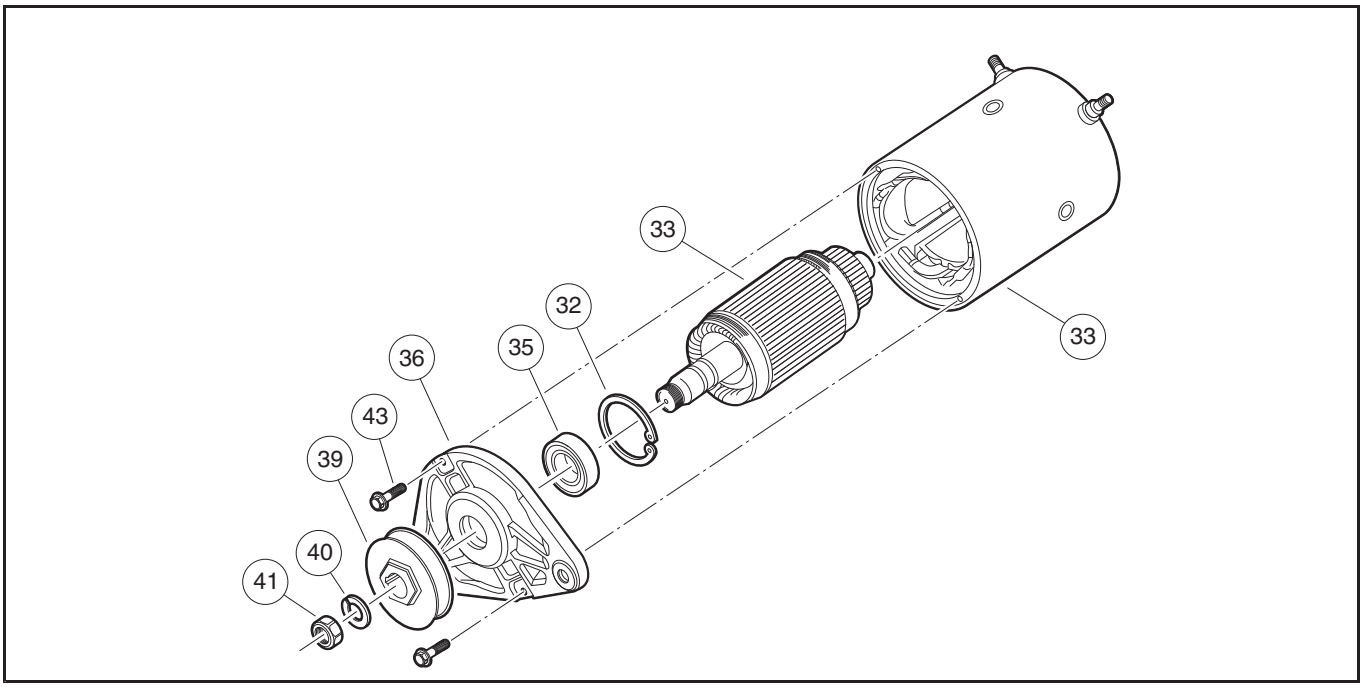

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Figure 20-6 Output End Cover Assembly, Armature and Housing

BEARING CLEANING AND INSPECTION

1. Using a clean cloth, 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 20-7, Page 20-5)**.
2. Replace the bearing if it is noisy, does not spin smoothly, or has excessive play. Check the bearings and replace if rusted, worn, cracked, or if there is an abnormal color change in the metal of the bearing. Bearings should be replaced if there is extensive wear or pitting on the balls or on the rolling surfaces. Do not remove the bearings unless they are to be replaced.

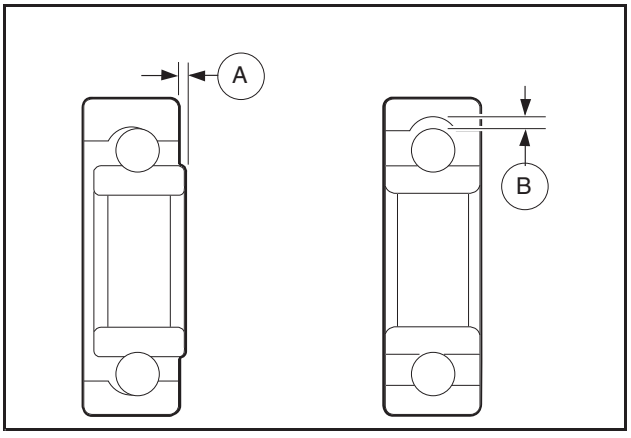

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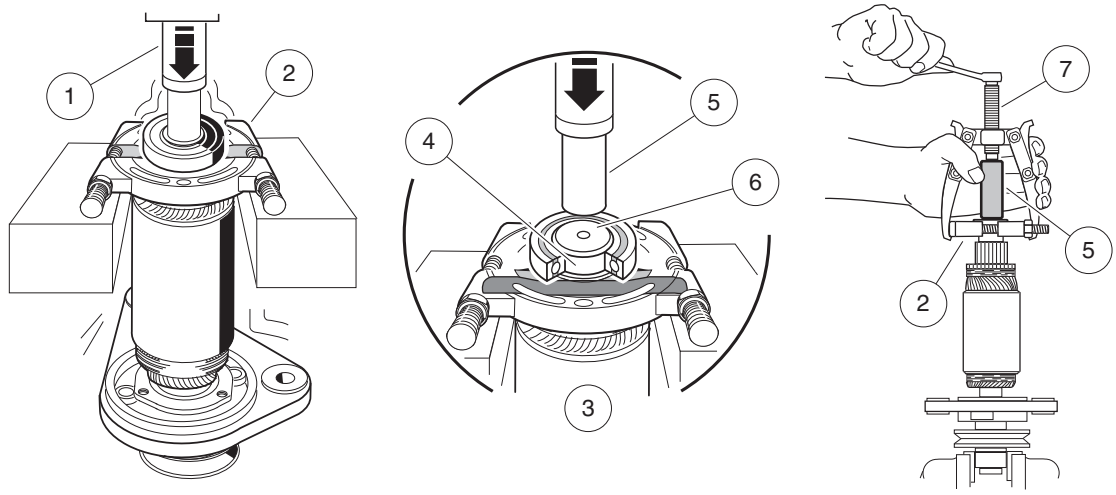
Figure 20-7 Bearing Play Inspection

BEARING REMOVAL

1. Place the wedge attachment tool (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 (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 20-8, Page 20-6)**.
2. Slide the bearing retainer ring (32) off of the output end of the shaft **(Figure 20-6, Page 20-5)**.



1. Press Ram 2. Wedge Attachment Tool 3. Bearing sectioned for clarity 4. Support inner race of bearing 5. Use a 1/2 inch socket or pipe 6. Press against armature shaft 7. Use bearing puller if a press is not available

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Figure 20-8 Bearing Removal

FIELD COIL ASSEMBLY

Replace entire field coil housing assembly if coils, pole shoes or terminals are damaged. **(Figure 20-9, Page 20-7)**.

VISUAL INSPECTION OF ARMATURE

Obvious defects can be seen by examining the armature. If an armature has frayed or charred insulation, broken wires or thrown solder, it is obvious without testing that it should be replaced. Faults 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

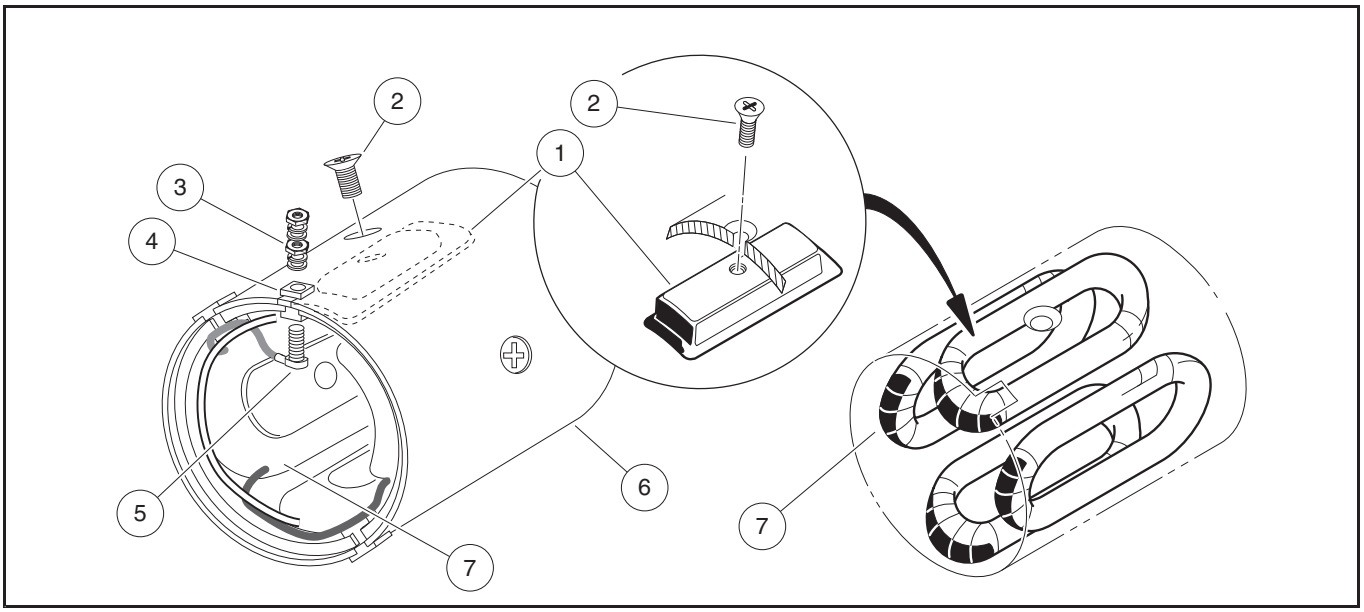

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Figure 20-9 Field Coil Assembly

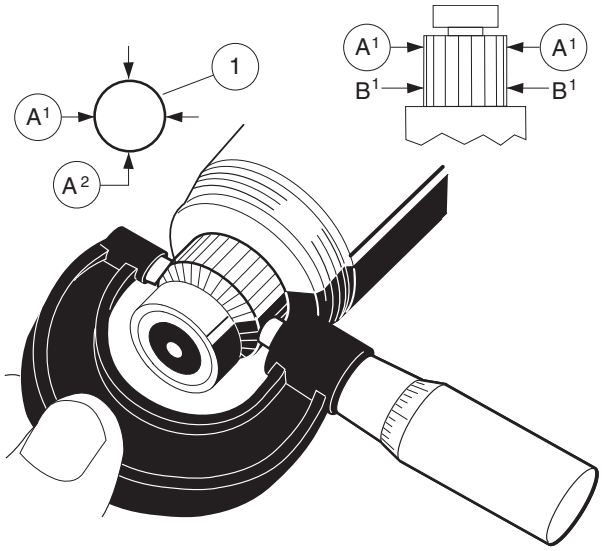
COMMUTATOR CLEANING AND INSPECTION

1. Clean the carbon dust, dirt and oil from the commutator. Visually inspect the commutator for worn, burned or glazed areas. Check for loose or raised commutator bars. Slight roughness of the commutator can be polished away with 400 grit (or finer) sandpaper. **See following CAUTION.**

⚠ CAUTION

- **Do not use emery cloth on 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.**

2. Using a micrometer, measure the outside diameter at two points along the commutator. If the commutator outside diameter is less than 1.535 inches (39 mm), replace the armature and bearings **(Figure 20-10, Page 20-8)**.



1. Measure each position in two places, 90 degrees apart

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Figure 20-10 Inspect Commutator

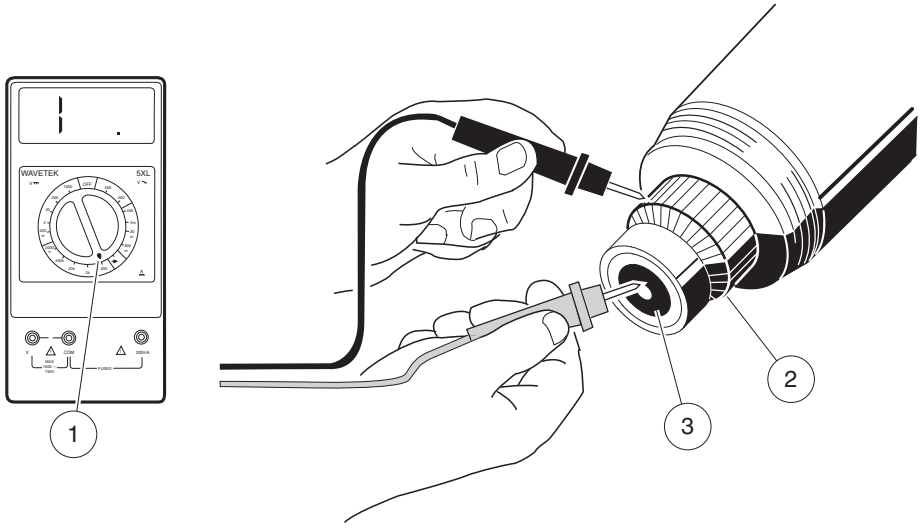
ARMATURE GROUND TEST

⚠ 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.*

Using a multimeter set on 200 ohms, 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 20-11, Page 20-9)**.



1. 200 Ohms Setting 2. Commutator 3. Armature Shaft

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Figure 20-11 Armature Ground Test

VISUAL INSPECTION OF FIELD COILS

If the insulation on the field coils appears blackened or charred, the serviceability of the coils is questionable. Burned or scorched coil insulation indicates the starter/generator has overheated due to overloads or grounded or shorted coil windings. Be sure the insulators are tight in the housing.

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)	1.60 in. (41 mm)
Concentric with armature shaft within	0.002 in. (0.051 mm)
Minimum commutator diameter for reslotting	1.65 in. (42 mm)
Undercut (Commutator must have a minimum diameter of 1.65 in (42 mm) for reslotting):	0.050 in. (1.3 mm)
Dielectric strength	500 VAC for one minute
Armature insulation resistance	0.2M (ohms) at 500 VDC
Starter field coil resistance	0.006 to 0.01 ohms
Generator field coil resistance	4.5 to 5.5 ohms

STARTER/GENERATOR ASSEMBLY

1. Slide the bearing retainer (32) onto the output end of the armature shaft (33) **(Figure 20-6, Page 20-5)**.

2. Press a new ball bearing (35) onto the output end of the armature **(Figure 20-6, Page 20-5)**. Press a new ball bearing onto the commutator end of the armature shaft. **See following CAUTION.**

⚠ CAUTION

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

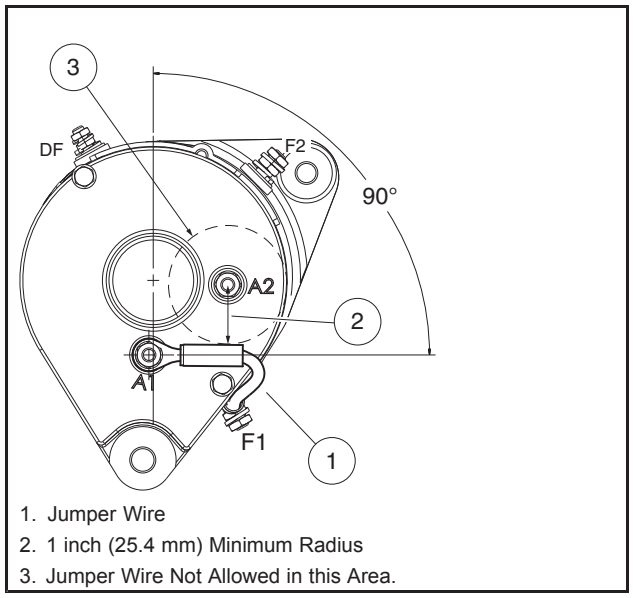
3. Install the drive end cover (36) onto the armature. Secure the bearing retainer ring (32) **(Figure 20-6, Page 20-5)**.
4. Slide the housing with field coils over the armature. Use the tapped mounting holes to align housing to the cover, rotate and orient as shown.

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

5. To prevent contact between the brushes and commutator as the commutator cover is installed, and possible damage to the brushes, 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 rest on the sides of the brushes and help prevent them from sliding towards the center of the cover **(Figure 20-5, Page 20-4)**.
6. Install the commutator end cover (23) onto the armature shaft. Use the tapped mounting holes to align housing to the cover, rotate and orient as shown. Install the two M6 x 180 mm bolts (20), and tighten to 60 in·lb (6.8 N·m) **(Figure 20-1, Page 20-2)**.
7. 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) in the openings in the commutator end cover (23) **(Figure 20-2, Page 20-2)**.
8. Install the belt pulley (39) onto the shaft, and install the lock washer (40) and M14 nut (41). Tighten the nut to 30 ft·lb (40.7 N·m) **(Figure 20-6, Page 20-5)**.
9. Install the A1 to F1 terminal jumper wire on the starter/generator.
   9.1. Loosely attach wire, flat washers, lock washers and nuts onto each terminal.
   9.2. Orient wire at A1 to be 1 inch (25.4 mm) away from A2 terminal as shown and tighten nut to 44 in·lb (5 N·m) **(Figure 20-12, Page 20-11)**. **See following NOTE.**

NOTE: *Secure bottom nut of terminal with wrench before tightening top nut.*

   9.3. Form wire against starter housing as shown and allow terminal at F1 to self-orient. Tighten nut to 44 in·lb (5 N·m). **See preceding NOTE.**



1. Jumper Wire
2. 1 inch (25.4 mm) Minimum Radius
3. Jumper Wire Not Allowed in this Area.

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Figure 20-12 A1 to F1 Terminal Jumper Wire Routing

STARTER/GENERATOR INSTALLATION

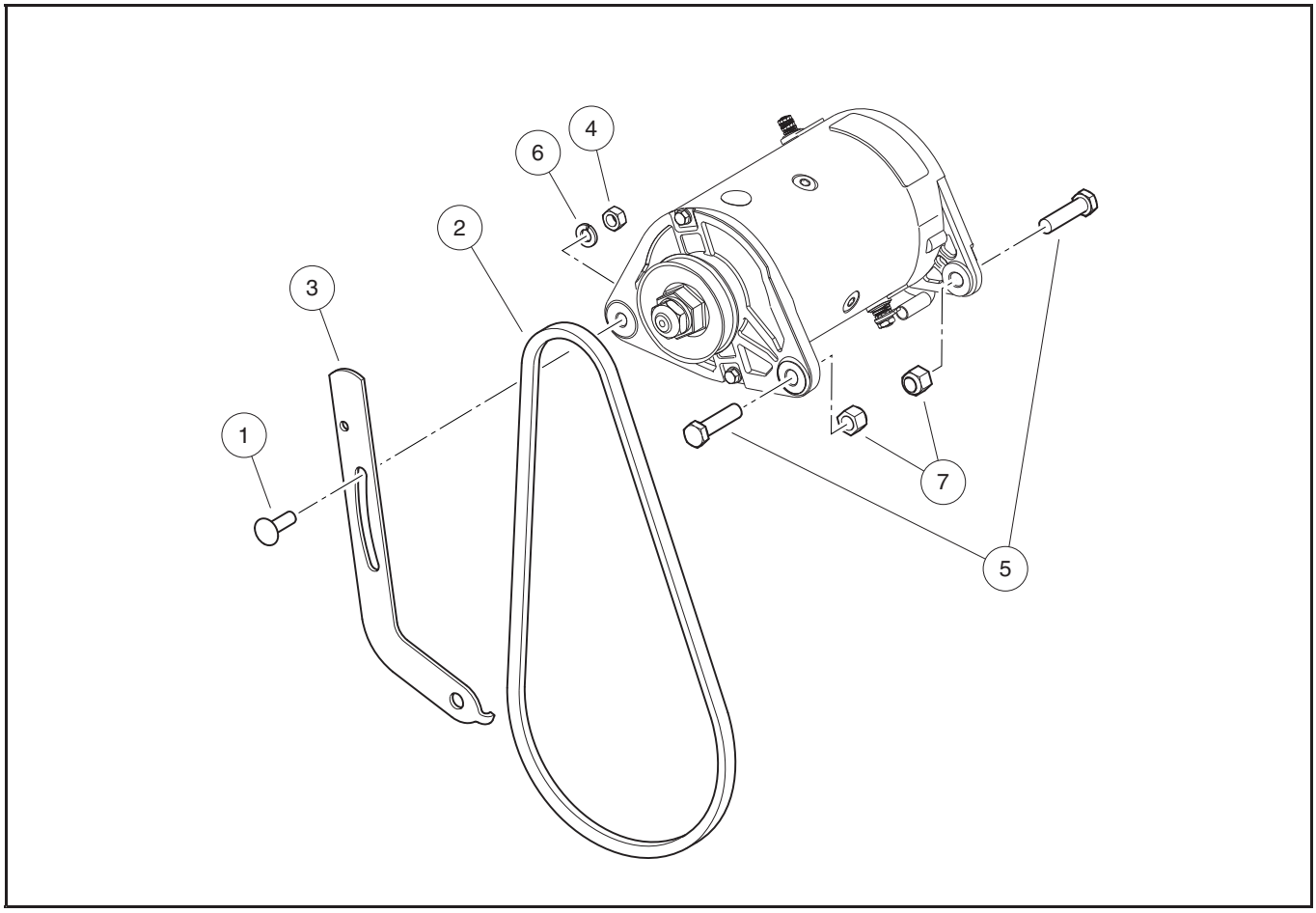

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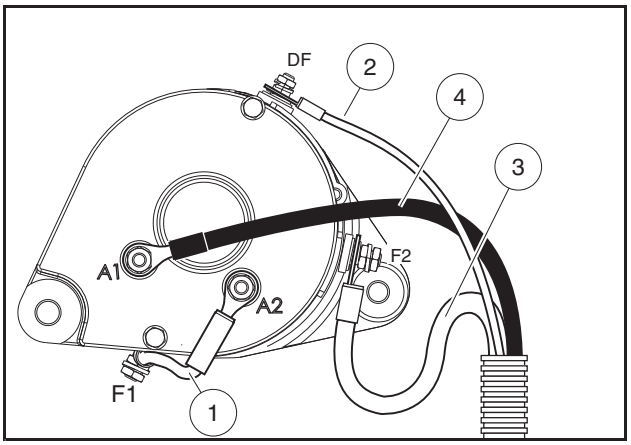
Figure 20-13 Starter/Generator Installation

1. Install the green wire (1) from the F1 terminal to the A2 terminal on the starter/generator **(Figure 20-14, Page 20-13)**. Install a flat washer, lock washer, and nut onto each terminal and tighten to 48 in·lb (5.4 N·m).
2. Position the starter/generator over the mounting bracket so that the bolts will go through the starter/generator before going through the bracket. Install pivot bolts (5) with the heads of the bolts facing as shown **(Figure 20-13, Page 20-12)**. Install lock nuts (7) finger-tight.
3. Install the adjustment bolt (1) through the adjusting bracket (3) and then through the starter/generator. Install a lock washer (6) and nut (4) onto adjustment bolt (1) finger-tight **(Figure 20-13, Page 20-12)**.
4. Install starter/generator belt (2) and adjust belt tension as instructed. **See Belt Tension Adjustment for EFI Engines on page 20-13.**
5. Connect the yellow wire (2) from the voltage regulator to the DF terminal on the starter/generator **(Figure 20-14, Page 20-13)**. Install a flat washer, lock washer, and nut onto the terminal. Tighten the nut to 31 in·lb (3.5 N·m).
6. Install the white wire (3) from the solenoid to the F2 terminal on the starter/generator **(Figure 20-14, Page 20-13)**. Install the black wire (4) from the frame to the A1 terminal on the starter/generator. Install a flat washer, lock washer and nut onto each terminal, and tighten the nut to 48 in·lb (5.4 N·m).
7. Connect battery and spark plug wire(s). **See Connecting the Battery-Gasoline Vehicles on page 1-5.**



3033

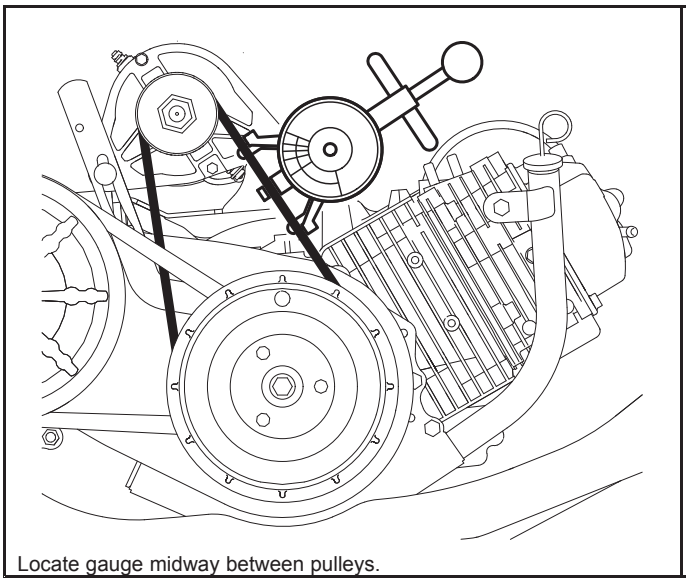
Figure 20-14 Starter/Generator Wiring

BELT TENSION ADJUSTMENT FOR EFI ENGINES

NOTE: *To prevent belt slipping while starting an EFI engine, follow procedure outlined below which is best performed by two people to expedite the process, but can be performed by a single individual if required.*

The amount a starter/generator belt is tensioned varies between a used and new belt.

EFI engines have higher starting torque demands that require consistent belt tension to prevent slipping. Belt tension should be checked periodically.



Locate gauge midway between pulleys.

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Figure 20-15 Belt Tension Gauge

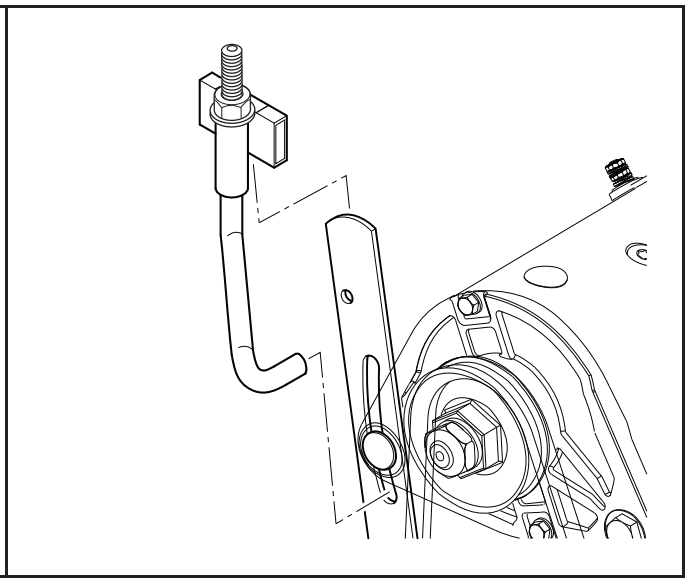

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Figure 20-16 Belt Tensioning Tool Installation

1. Disconnect battery and spark plug wire(s). **See Disconnecting the Battery-Gasoline Vehicles on page 1-5.**
2. Access engine compartment.
   – Remove seat and rear access panel (if equipped).
   – Raise cargo bed (if equipped).

– Use combination of above methods.

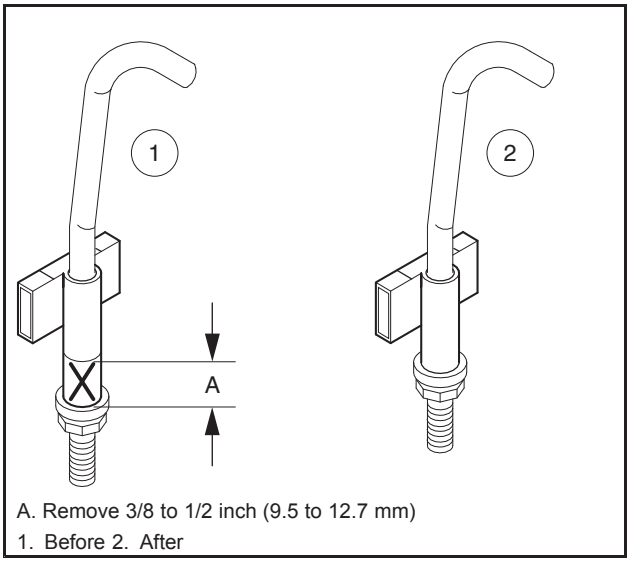
3. Mark a location on belt to repeat tension measurement each time. Use paint pen or permanent marker of light color.
4. **For Existing Belts Only:** Verify current belt tension using Universal Belt Tension Gauge (OTC® 6673 recommended) **(Figure 20-15, Page 20-13)**. Proper tension for a used starter/generator belt is 75 to 85 lbf (334 to 378 N).
   – If belt tension is within accepted range, no further action is needed. Connect battery and spark plug wire(s). **See Connecting the Battery-Gasoline Vehicles on page 1-5.**
   – If belt tension is not within accepted range, continue procedure. **See following NOTE.**

NOTE: *To expedite procedure for existing belt and avoid need for a pry bar, first install belt tension tool and then loosen starter/generator mounting hardware.*

5. Tighten starter/generator mounting hardware (4 and 7) finger-tight **(Figure 20-13, Page 20-12)**.
6. Install belt tension tool (P/N 102570401).
   6.1. Carefully insert pry bar between starter/generator and bracket.
   6.2. Carefully lift starter up until tension tool can be installed as shown over the slotted adjustment bracket **(Figure 20-16, Page 20-13)**. Note orientation of tension tool on the slotted adjustment bracket and how the threaded J-bolt is inserted into the slot under the starter/generator mounting ear.

NOTE: *In some cases, the threaded J-bolt of the belt tension tool does not have enough length to consistently fit under the starter/generator mounting ear. Fit can be greatly improved by modifying the tension tool using the following procedure.*
   – *Remove nut and J-bolt from bracket.*
   – *Grind or cut 3/8 to 1/2 inch (9.5 to 12.7 mm) from bracket as shown to increase the effective length of the J-bolt **(Figure 20-17, Page 20-14)**.*
   – *Install J-bolt and nut into bracket.*

   6.3. Remove pry bar.



A. Remove 3/8 to 1/2 inch (9.5 to 12.7 mm)
1. Before 2. After

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Figure 20-17 Belt Tension Tool Modification (If Necessary)

7. Tension belt.

7.1. Tighten nut on belt tension tool 1/2 turn and check belt tension with gauge **(Figure 20-15, Page 20-13)**.

NOTE: *To prevent errors in measurement caused by residual tension, ensure to loosen, then reapply, the Universal Belt Tension gauge between measurements.*

7.2. Continue to tighten in 1/2 turn increments until proper belt tension is achieved.
– Proper tension for a **used** starter/generator belt is 75 to 85 lbf (334 to 378 N).

– Proper tension for a **new** starter/generator belt is 120 to 130 lbf (534 to 578 N).

8. Seat the belt.
   8.1. Remove all other tools.
   8.2. The belt tension tool can be temporarily left in place.
   8.3. Connect battery only. DO NOT CONNECT SPARK PLUG WIRE. **See Connecting the Battery-Gasoline Vehicles on page 1-5. See following WARNING.**

⚠ WARNING

- **Remove pry bar before starting engine.**
- **Ensure clearance between F2 terminal and starter/generator bracket before starting engine.**

   8.4. Engage starter and crank engine a minimum of 5 seconds and a maximum of 15 seconds to fully seat the belt into pulleys and help eliminate any slack.
9. Repeat step 7.
10. Maintain tension and tighten adjustment nut (4) to 15 to 18 ft·lb (20 to 24.5 N·m). Tighten hex nuts (7) to 20 to 25 ft·lb (27 to 34 N·m) **(Figure 20-13, Page 20-12)**.
11. Remove belt tension tool.
12. Confirm proper belt tension with a final measurement.
13. Connect spark plug wire.

VOLTAGE REGULATOR

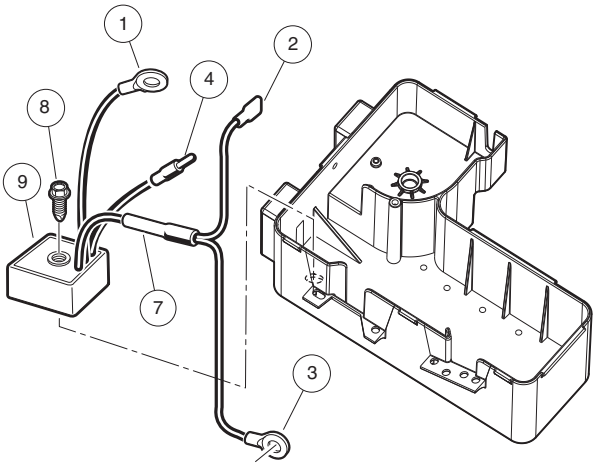
See General Warnings on page 1-1.

TESTING THE VOLTAGE REGULATOR

See Test Procedure 13 – Voltage Regulator on page 18-32.

VOLTAGE REGULATOR REMOVAL

1. Disconnect battery and spark plug wire(s). **See Disconnecting the Battery-Gasoline Vehicles on page 1-5.**
2. Remove the electrical component box cover.
3. 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 (NO) terminal of the kill limit switch and at the battery frame ground **(Figure 20-18, Page 20-16)**.
4. Remove the voltage regulator mounting screw (8) and remove the voltage regulator (9).



1. Red wire to solenoid. 2. To kill limit switch. 3. To frame ground. 4. To bullet connector.

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Figure 20-18 Voltage Regulator

VOLTAGE REGULATOR INSTALLATION

1. Position the voltage regulator (9) in the electrical component box and install the mounting screw (8) **(Figure 20-18, Page 20-16)**. Tighten screw to 23 in·lb (2.6 N·m).
2. Connect 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) at the battery frame ground **(Figure 20-18, Page 20-16)**.
3. Install snap-on electrical component box cover. Be sure to firmly press down all corners. Install screw and tighten to 18 in·lb (2 N·m).
4. Connect battery and spark plug wire(s). **See Connecting the Battery-Gasoline Vehicles on page 1-5.**
5. Place Forward/Reverse handle in NEUTRAL and place the neutral lockout switch in the MAINTENANCE position. Start the engine and check regulator for proper functioning as described in the voltage regulator test procedure. **See Voltage Regulator on page 18-32.**

ENGINE CONTROL UNIT (ECU)

CAUTION

- **The Engine Control Unit (ECU) and Throttle Body are to be purchased as one unit. They are matched pairs with matching serial numbers. Do not mix an ECU with another Throttle Body of a different serial number. Doing so violates emissions standards and warranty.**

The ECU is located in the engine compartment.

TESTING THE ENGINE CONTROL UNIT

See Test Procedure 4 – EFI System (ECU and Sensors) on page 18-22.

ENGINE CONTROL UNIT REMOVAL

1. Disconnect battery. **See Disconnecting the Battery-Gasoline Vehicles on page 1-5.**
2. Remove ECU mounting plate bolts.
3. Disconnect gray and black wire connectors.

ENGINE CONTROL UNIT INSTALLATION

⚠ WARNING

- **To prevent damage to the ECU, never mix the black and gray connectors that attach to it. The black connector is tethered to the ECU mounting plate to help prevent accidentally installing it in the gray port.**

1. Mount ECU to plate with bolts and tighten to 108 in·lb (12.2 N·m).
2. Install gray connector to the gray port on the ECU. **See preceding WARNING.**
3. Install black connector to the black port on the ECU.
4. Connect the battery. **See Connecting the Battery-Gasoline Vehicles on page 1-5.**

KEY SWITCH

See General Warnings on page 1-1.

TESTING THE KEY SWITCH

See Test Procedure 5 – Key Switch (Start Circuit) on page 18-25.

See Test Procedure 6 – Key Switch (Engine Kill Circuit) on page 18-26.

KEY SWITCH REMOVAL

1. Disconnect the batteries and spark plug.
2. Remove instrument panel. **See Instrument Panel Removal on page 4-10.**

NOTE: *Take care to prevent key switch terminals and wires from touching the metal frame around the dash.*

3. Disconnect the wires from the key switch. Do not allow wires to touch.
4. From the back of the instrument panel, push down on the retaining tabs surrounding the key switch (3) and remove the key switch cap (6). Using a 1-inch socket, hold the key switch (3) and remove the switch retaining nut (5) from the outside of the instrument panel **(Figure 20-19, Page 20-18)**.

KEY SWITCH INSTALLATION

1. Position the key switch (3) and key switch washer (1) in the instrument panel, then install and tighten the key switch nut (5) to 35 to 45 in·lb (4 to 5 N·m). Install key switch cap (6) into instrument panel, align the bent washer tab with the slot in the plastic **(Figure 20-19, Page 20-18)**.
2. Refer to the wiring diagram to connect the wires to the key switch terminals. **See Wiring Diagrams, Section 18, Page 18-8.**
3. Install instrument panel. **See Instrument Panel Installation on page 4-10.**
4. Connect the battery and spark plug.

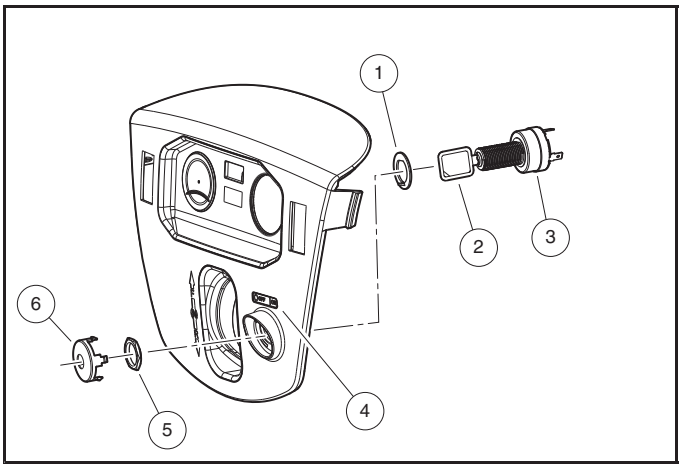

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Figure 20-19 Key Switch

MAINTENANCE/OPERATE SWITCH

TESTING THE MAINTENANCE/OPERATE SWITCH

See Test Procedure 9 – Maintenance/Operate Switch – Pedal-Start Vehicles on page 18-28.

MAINTENANCE/OPERATE SWITCH REMOVAL

1. Disconnect the battery and spark plug wire(s).
2. Using a 5/8 inch (16 mm) wrench, remove maintenance/operate boot/hex nut.
3. Remove maintenance/operate switch from bracket.
4. Disconnect the two spade terminals and remove switch.

MAINTENANCE/OPERATE SWITCH INSTALLATION

1. Connect the three spade terminals **(Figure 18-12, Page 18-28)**.
2. Make sure groove switch is aligned with tang on bracket and install switch. Tighten maintenance/operate switch boot/hex nut to 16 in·lb (1.8 N·m).
3. Connect the battery.

NEUTRAL LOCKOUT LIMIT SWITCH

See General Warnings on page 1-1.

TESTING THE NEUTRAL LOCKOUT LIMIT SWITCH

See Test Procedure 10 – Neutral Lockout Limit Switch – Pedal-Start Vehicles Only on page 18-29.

NEUTRAL LOCKOUT 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 battery and spark plug wire(s). **See Disconnecting the Battery-Gasoline Vehicles on page 1-5.**
3. Disconnect the 3-wire connector from the neutral lockout limit switch (1) located on the transaxle.
4. Remove two nuts (3) and washers (4) from the neutral lockout limit switch (1) and slide the limit switch off of the screws.

NEUTRAL LOCKOUT LIMIT SWITCH INSTALLATION

1. Install the limit switch (1) with washers (4) and nuts (3) and tighten to 5 in·lb (0.6 N·m). Move the Forward/Reverse handle to make sure the switch actuates. **See following CAUTION.**

⚠ CAUTION

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

2. Connect the 3-wire connector to the neutral lockout limit switch lead.
3. Connect battery and spark plug wire(s). **See Connecting the Battery-Gasoline Vehicles on page 1-5.**
4. Test drive the vehicle in both forward and reverse for proper operation.

SOLENOID

See General Warnings on page 1-1.

TESTING THE SOLENOID

See Test Procedure 8 – Solenoid on page 18-27.

SOLENOID REMOVAL

1. Disconnect battery and spark plug wire(s). **See Disconnecting the Battery-Gasoline Vehicles on page 1-5.**
2. Remove electrical component box cover **(Figure 20-20, Page 20-23)**.
3. Disconnect all the wires from the solenoid.
4. Remove the two screws securing the solenoid in place. Remove the solenoid.

SOLENOID INSTALLATION

1. Install the solenoid in the electrical component box **(Figure 20-20, Page 20-23)**. Use two screws to secure the solenoid to the box and tighten to 14 in·lb (1.6 N·m).
2. Connect all wires as indicated. **See Wiring Diagrams on page 18-8.**
   - 2.1. Connect the 4-gauge white wire from the starter/generator, the 18-gauge white wire from the fuel gauge/hour meter, and the 18-gauge red wire from the voltage regulator to the large post on the solenoid.
   - 2.2. Connect the 4-gauge red wire from the positive (+) battery terminal and the 10-gauge red wire and 16-gauge orange wire from the fuse blocks to the other large post on the solenoid.
   - 2.3. Connect the 18-gauge orange wire from accelerator pedal limit switch to small post on the solenoid.
   - 2.4. Connect the 18-gauge blue wire from the key 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 electrical box cover.
5. Connect battery and spark plug wire(s). **See Connecting the Battery-Gasoline Vehicles on page 1-5.**

FUSE

See General Warnings on page 1-1.

ATC-style fuses are located inside the electrical component box near the battery.

ATM-style fuses are located on the main wire harness in front of the engine.

TESTING THE FUSE

See Test Procedure 2 – Fuses on page 18-19.

FUSE REMOVAL

1. Disconnect battery. **See Disconnecting the Battery-Gasoline Vehicles on page 1-5.**
2. **ATC Fuse Only:** Remove electrical component box cover cover.

   ATM Fuse Only: Remove fuse holder cover.
3. 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. **ATC Fuse Only:** Install the snap-on electrical box cover by pressing down firmly on all corners and install the screw, tightening to 18 in·lb (2 N·m).

   ATM Fuse Only: Install the fuse holder cover.
3. Connect battery. **See Connecting the Battery-Gasoline Vehicles on page 1-5.**

KILL LIMIT SWITCH

See General Warnings on page 1-1.

TESTING THE KILL LIMIT SWITCH

See Test Procedure 14 – Kill Limit Switch – Pedal-Start Vehicles Only on page 18-33.

KILL LIMIT SWITCH REMOVAL

1. Disconnect battery and spark plug wire(s). **See Disconnecting the Battery-Gasoline Vehicles on page 1-5.**
2. Remove electrical component box cover (1) **(Figure 20-20, Page 20-23)**.
3. Remove the two nuts (9) and washers (10) securing the accelerator pedal limit switch (11). Do not disconnect the wires attached to accelerator pedal limit switch (11) **(Figure 20-20, Page 20-23)**.
4. Disconnect the wires from the kill limit switch (12).
5. Remove the kill limit switch (12).

KILL LIMIT SWITCH INSTALLATION

1. Connect the white/black wire to the common (COM) terminal and the blue wire to the normally open (NO) terminal of the kill limit switch (12) and place the switch on the mounting screws located in the electrical component box **(Figure 20-20, Page 20-23)**. Place the accelerator limit switch (11) on the mounting screws located in the electrical component box.
2. Secure the switches using two washers (10) and two nuts (9). 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. Press and release the accelerator pedal to make sure that both switches are being activated when the pedal is released.
4. Install electrical component box cover (1) **(Figure 20-20, Page 20-23)**. Be sure to press down firmly all corners. Install screw (20) and tighten to 18 in·lb (2 N·m).
5. Connect battery and spark plug wire(s). **See Connecting the Battery-Gasoline Vehicles on page 1-5.**

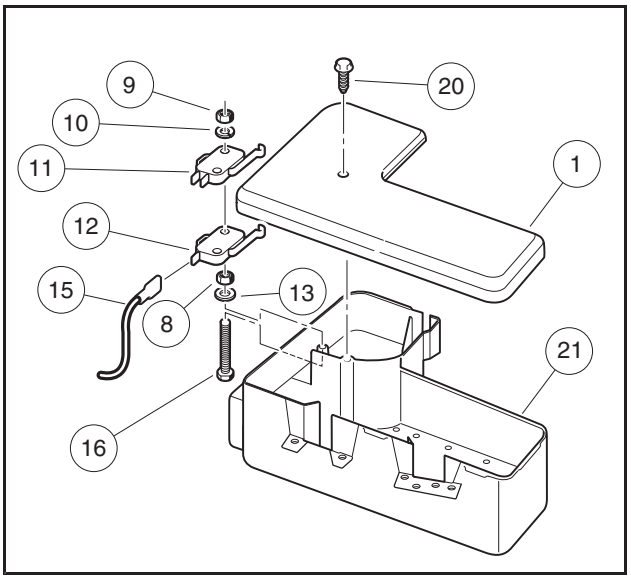

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Figure 20-20 Accelerator Starter and Kill Limit Switches

REVERSE WARNING BUZZER

See General Warnings on page 1-1.

TESTING THE REVERSE WARNING BUZZER

See Test Procedure 17 – Reverse Buzzer and Reverse Buzzer Limit Switch on page 18-36.

REVERSE WARNING BUZZER REMOVAL

1. Disconnect battery and spark plug wire(s). **See Disconnecting the Battery-Gasoline Vehicles on page 1-5.**
2. Remove the instrument panel. **See Instrument Panel Removal, Section 4, Page 4-10.**
3. Disconnect the wires from the reverse warning buzzer (2) **(Figure 20-21, Page 20-24)**. Do not allow wires to touch.
4. Remove the mounting screws (1) securing the buzzer (2) to the instrument panel.

REVERSE WARNING BUZZER INSTALLATION

1. Install the screws (1) through the buzzer (2) mounting tabs and tighten to 3.5 in·lb (0.40 N·m) **(Figure 20-21, Page 20-24)**.
2. Connect the black wire from the key switch to the negative (–) terminal on the buzzer.
3. Connect the orange/white wire from the wire harness to the positive (+) terminal on the buzzer.
4. Install instrument panel. **See Instrument Panel Installation, Section 4, Page 4-10.** Be sure that the key switch terminals cannot touch the frame and that the panel is properly seated and snapped in place.
5. Connect battery and spark plug wire(s). **See Connecting the Battery-Gasoline Vehicles on page 1-5.**

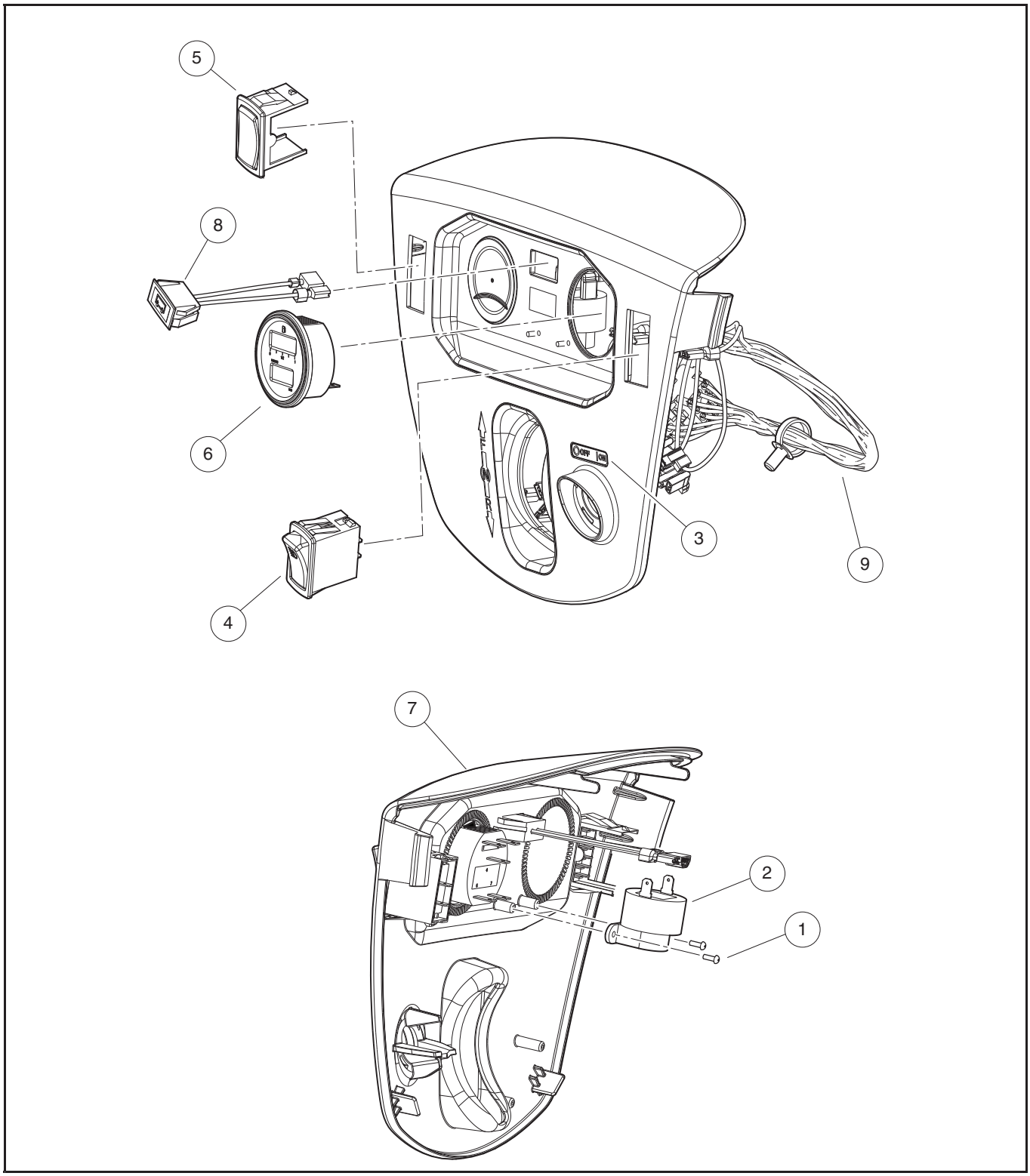

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Figure 20-21 Instrument Panel Switches

REVERSE BUZZER LIMIT SWITCH

See General Warnings on page 1-1.

TESTING THE REVERSE BUZZER LIMIT SWITCH

See Test Procedure 17 – Reverse Buzzer and Reverse Buzzer Limit Switch on page 18-36.

REVERSE BUZZER LIMIT SWITCH REMOVAL

1. Disconnect battery and spark plug wire(s). **See Disconnecting the Battery-Gasoline Vehicles on page 1-5.**
2. Cut the wire tie that retains the limit switch leads to the instrument panel harness.
3. Disconnect the wire connector from the reverse buzzer limit switch (3) located on the back of the Forward/Reverse shifter assembly **(Figure 20-22, Page 20-26)**.
4. Remove the nuts (4) and washers (5) from the reverse buzzer switch (3) and slide the reverse buzzer switch off of the screws (2).

REVERSE BUZZER LIMIT SWITCH INSTALLATION

1. Install the reverse buzzer switch (3) with two screws (2) **(Figure 20-22, Page 20-26)**, that attach the buzzer to the shifter assembly. Install washers (5) and tighten nuts (4) to 5 in·lb (0.6 N·m). **See following CAUTION.**

⚠ CAUTION

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

2. Place the Forward/Reverse handle in REVERSE and make sure that both switches actuate.
3. Connect the two wire connector to the reverse buzzer limit switch (3).
4. Connect battery and spark plug wire(s). **See Connecting the Battery-Gasoline Vehicles on page 1-5.**
5. Turn the key switch to the ON position. Shift the Forward/Reverse handle to the REVERSE position. The buzzer should sound.

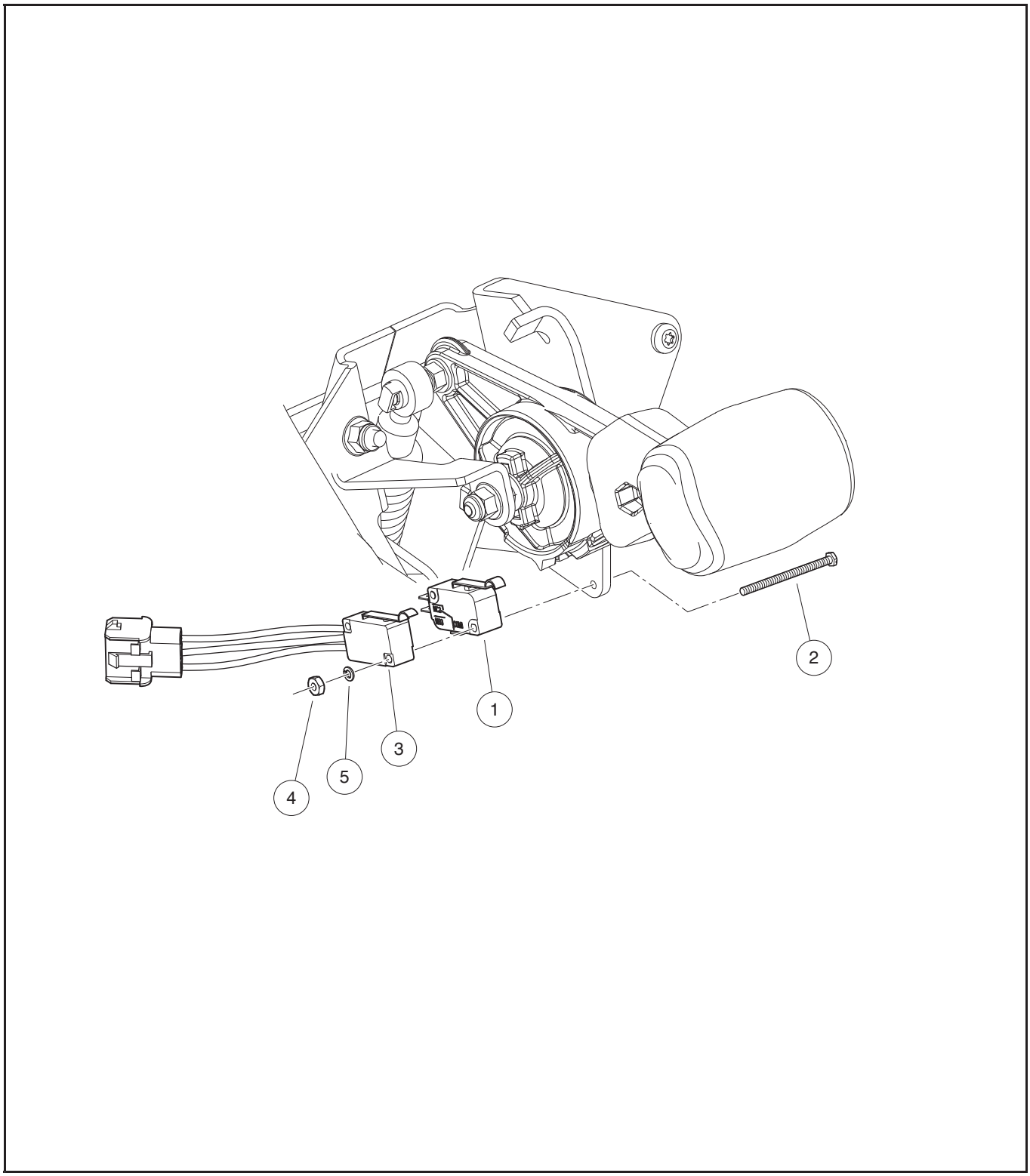

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Figure 20-22 Forward/Reverse Assembly Switches

LOW OIL WARNING LIGHT

See General Warnings on page 1-1.

TESTING THE LOW OIL WARNING LIGHT

See Test Procedure 18 – Low Oil Warning Light (LED) on page 18-36.

LOW OIL WARNING LIGHT REMOVAL

1. Disconnect battery and spark plug wire(s). **See Disconnecting the Battery-Gasoline Vehicles on page 1-5.**
2. Remove the instrument panel. **See Instrument Panel Removal, Section 4, Page 4-10.**
3. Disconnect the wires from the low oil warning light (6) **(Figure 20-21, Page 20-24)**. Do not allow wires to touch.
4. Press the retaining tabs and remove the low oil warning light from the instrument panel.

LOW OIL WARNING LIGHT INSTALLATION

1. Push a new unit into hole in the instrument panel until plastic tabs engage instrument panel **(Figure 20-21, Page 20-24)**.
2. Connect yellow wire to positive (+) terminal and black wire to negative (-) terminal of the low oil warning light.
3. Install the instrument panel. **See Instrument Panel Installation, Section 4, Page 4-10.** Be sure that key switch terminals cannot touch the frame and that panel is properly seated and snapped in place.
4. Connect battery and spark plug wire(s). **See Connecting the Battery-Gasoline Vehicles on page 1-5.**

FUEL GAUGE/HOUR METER

See General Warnings on page 1-1.

TESTING THE FUEL GAUGE/HOUR METER

See Test Procedure 23 – Fuel Gauge on page 18-40. Also see Test Procedure 24 – Hour Meter on page 18-41.

GENERAL INFORMATION

With the key switch in the OFF position, the fuel gauge field is blank; however, the hour meter field is always ON. When the key switch is turned to ON, the fuel gauge field activates. 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 (one tenth) hour, but does not record additional time unless the key switch is in the ON position and the engine is on. When recording, the hourglass icon on the left blinks.

FUEL GAUGE/HOUR METER REMOVAL

1. Disconnect battery and spark plug wire(s). **See Disconnecting the Battery-Gasoline Vehicles on page 1-5.**
2. Remove the instrument panel. **See Instrument Panel Removal, Section 4, Page 4-10.**
3. Disconnect the wires from the fuel gauge/hour meter (6). Do not allow wires to touch. **(Figure 20-21, Page 20-24)**.

4. Alternate pulling the lower and upper tabs away from the gauge housing to remove clip. Pull gauge/meter from the instrument panel.

FUEL GAUGE/HOUR METER INSTALLATION

1. Install a new fuel gauge/hour meter (6) into the hole in the instrument panel until the flange seats against the instrument panel **(Figure 20-21, Page 20-24)**.
2. Connect the wires to the fuel gauge/hour meter. **See Wiring Diagrams on page 18-8.**
3. Install the instrument panel. **See Instrument Panel Installation, Section 4, Page 4-10.** Be sure that key switch terminals cannot touch the frame and that panel is properly seated and snapped in place.
4. Connect battery and spark plug wire(s). **See Connecting the Battery-Gasoline Vehicles on page 1-5.**

FUEL LEVEL SENDING UNIT

See General Warnings on page 1-1.

The fuel level sending unit is an integral part of the fuel pump module and is not replaceable. Thoroughly test the fuel level sending unit before replacing the fuel pump module.

TESTING THE FUEL LEVEL SENDING UNIT

See Test Procedure 22 – Fuel Level Sending Unit on page 18-39.

OIL LEVEL SENSOR

See General Warnings on page 1-1.

TESTING THE OIL LEVEL SENSOR

See Test Procedure 19 – Oil Level Sensor on page 18-37.

OIL LEVEL SENSOR REMOVAL

See Oil Level Sensor Removal on page 22-12.

OIL LEVEL SENSOR INSTALLATION

See Oil Level Sensor Installation on page 22-12.

VOLTAGE LIMITER

See General Warnings on page 1-1.

TESTING THE VOLTAGE LIMITER

See Test Procedure 27 – Voltage Limiter on page 18-43.

VOLTAGE LIMITER REMOVAL

NOTE: *Battery will charge reducing the voltage going to accessories.*

1. Turn the key switch OFF and remove the key. Place the Forward/Reverse handle in the NEUTRAL position. Chock the wheels.
2. Disconnect battery and spark plug wire(s). **See Disconnecting the Battery-Gasoline Vehicles on page 1-5.**
3. Remove the cowl. **See Cowl Removal, Section 4, Page 4-5.**
4. The voltage limiter is located on the driver side cowl frame.
5. Disconnect wires from the voltage limiter (1). Do not allow wires to touch **(Figure 20-23, Page 20-29)**.
6. Remove the mounting hardware (2) from the voltage limiter and remove from vehicle.

VOLTAGE LIMITER INSTALLATION

1. Mount the voltage limiter to the driver side frame using the mounting hardware and tighten to 25 in·lb (2.8 N·m) **(Figure 20-23, Page 20-29)**.
2. Connect the black wire from harness to the black wire from limiter.
3. Connect the green wire from the harness to the green wire from the limiter.
4. Install the cowl. **See Cowl Installation, Section 4, Page 4-5.**
5. Connect battery and spark plug wire(s). **See Connecting the Battery-Gasoline Vehicles on page 1-5.**

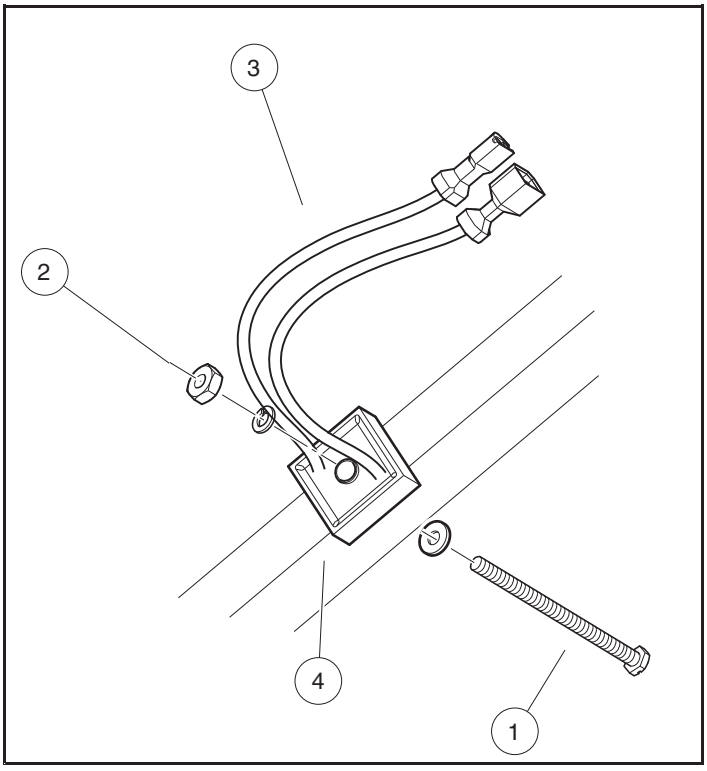

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Figure 20-23 Voltage Limiter

HEADLIGHT SWITCH

See General Warnings on page 1-1.

TESTING THE LIGHT SWITCH

See Test Procedure 25 – Light Switch on page 18-42.

HEADLIGHT SWITCH REMOVAL

1. Remove the instrument panel. **See Instrument Panel Removal, Section 4, Page 4-10.**
2. Disconnect the wires from the light switch (4 and 9) **(Figure 20-21, Page 20-24)**.
3. Collapse the tabs and un-snap the light switch(4) from instrument panel.

HEADLIGHT SWITCH INSTALLATION

1. Connect the wires to the light switch (4 and 9) **(Figure 20-21, Page 20-24)**.
2. Reinsert light switch (4) to instrument panel.
3. Install the instrument panel. **See Instrument Panel Installation on page 4-10.** Be sure that key switch terminals cannot touch the frame and the instrument panel is properly seated and snapped in place.
4. Connect battery and spark plug wire(s). **See Connecting the Battery-Gasoline Vehicles on page 1-5.**

HEADLIGHTS

See General Warnings on page 1-1.

TESTING THE HEADLIGHT SOCKET

See Test Procedure 26 – Voltage at Headlight Socket on page 18-42.

HEADLIGHT BEZEL REMOVAL

1. Disconnect the batteries and discharge the controller. Disconnecting the Batteries – Electric Vehicles on page 1-4
2. Remove the cowl. **See Cowl Removal, Section 4, Page 4-5.**
3. Remove the front fenders. **See Front Bumper and Side Fender Removal, Section 4, Page 4-9.**
4. Loosen and remove the M6 self-tapping bolts (3) that attach the bezel (1) to the vehicle frame. **(Figure 20-24, Page 20-32)**.

HEADLIGHT BEZEL INSTALLATION

1. Install bezel (1) to vehicle frame.
2. Install the three M6 self-tapping bolts (3) that attach the bezel onto frame. Tighten to 44 in·lb (5 N·m).
3. Install the front fenders. **See Front Bumper and Side Fender Installation, Section 4, Page 4-9.**
4. Install the cowl. **See Cowl Installation, Section 4, Page 4-5.**
5. Connect the batteries. **See Connecting the Batteries – Electric Vehicles, Section 1, Page 1-4.**

HEADLIGHT BULB REMOVAL (HALOGEN)

1. Disconnect the batteries. **See Disconnecting the Batteries – Electric Vehicles, Section 1, Page 1-4.**
2. Remove cowl. **See Cowl Removal, Section 4, Page 4-5.**
3. Remove front fenders. **See Front Bumper and Side Fender Removal, Section 4, Page 4-9.**
4. Rotate the bulb (4) (but do not touch) in a 90–degree angle and pull out of lens assembly (5). **(Figure 20-24, Page 20-32)**.

HEADLIGHT BULB INSTALLATION (HALOGEN)

1. Install bulb (4) (but do not touch) into socket, install into lens assembly (5). **(Figure 20-24, Page 20-32)**.
2. Connect the batteries. **See Connecting the Batteries – Electric Vehicles on page 1-4.**
3. Install front fenders. **See Front Bumper and Side Fender Installation, Section 4, Page 4-9.**
4. Install cowl. **See Cowl Installation, Section 4, Page 4-5.**

HEADLIGHT BULB REMOVAL (LED)

1. Disconnect the batteries.
2. Remove cowl. **See Cowl Removal, Section 4, Page 4-5.**
3. Remove front fenders. **See Front Bumper and Side Fender Removal, Section 4, Page 4-9.**
4. Remove the three screws (2) and pull bulb assembly (6) out of bezel (1). **(Figure 20-24, Page 20-32)**

HEADLIGHT BULB INSTALLATION (LED)

1. Install bulb assembly (6) into bezel (1) and secure with screws (2). **(Figure 20-24, Page 20-32)**
2. Connect the batteries. **See Connecting the Batteries – Electric Vehicles on page 1-4.**
3. Install front fenders. **See Front Bumper and Side Fender Installation, Section 4, Page 4-9.**
4. Install cowl. **See Cowl Installation, Section 4, Page 4-5.**

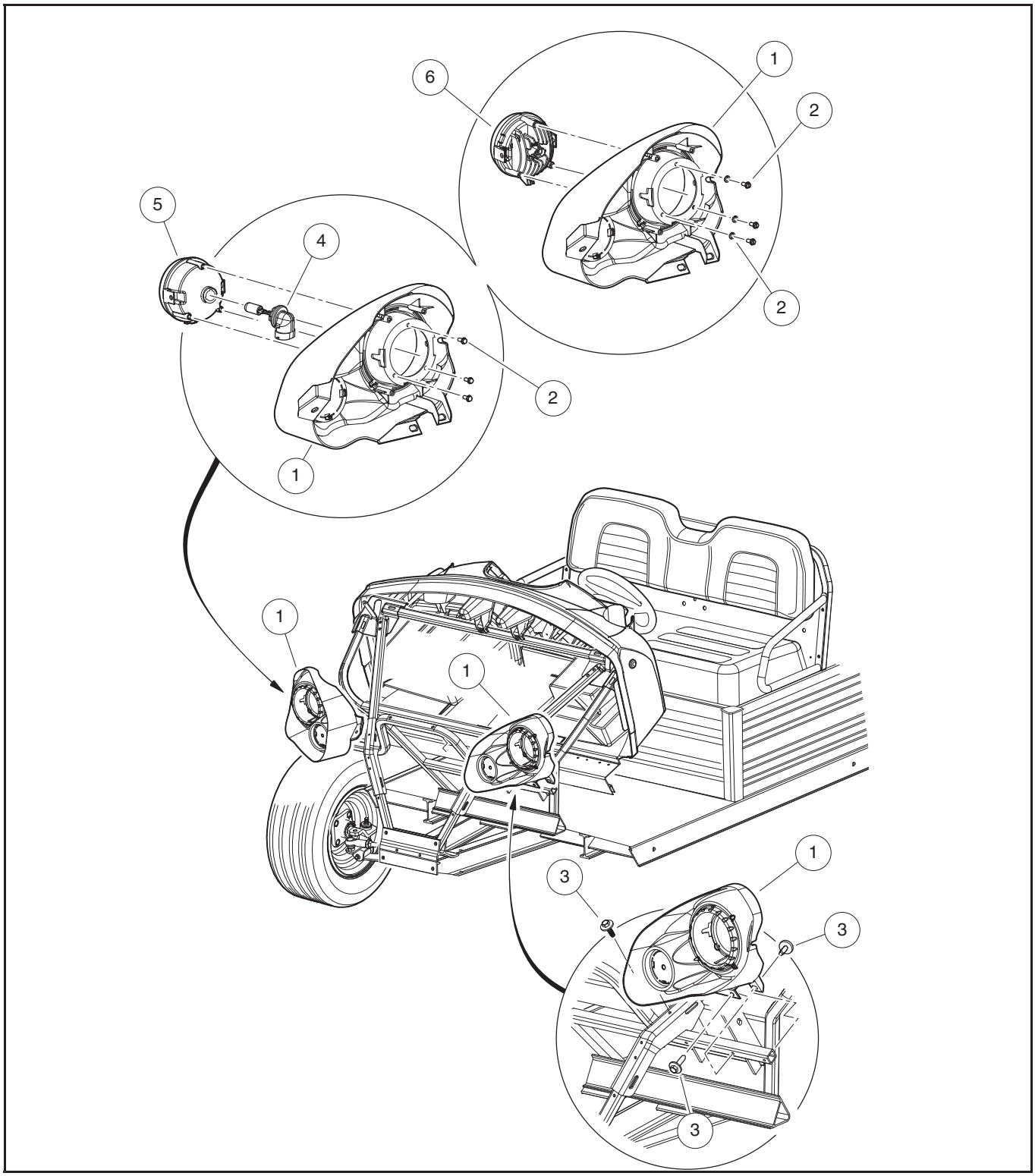

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Figure 20-24 Headlight Assembly

BATTERY

See General Warnings on page 1-1.

⚠ DANGER

- **Due to the danger of an exploding battery, wear a full face shield and rubber gloves when working on or near batteries.**
- **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 and WARNING statements.

Gasoline vehicles are equipped with 12-volt top-post battery. 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 26, top-post battery, with a 525 cold cranking amp rating and a reserve capacity of at least 85 minutes is recommended. The group 26 classification indicates battery size: 8 inches W x 6-3/4 inches D x 7 inches H (20.3 cm W x 17.2 cm D x 17.8 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 – Battery on page 18-17.

See Test Procedure 20 – Battery Test (Under Load) on page 18-37.

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 41 in·lb (4.3 N·m), coat terminals with Battery Terminal Protector Spray (CC P/N 1014305) to prevent future corrosion. **See preceding WARNINGS and following CAUTION.**

⚠ CAUTION

- **If battery wire terminals are damaged or corroded, replace or clean them as necessary. Failure to do so may cause them to overheat during operation and could result in a fire, property damage, or personal injury.**

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 20-34.**
3. Check battery periodically to see that it is in a full state of charge. **See Charging the Battery on page 20-35.**
4. Keep battery hold-down clamp tight. **See Vibration Damage on page 20-34.**

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 20-36.**

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.

BATTERY REMOVAL

See General Warnings on page 1-1. Also see DANGER at beginning of Battery topic.

1. Turn the key switch OFF and remove the key. Place the Forward/Reverse handle in the NEUTRAL position. Chock the wheels.
2. Disconnect battery and spark plug wire(s). **See Disconnecting the Battery-Gasoline Vehicles on page 1-5.**
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 Warnings on page 1-1. Also see DANGER at beginning of Battery topic.

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 positive (+) charger cable to the positive (+) battery post.
3. Attach the negative (–) charger cable to the negative (–) battery post.
4. The battery may be charged with a slow charge (3 to 10 amps) or a fast charge (20 to 30 amps). Charge until the battery voltage is greater than 12.4 volts. **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 Warnings on page 1-1. Also see DANGER at beginning of Battery topic.

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 41 in·lb (4.3 N·m). A loose battery clamp may allow the battery to become damaged from vibration or jarring.
3. Connect battery and spark plug wire(s). **See Connecting the Battery-Gasoline Vehicles on page 1-5.**

BATTERY STORAGE

See General Warnings on page 1-1. Also see DANGER at beginning of Battery topic.

1. Keep the battery clean and free of corrosion. **See Preventive Maintenance on page 20-33.**
2. The battery cables should be disconnected from the battery so the battery can be connected to the charger. The battery can be left in the vehicle. Disconnect the negative (–) cable first.
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 voltage drops below 12.4 volts, 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 Warnings on page 1-1. Also see DANGER at beginning of Battery topic.

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

NOTE: *Verify that all cables (fuel tank, engine, battery, starter/generator and voltage regulator) are connected securely.*

TESTING THE GROUND CABLES

See Test Procedure 3 – Ground Cables on page 18-21.

SECTION 21 — ELECTRICAL COMPONENTS: KEY-START GAS VEHICLE

⚠ DANGER

- **See General Warnings on page 1-1.**

⚠ WARNING

- **See General Warnings on page 1-1.**

GENERAL INFORMATION

⚠ WARNING

- **To prevent damage to the ECU, never mix the black and gray connectors that attach to it. The black connector is tethered to the ECU mounting plate to help prevent accidentally installing it in the gray port.**

This section covers only the components that make the key-start gasoline vehicle different from the pedal-start gasoline vehicle. Use this information in addition to the **Electrical Components: Pedal-Start Gas Vehicle** section. Most components are shared between the two systems except for the following items unique to the key-start vehicle:

- **Key Switch:** Only way to start and shut off the engine.
- **Accelerator Pedal:** Is not linked to the accelerator pedal limit switch and kill limit switch in the electrical component box because these switches are omitted for key-start applications.
- **Charging Diode:** Is connected to the solenoid in the electrical component box.
- **Forward/Reverse Shifter:** Is not linked to the neutral lockout limit switch on the transaxle because this switch is omitted for key-start applications.

KEY SWITCH

See General Warnings on page 1-1.

TESTING THE KEY SWITCH

See Test Procedure 2 – Key Switch (ON Position) on page 19-7.

See Test Procedure 3 – Key Switch (START Position) on page 19-7.

See Test Procedure 6 – Key Switch (Engine Kill Circuit) on page 18-26.

KEY SWITCH REMOVAL

1. Disconnect the batteries and spark plug.
2. Remove instrument panel. **See Instrument Panel Removal on page 4-10.**

NOTE: *Take care to prevent key switch terminals and wires from touching the metal frame around the dash.*

3. Disconnect the wires from the key switch. Do not allow wires to touch.

4. From the back of the instrument panel, push down on the retaining tabs surrounding the key switch (3) and remove the key switch cap (6). Using a 1-inch socket, hold the key switch (3) and remove the switch retaining nut (5) from the outside of the instrument panel **(Figure 21-1, Page 21-2)**.

KEY SWITCH INSTALLATION

1. Position the key switch (3) and key switch washer (1) in the instrument panel, then install and tighten the key switch nut (5) to 35 to 45 in·lb (4 to 5 N·m). Install key switch cap (6) into instrument panel, align the bent washer tab with the slot in the plastic.**(Figure 21-1, Page 21-2)**.
2. Refer to the wiring diagram to connect the wires to the key switch terminals. **See Wiring Diagrams, Section 19, Page 19-2.**
3. Install instrument panel. **See Instrument Panel Installation on page 4-10.**
4. Connect the battery and spark plug.

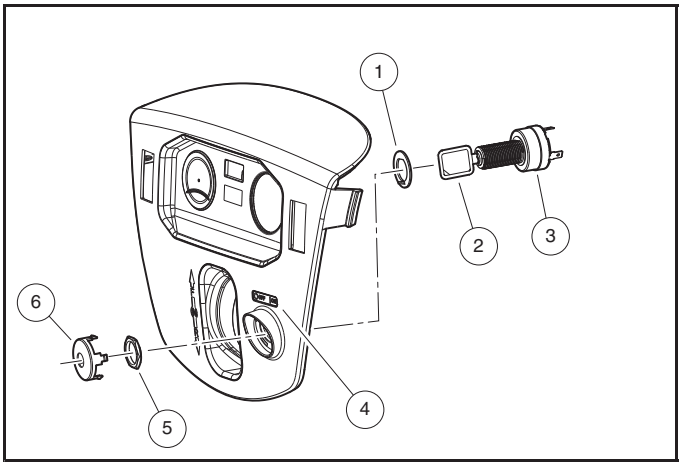

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Figure 21-1 Key Switch

MAINTENANCE/OPERATE SWITCH

TESTING THE MAINTENANCE/OPERATE SWITCH

See Test Procedure 5 – Maintenance/Operate Switch – Key-Start Vehicles on page 19-9.

MAINTENANCE/ OPERATE SWITCH REMOVAL

1. Disconnect the battery and spark plug wire(s).
2. Using a 5/8 inch (16 mm) wrench, remove maintenance/operation boot/hex nut.
3. Remove maintenance/operation switch from bracket.
4. Disconnect the two spade terminals and remove switch.

MAINTENANCE/OPERATE SWITCH INSTALLATION

1. Connect the two spade terminals **(Figure 19-7, Page 19-9)**.
2. Make sure groove in switch is aligned with tang on bracket and install switch. Tighten maintenance/operation switch boot/hex nut (6) to 16 in·lb (1.8 N·m).
3. Connect the battery.

SOLENOID

See General Warnings on page 1-1.

TESTING THE SOLENOID

See Test Procedure 8 – Solenoid on page 18-27.

SOLENOID REMOVAL

1. Disconnect battery and spark plug wire(s). **See Disconnecting the Battery-Gasoline Vehicles on page 1-5.**
2. Remove electrical component box cover **(Figure 20-20, Page 20-23)**.
3. Disconnect all the wires from the solenoid.
4. Remove the two screws securing the solenoid in place. Remove the solenoid.

SOLENOID INSTALLATION

1. Install the solenoid in the electrical component box. Use two screws to secure the solenoid to the box and tighten to 14 in·lb (1.6 N·m).
2. Connect all wires as indicated. **See Wiring Diagrams on page 19-2.**
   2.1. Connect the 4-gauge white wire from the starter/generator, the 18-gauge white wire from the fuel gauge/hour meter, the 18-gauge red wire from the voltage regulator, and the 10-gauge white wire from the charging diode to the large post on the solenoid.
   2.2. Connect the 4-gauge red wire from the positive (+) battery terminal, the 10-gauge red wire and 16-gauge orange wire from the fuse blocks, and the 10-gauge red wire from the charging diode to the other large post on the solenoid.

2.3. Connect the 18-gauge orange wire from accelerator pedal limit switch to small post on the solenoid.

2.4. Connect the 18-gauge blue wire from the key 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 electrical box cover.
5. Connect battery and spark plug wire(s). **See Connecting the Battery-Gasoline Vehicles on page 1-5.**

CHARGING DIODE

See General Warnings on page 1-1.

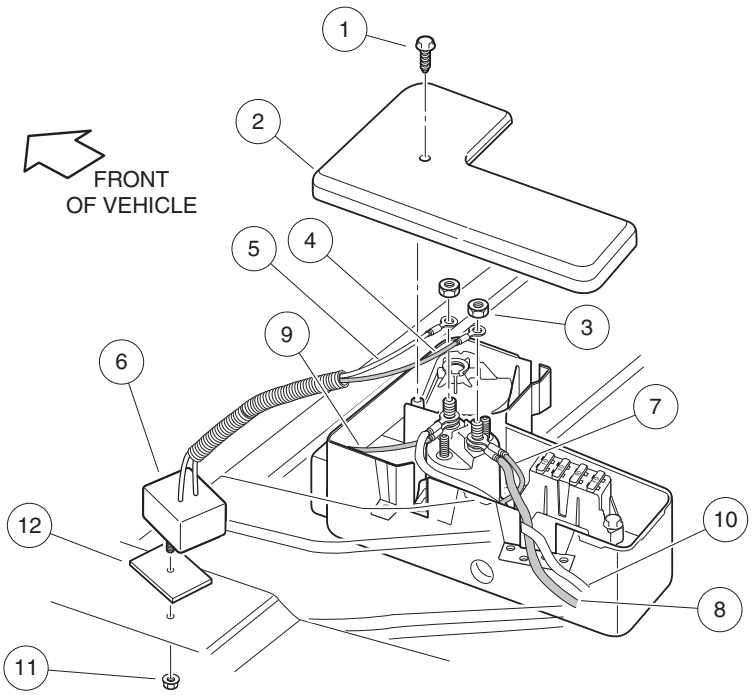
TESTING THE CHARGING DIODE

See Test Procedure 6 – Charging Diode (Generator Circuit) – Key-Start Vehicles Only on page 19-10.

CHARGING 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 battery and spark plug wire(s). **See Disconnecting the Battery-Gasoline Vehicles on page 1-5.**
3. Remove the screw (1) and electrical component box cover (2) **(Figure 21-2, Page 21-5)**.
4. Remove the nuts (3) from the two large solenoid posts and disconnect the charging diode wires (4 and 5) from the solenoid.

   4.1. Observe color orientation of the wires with the terminal locations on the solenoid. The 10-gauge red wire (4) from the charging diode (6) should be attached to the same terminal as the red wire (7) from the fuse block and the red wire (8) from the battery. The 10-gauge white wire (5) should be attached to the other large solenoid post, along with the red wire (9) from the voltage regulator and the white wire (10) from the starter/generator.
5. Remove the nut (11), the charging diode (6), and thermal transfer pad (12) from the chassis. Discard transfer pad (12).



Some wires omitted for clarity.

2978

Figure 21-2 Charging Diode

CHARGING DIODE INSTALLATION

1. Thoroughly clean and dry the area of the chassis where the new charging diode (6) is to be attached.
2. Peel the protective film from both sides of the new thermal pad (12) **(Figure 21-2, Page 21-5)**. **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 charging diode (6) using the new thermal transfer pad (12) and mounting nut (11). Tighten nut (11) to 25 in·lb (2.8 N·m) **(Figure 21-2, Page 21-5)**.
4. Route and connect the red (4) and white (5) diode wires to the solenoid posts in the electrical component box. **See following WARNING.**

⚠ WARNING

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

4.1. Connect the 10-gauge red wire (4) from the charging diode to the solenoid post with the fuse block and battery red wires (7 and 8). Tighten locknut (3) to 55 in·lb (6.2 N·m) **(Figure 21-2, Page 21-5)**.

4.2. Connect the 10-gauge white wire (5) to the other large solenoid post, along with the red wire (9) from the voltage regulator and white wire (10) from the starter/generator. Tighten nut (3) to 55 in·lb (6.2 N·m).

5. Replace the electrical component box cover (2) and screw (1) and tighten the screw to 18 in·lb (2.0 N·m).
6. Connect battery and spark plug wire(s). **See Connecting the Battery-Gasoline Vehicles on page 1-5.**

SECTION 22 — ENGINE (SUBARU EX40)

⚠ DANGER

- **See General Warnings on page 1-1.**

⚠ WARNING

- **See General Warnings on page 1-1.**

GENERAL INFORMATION

See General Warnings on page 1-1.

This vehicle is powered by a Subaru EX40, high-compression, chain driven, overhead cam engine. The engine offers a heavy-duty construction featuring cast iron cylinder liner for longer life, dual ball bearing crankshaft support, low oil level sensor and heavy-duty air cleaner system, to name a few characteristics. **See following NOTE.**

NOTE: *Engine rotation is counterclockwise as viewed from the clutch side of the engine.*

This section contains information for removing and replacing the engine. For complete instruction on engine disassembly, repair, rebuilding, and reassembly, see your authorized dealer.

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. Compression should be:

At a normal cranking speed of 1050 to 1100 RPM, the compression should typically be approximately 167 psig (1151 kPa). This value could vary slightly depending on wear of components affecting compression.

See the Subaru EX40 Engine Repair and Rebuild Manual for complete teardown, rebuild and repair information.

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 counterclockwise as viewed from the clutch side of the engine.

TORQUE SPECIFICATIONS

ITEM	SIZE	TORQUE	
Flywheel retaining nut	M18	80 ft·lb (110 N·m)	
Crankcase cover to block bolts	M8	250 in·lb (28.3 N·m)	
Cylinder head bolts	M10	**1st Step** **New head and bolts:** 159 in·lb (18 N·m)	**2nd Step** **New head and bolts:** 336 in·lb (38 N·m)
		Used head and bolts: 159 in·lb (18 N·m)	**Used head and bolts:** 265 in·lb (30 N·m)
	M8	159 in·lb (18 N·m)	2nd step not needed
Connecting rod bolts	M8	221 in·lb (25 N·m)	
Spark plug	13/16 in. (21 mm) plug socket	**New:** 120 in·lb (13.5 N·m)	
		Re-tightening: 216 in·lb (24.5 N·m)	
Exhaust flange nuts	M8	177 in·lb (20 N·m)	
Ignition coil	M6	71 in·lb (8 N·m)	
Oil sensor	M6	80 in·lb (9 N·m)	
Oil drain plug	M14	18 ft·lb (24.4 N·m)	
Fan housing screws	M6	90 in·lb (10 N·m)	
Fan cover 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	VALUES
Spark plug gap	0.024 to 0.028 in. (0.6 to 0.7 mm)
Valve clearance – Intake & Exhaust (cold)	0.0047 to 0.0059 in. (0.12 to 0.15 mm)
Ignition coil air gap	0.012 to 0.020 in. (0.3 to 0.5 mm)
Compression pressure:	167 psig (1151 kPa) Allowable Lower Pressure: 120 psig (827 kPa)

ENGINE OIL – GASOLINE VEHICLE

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

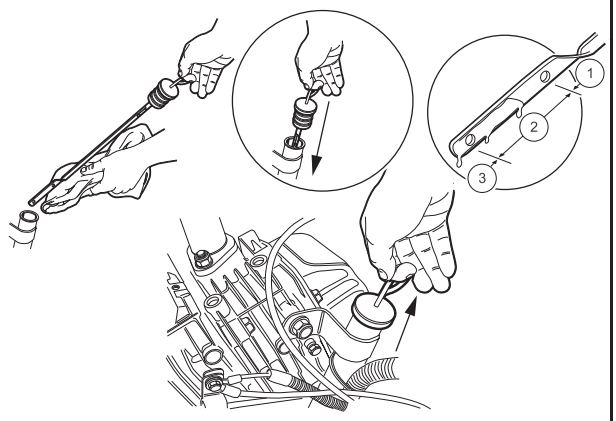
1. Remove the oil level dipstick from the oil filler tube, and wipe oil off dipstick **(Figure 22-1)**. **See following CAUTION.**

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. Insert the 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.*



1. Full level 2. Safe level 3. Low level

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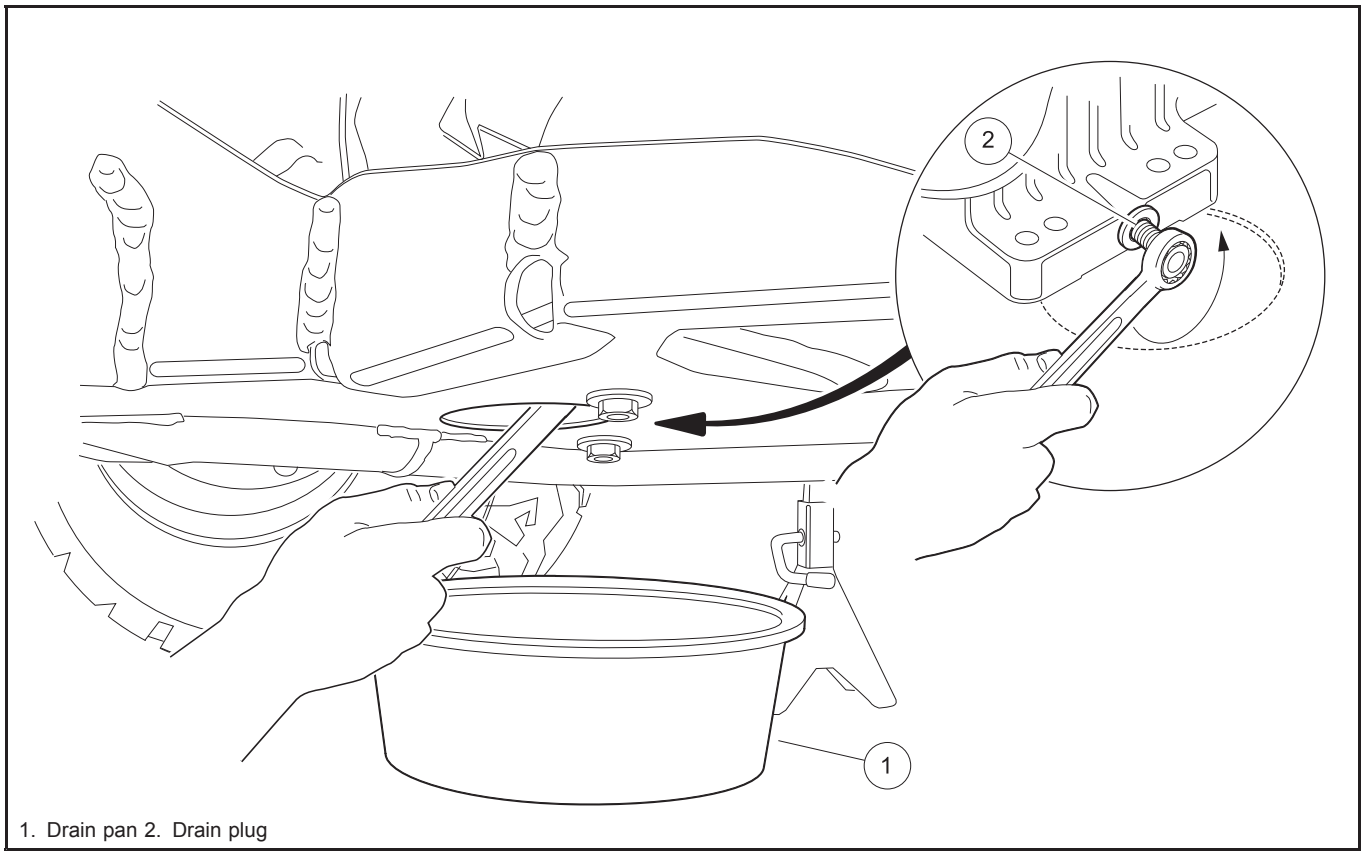
Figure 22-1 Engine Oil Level Check

Engine Oil Change

Engine oil should be changed after the first 100 hours of operation. After that, it 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 and place the Maintenance/Operate switch in the MAINTENANCE position.
3. Disconnect battery and spark plug wire. **See Disconnecting the Battery-Gasoline Vehicles on page 1-5.**
4. Position a pan designed for oil changes under the drain plug (1) **(Figure 22-2)**.



1. Drain pan 2. Drain plug

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Figure 22-2 Engine Oil Drain Plug and Pan

5. Use a 14 mm socket or 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 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 wrench and replace the oil drain plug, turning it clockwise, and tighten to 18 ft·lb (24.4 N·m).
8. 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. The engine requires 40.5 fl-oz (1.2 L) of oil per change. 10W-30 or 5W-30 grade SE or higher is recommended. Refer to oil viscosity guidelines for selection of oil grade **(Figure 22-3)**. Replace the dipstick.

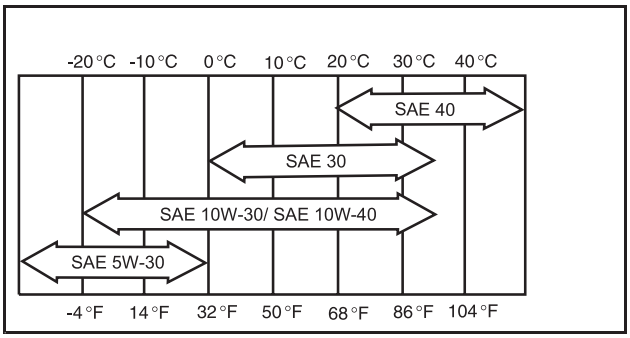

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Figure 22-3 Oil Viscosity Chart

9. Connect battery and spark plug wire. **See Connecting the Battery-Gasoline Vehicles on page 1-5.**
10. With the Forward/Reverse handle in the NEUTRAL position and the Maintenance/Operate switch in the OPERATE position, start and run the engine for a few minutes. Observe the drain plug from under the vehicle and watch for oil leaks. If leaks appear, begin with step 1 and repeat the appropriate steps as needed to correct the problem.
11. Remove the dip stick and check the engine oil as a final step. Replace the dip stick.

SPARK PLUG

Spark plugs are selected to suit specific engine design and vehicle operating conditions. The spark plug (CC P/N 47539956001) is designed to give maximum life and efficient combustion of fuel. The spark gap should be set from 0.024 to 0.028 in. (0.6 to 0.7 mm).

Spark Plug Removal

⚠ 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 in. (21 mm), deep well socket with ratchet or spark plug wrench to loosen the plug.

Spark Plug Cleaning, Inspection and Repair

Examine the plug **(Figure 22-4, Page 22-6)**. 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.**

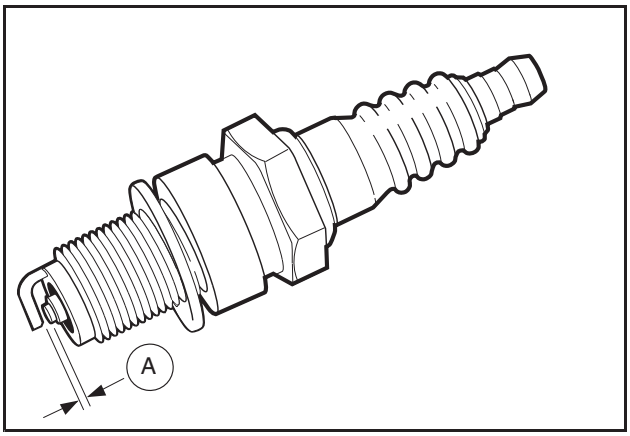

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Figure 22-4 Spark Plug

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-in. (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) from 0.024 to 0.028 in. (0.6 to 0.7 mm) **(Figure 22-4, Page 22-6)**.

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.

Install the spark plug by threading it in until finger tight, then tighten the spark plug to the following torque:

- **New:** 120 in·lb (13.5 N·m).
- **Re-tightening:** 216 in·lb (24.5 N·m).

BREATHER

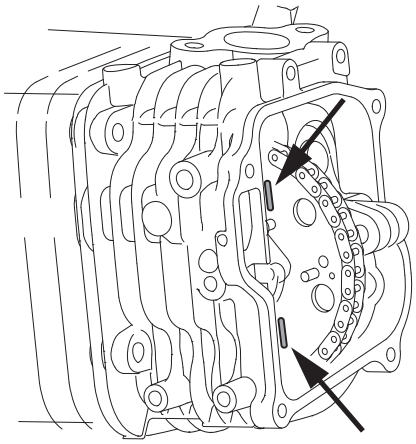
The function of the breather is to create a vacuum in the crankcase which prevents oil from being forced out of the engine through the piston rings, oil seals or gaskets. The breather has a reed valve which limits the direction of air flow caused by the piston moving up and down. Air can flow out of 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.

VALVE CLEARANCE CHECK AND ADJUSTMENT

NOTE: *Check and adjust clearance when the engine is cold.*

1. If equipped, remove air deflector from top of engine.
2. Remove rocker cover.
3. Turn the crankshaft until the piston is at top dead center of the compression stroke **(Figure 22-5, Page 22-7)**.
4. Using a feeler gauge (1), measure the clearance between the adjuster screw (3) and the top of the valve stem **(Figure 22-6, Page 22-7)**.
5. If necessary, loosen the lock nut (2) and turn the adjuster (3) up or down to adjust the clearance to 0.0047 in. (0.12 mm) for both intake and exhaust. Once clearance is correct, tighten the lock nut (2) to 52 in·lb (6 N·m).
6. After adjusting valve clearances, rotate the crankshaft several full revolutions and verify that the intake and exhaust valve clearance are still correct.



At TDC, the two punch marks on cam sprocket are parallel with the cylinder head surface.

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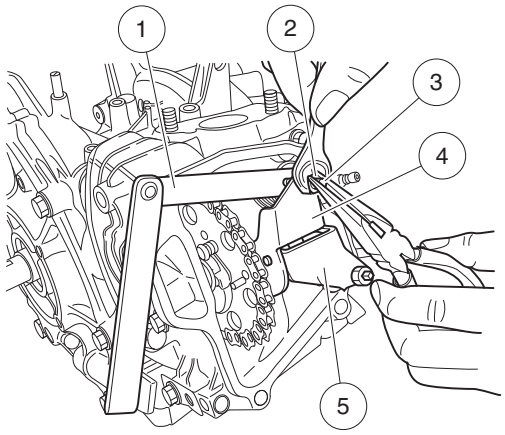
Figure 22-5 Top Dead Center (TDC) – EX40 Engine



1. Feeler Gauge 2. Lock Nut 3. Adjuster Screw 4. Rocker Arm (exhaust) 5. Rocker Arm (intake)

3035

Figure 22-6 Setting Valve Clearance – EX40 Engine

ENGINE REMOVAL

See General Warnings on page 1-1.

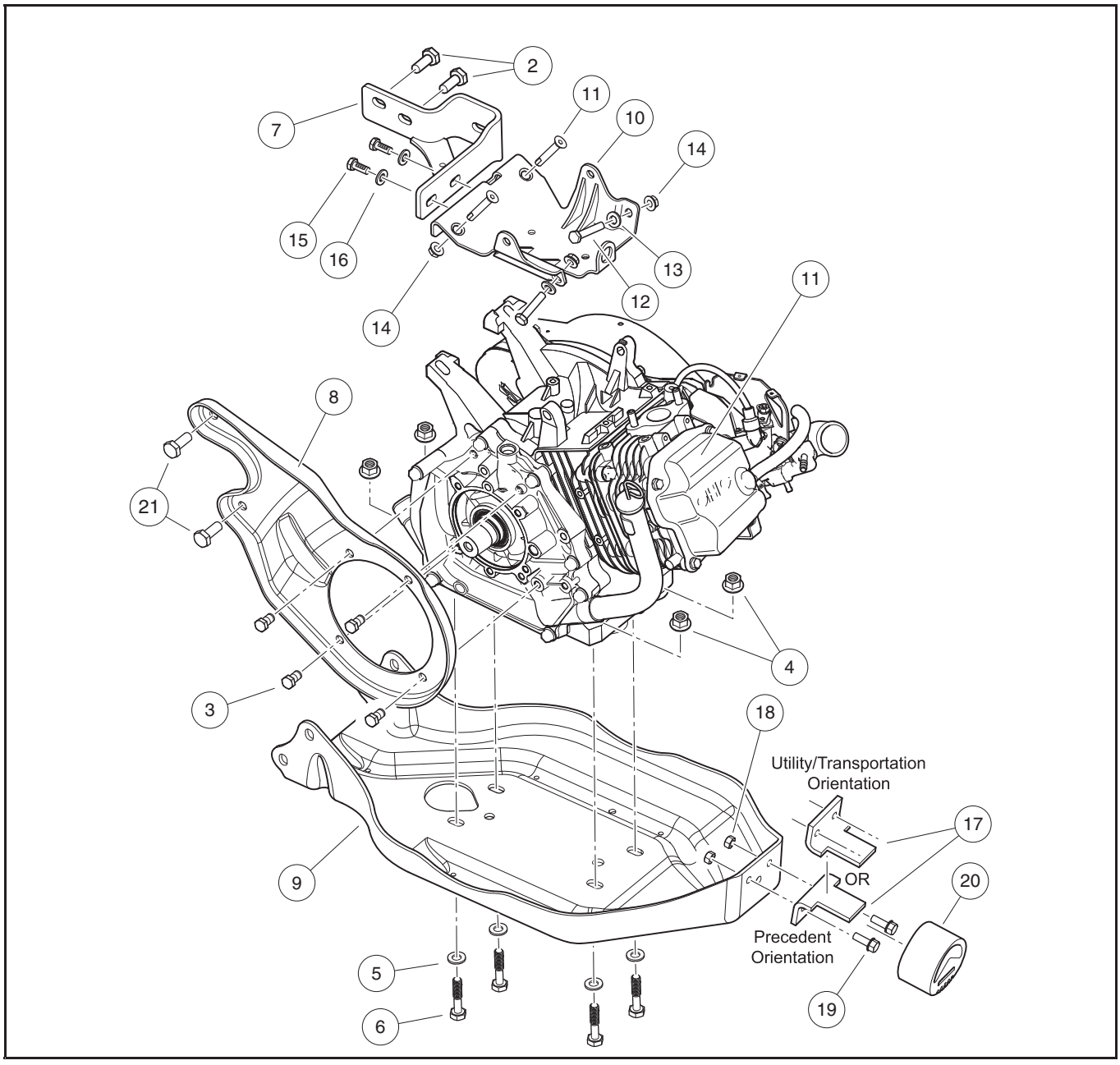


Figure 22-7 EX40 Engine and Mounting Brackets

⚠ CAUTION

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

1. Disconnect battery and spark plug wire(s). **See Disconnecting the Battery-Gasoline Vehicles on page 1-5.**

2. For some vehicles, the engine (1) can be removed by lifting it up and out of the chassis. For other vehicles, it is easier to remove the entire powertrain assembly first. If removing powertrain, **see Transaxle Removal on page 26-9**.
3. If equipped, remove air deflector from top of engine.
4. Disconnect governor cable and P-clamp, air intake hose, fuel line, wire harness connectors, ground cable, and accelerator cable P-clamp. **See Fuel System: Gasoline Vehicles, Section 23, Page 23-1.**
5. Remove starter/generator and belt. **See Starter/Generator Removal, Section 20, Page 20-1.**
6. Remove drive clutch. **See Drive Clutch Removal, Section 25, Page 25-5.**
7. Remove muffler. **See Muffler Removal, Section 24, Page 24-1.**
8. Remove engine mounting hardware (2, 3, 4, 5, and 6) from muffler bracket (7), clutch plate (8), and engine pan (9) **(Figure 22-7, Page 22-8)**.
9. Lift engine (1) from engine pan (9). **See following NOTE.**

NOTE: *The engine weighs approximately 54 lb (24.5 kg).*

10. Remove crankcase oil drain plug and drain all oil from crankcase. Dispose of engine oil properly.
11. If replacing engine (1), remove starter/generator mounting weldment (10) and retain for installation on new engine. **See following NOTE.**

NOTE: *If replacing engine and throttle body, the ECU must also be replaced. Throttle bodies and ECU's are matched pairs.*

ENGINE INSTALLATION

See General Warnings on page 1-1.

1. If replacing engine (1), install starter/generator mounting weldment (10) on engine with screws (11), bolts (12), washers (13), and locknuts (14) **(Figure 22-7, Page 22-8)**. Tighten locknuts (14) only finger-tight at this time.
2. Install oil drain plug and tighten to 18 ft·lb (24.4 N·m).
3. Place engine (1) onto engine pan (9) and secure with mounting hardware (4, 5, and 6). Leave flange nuts (4) loose at this time.
4. Install clutch plate (8) with bolts (3 and 21). Leave bolts loose at this time.
5. Install bolts (2) through muffler bracket (7) into transaxle but do not tighten.
6. Tighten hardware in the following order:
   - 6.1. Tighten bolts (3) to 27 ft·lb (36 N·m).
   - 6.2. Tighten bolts (21) to 50 ft·lb (68 N·m).
   - 6.3. Tighten bolts (2) to 50 ft·lb (68 N·m).
   - 6.4. Tighten flange nuts (4) to 33 ft·lb (40.6 N·m).
   - 6.5. Tighten locknuts (14) and bolts (15) to 17 ft·lb (23 N·m).
7. Install drive clutch. **See Drive Clutch Installation, Section 25, Page 25-11.**
8. Install muffler. **See Muffler Installation, Section 24, Page 24-1.**
9. Install starter/generator and belt. **See Starter/Generator Installation, Section 20, Page 20-12.**
10. If necessary, install powertrain. **See Transaxle Installation, Section 26, Page 26-13.**
11. Connect air intake hose, fuel line, wire harness connectors, ground cable and governor cable. **See Fuel System: Gasoline Vehicles, Section 23, Page 23-1.**
12. If equipped, install air deflector on top of engine.
13. Secure accelerator cable and governor cable P-clamps to engine. Tighten P-clamp bolts to 36 in·lb (4.0 N·m).

14. Check all hardware for proper torque/tightness.
15. Fill engine to proper level with correct type of oil. **See Engine Oil – Gasoline Vehicle, Section 22, Page 22-2.**

⚠ CAUTION

- **Do not overfill with oil.**

16. Connect battery and spark plug wire(s). **See Connecting the Battery-Gasoline Vehicles on page 1-5.**
17. Adjust the engine RPM setting. **See Engine RPM Adjustment on page 23-13.**
18. Test-drive vehicle to ensure all systems are functional and correctly adjusted.

FLYWHEEL

See General Warnings on page 1-1.

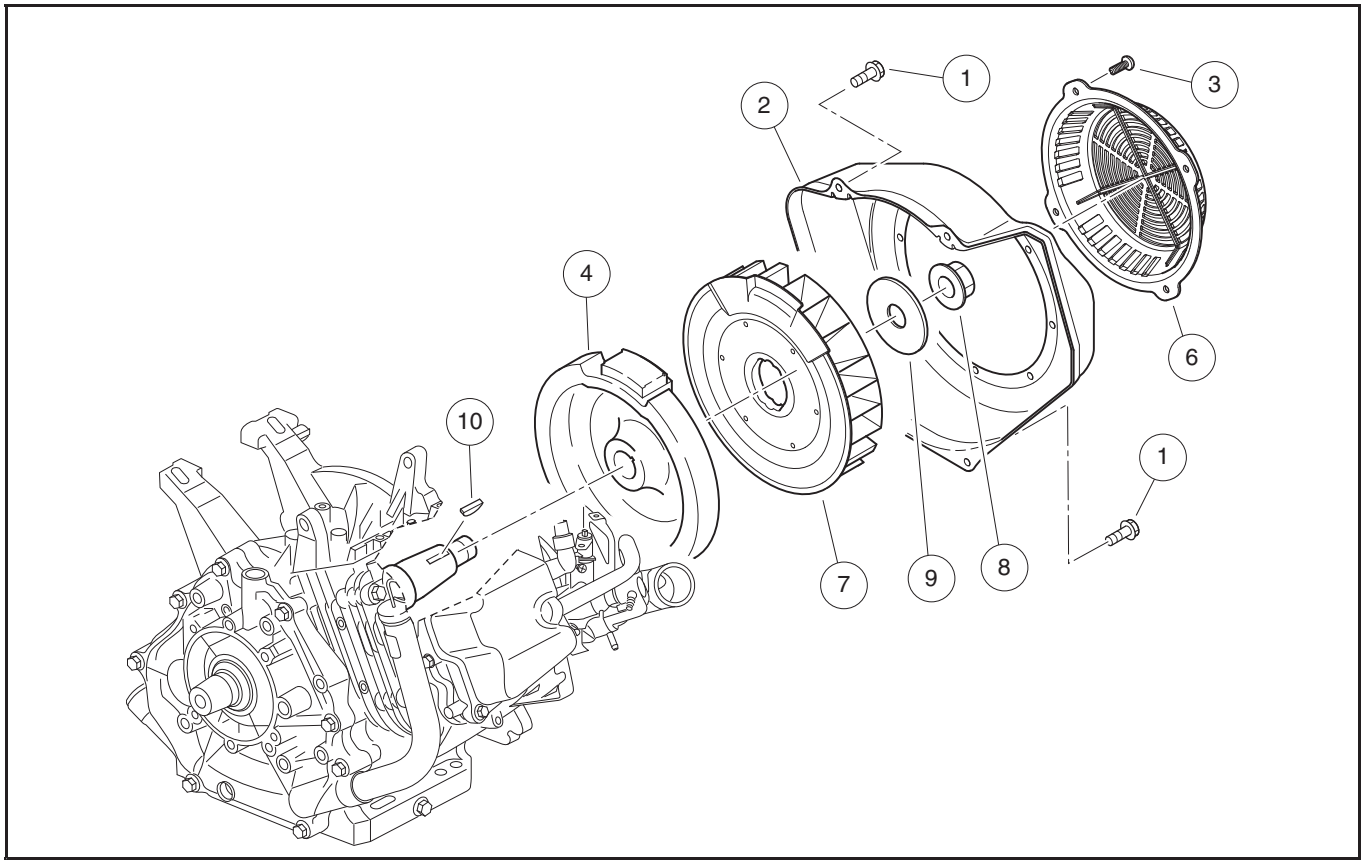


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Figure 22-8 Flywheel, Fan and Fan Housing – EX40

FLYWHEEL REMOVAL

1. Remove screws (1) and fan housing (2) **(Figure 22-8, Page 22-10)**.

2. Hold flywheel (4) only, not fan (7), with strap wrench (5) and use a 24 mm socket to remove flywheel nut (8) and flat washer (9) by turning it counterclockwise **(Figure 22-9, Page 22-11)**. **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.**

3. Temporarily install flywheel nut (8) onto end of crankshaft to protect threads and to prevent flywheel (4) from falling off while being pulled.
4. Detach flywheel (4) from crankshaft with a large, two-jaw puller.
5. Remove flywheel nut (8) and flywheel (4) from crankshaft.
6. Remove woodruff key (10) from groove in crankshaft.

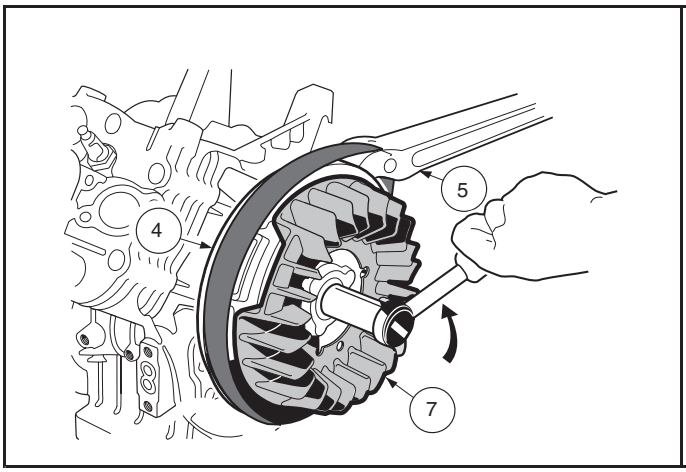

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Figure 22-9 Flywheel Nut Removal

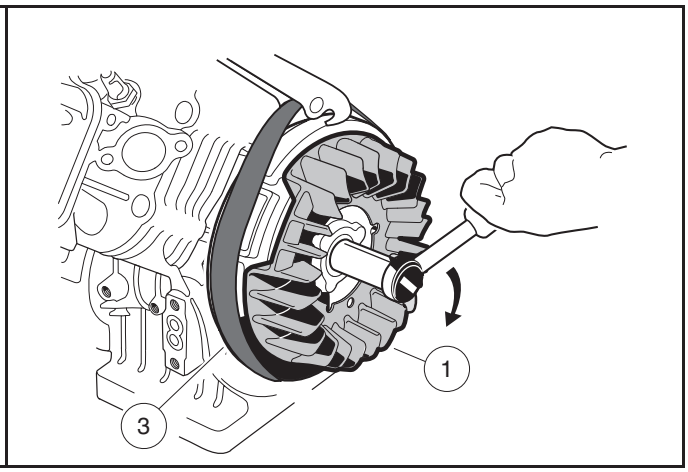

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Figure 22-10 Fan and Flywheel Installation

FLYWHEEL INSTALLATION

1. Wipe off any oil on tapered portions of crankshaft and flywheel (4) **(Figure 22-8, Page 22-10)**.
2. Insert woodruff key (10) into keyway of crankshaft. Then align groove in flywheel (4) to woodruff key (10) and push flywheel onto crankshaft until it seats. Install and fan (7), flat washer (9), and nut (8) finger-tight.
3. Use a strap wrench (3) to keep flywheel and fan assembly (1) from turning while tightening flywheel nut to 80 ft·lb (110 N·m) **(Figure 22-10, Page 22-11)**. **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.**

4. Install fan housing (2) and tighten screws (1) to 90 in·lb (10 N·m) **(Figure 22-8, Page 22-10)**.

OIL LEVEL SENSOR

TESTING THE OIL LEVEL SENSOR

See Oil Level Sensor on page 18-37.

OIL LEVEL SENSOR REMOVAL

1. Drain oil from engine. **See Engine Oil – Gasoline Vehicle, Section 22, Page 22-2.**
2. Remove flywheel. **See Flywheel Removal on page 22-10.**
3. Remove bolt (1) securing oil sensor wire clamp (2) to engine.
4. Disconnect oil level sensor wire (3) from wire harness **(Figure 22-11, Page 22-12)**.
5. Remove two bolts (4) securing oil sensor (5) in engine.
6. Pull oil level sensor (5) out of engine.

OIL LEVEL SENSOR INSTALLATION

1. Lubricate oil level sensor o-ring with oil and carefully insert sensor (5) into engine until fully seated.
2. Secure sensor (5) to engine with two bolts (4) and tighten to 80 in·lb (9 N·m) **(Figure 22-11, Page 22-12)**.
3. Connect oil level sensor wire (3) to wire harness.
4. Secure oil sensor wire (3) with clamp (2) and bolt (1). Tighten bolt to 80 in·lb (9 N·m).
5. Install flywheel and fan shroud. **See Ignition Coil Removal on page 22-13.**
6. Fill engine to proper level with correct type of oil. **See Engine Oil – Gasoline Vehicle, Section 22, Page 22-2.**

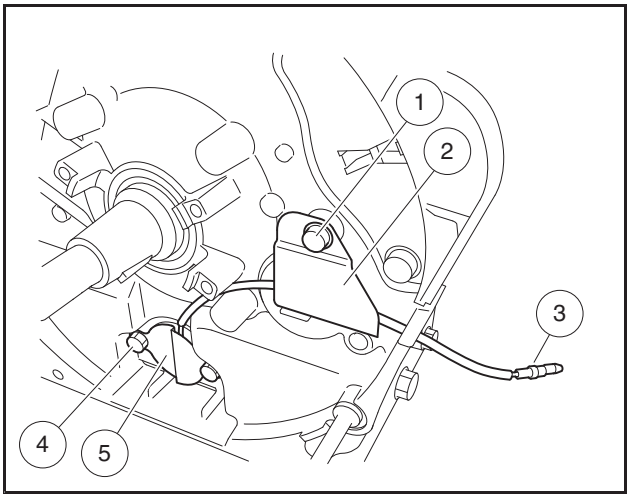

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Figure 22-11 Oil Level Sensor – EX40

IGNITION COIL

See General Warnings on page 1-1.

TESTING THE IGNITION COIL

See Test Procedure 15 – Ignition Spark on page 18-34 and Test Procedure 16 – Ignition Coil on page 18-35.

IGNITION COIL REMOVAL

1. Remove screws (1) and fan housing (2) **(Figure 22-8, Page 22-10)**.
2. Disconnect ignition coil primary lead wire (12) from spade terminal (13) on ignition coil (11) **(Figure 22-12, Page 22-13)**.
3. Remove two bolts (10) and pull ignition coil (11) from engine.

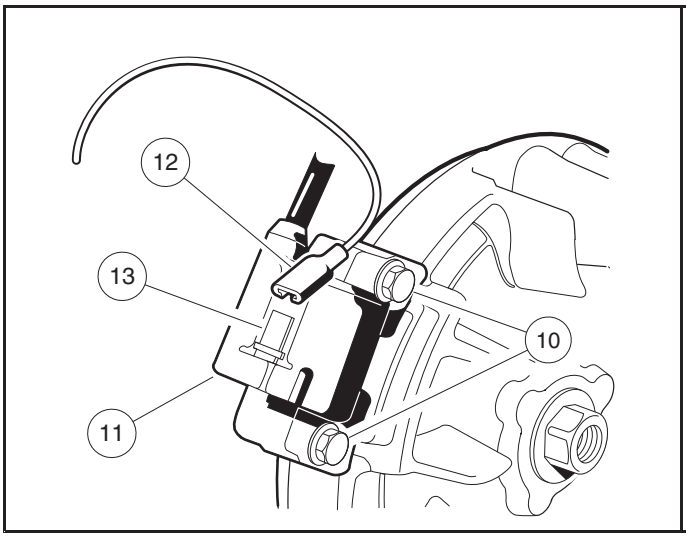

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Figure 22-12 Ignition Coil

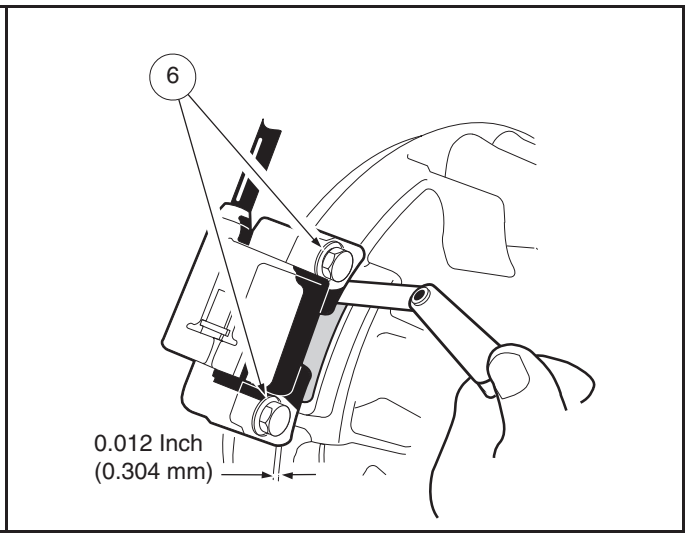

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Figure 22-13 Adjust Ignition Coil Air Gap

IGNITION COIL INSTALLATION

1. Position ignition coil (11) onto engine and tighten two mounting bolts (10) finger-tight at this time **(Figure 22-12, Page 22-13)**.
2. Rotate flywheel until its magnet is positioned directly under ignition coil (11). Use a bronze feeler gauge to set air gap between ignition coil and flywheel magnet from 0.012 to 0.020 in. (0.3 to 0.5 mm) **(Figure 22-13, Page 22-13)**.
3. Tighten ignition coil bolts (6) to 71 in·lb (8 N·m).
4. Connect ignition coil primary lead wire (12) to terminal (13) on coil **(Figure 22-12, Page 22-13)**.

SNUBBER

See General Warnings on page 1-1.

NOTE: *The snubber is installed on the gasoline vehicle only.*

SNUBBER REMOVAL

1. Support the powertrain with a floor jack under the engine pan (1) so that the snubber (2) is raised slightly and does not rest on the vehicle frame **(Figure 22-14, Page 22-14)**.
2. Remove the two bolts (3) and two lock nuts (4) securing the snubber bracket (5) to the engine pan (1).
3. Slide snubber (2) and bracket (5) assembly toward battery to remove it from vehicle.
4. Slide snubber (2) off bracket (5).

SNUBBER INSTALLATION

1. Slide snubber (2) onto bracket (5) **(Figure 22-14, Page 22-14)**.
2. Install bracket and snubber assembly onto engine pan (1).
3. Tighten lock nuts (4) from 20 to 25 ft·lb (27.1 to 33.9 N·m).

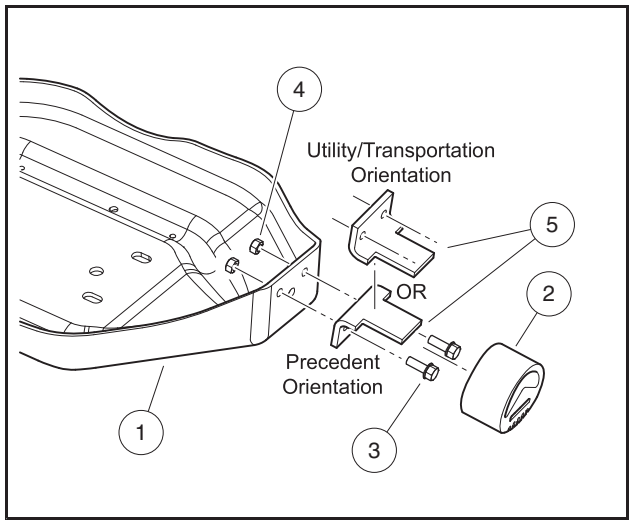

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Figure 22-14 Snubber

SECTION 23 — FUEL SYSTEM: GASOLINE VEHICLES

⚠ DANGER

- **See General Warnings on page 1-1.**

⚠ WARNING

- **See General Warnings on page 1-1.**
- **Fuel may be under pressure. Use extreme caution when disconnecting fuel line to prevent the spray of fuel onto hot engine. See Relieving Fuel Pressure on page 23-2.**
- **To prevent damage to the ECU, never mix the black and gray connectors that attach to it. The black connector is tethered to the ECU mounting plate to help prevent accidentally installing it in the gray port.**

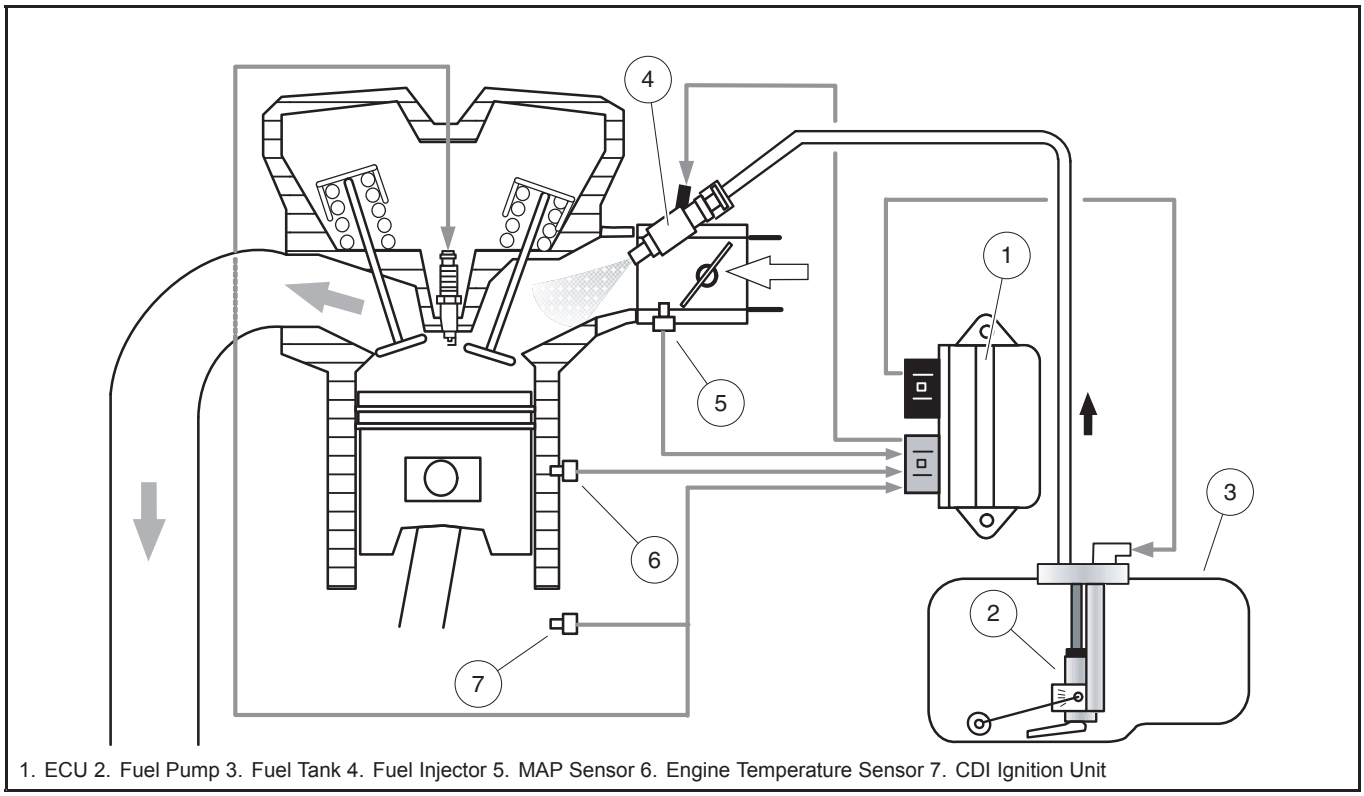
GENERAL INFORMATION

The engine is equipped with a throttle body/fuel injector assembly that is controlled by an ECU and requires no adjustment. The ECU monitors engine conditions through inputs from a Manifold Absolute Pressure (MAP) sensor, engine block temperature sensor and ignition timing.

EFI SYSTEM FEATURES/SPECIFICATIONS

NOTE: *This manual covers ECU software version F6i33051.*

- The ECU and throttle body/fuel injector assembly are matched pairs and are not available separately
- Fuel pump and low oil warning light operates for a few seconds when key switch is turned to the ON position; it stops if no engine RPM is detected by the ECU
- The ECU blinks fault codes through the Low Oil Warning Lamp
- In-tank fuel pump
- Return-less system
- High fuel pressure system (36 to 38 psig (250 to 260 kPa))
- Controls fuel pump, fuel injector, and oil lamp
- Automatic altitude compensation
- Flow: 16 L per hour minimum @ 12-volts/36 psig (250 kPa)
- Current draw: 2-amps maximum
- Throttle Body Bore: 31 mm diameter
- Open-loop system (i.e. oxygen sensor not used)
- Separate EFI wire harness
- Fail-safe function



1. ECU 2. Fuel Pump 3. Fuel Tank 4. Fuel Injector 5. MAP Sensor 6. Engine Temperature Sensor 7. CDI Ignition Unit

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Figure 23-1 EFI System Components

RELIEVING FUEL PRESSURE

In the event that servicing the EFI fuel system necessitates removal of the fuel delivery hose, extreme caution must be exercised. The fuel system is under high pressure even with the engine not running. Disconnecting any part of the fuel delivery system, without first depressurizing the system, will result in a sudden release of pressurized gasoline at the connection. To prevent possible serious injury or death, fuel pressure must be relieved before disconnecting or removing the pump, hose and throttle body.

Either of these suggested procedures MUST be followed before attempting ANY service work on the EFI fuel system. Following these will relieve any pressure in the fuel hose prior to opening the fuel system.

TO RELIEVE FUEL PRESSURE

- Shut off engine, disconnect battery,
  See Disconnecting the Battery-Gasoline Vehicles on page 1-5.

  Wait 15 minutes or more to allow pressure to dissipate.

  – or –

- Unplug fuel pump module at fuel tank and crank engine for 5 seconds to start reducing fuel pressure. Pause and repeat an additional 5 seconds to allow pressure to dissipate.

NOTE: *To absorb any residual fuel the may be present in the fuel hose, place a rag or towel around the hose at the end being disconnected.*

THROTTLE BODY

See General Warnings on page 1-1.

Before suspecting the throttle body 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 on page 22-5.**
- Air filter element. **See Air Filter on page 23-15.**
- Air intake system (for restriction of air flow). **See Air Intake System on page 23-14.**
- Exhaust system (for restrictions). **See Exhaust System: Gasoline Vehicles on page 24-1.**
- Fuel pump. **See Fuel Pump Module on page 23-18.**
- Fuel line. **See Fuel Line on page 23-16.**
- Fuel pickup screen or filter. **See Fuel Filter on page 23-23.**

THROTTLE BODY REMOVAL

See General Warnings on page 1-1.

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 battery. **See Disconnecting the Battery-Gasoline Vehicles on page 1-5.**
3. If equipped, remove air deflector from top of engine.
4. If necessary, remove fuel tank to increase access to the throttle body (1). **See Fuel Tank Removal, Section 23, Page 23-21.**
5. Clean the throttle body (1) and surrounding area **(Figure 23-2, Page 23-4)**.
6. Disconnect breather hose (2) from air intake adapter (3).
7. Disconnect governor cable from bracket (4).
8. Disconnect fuel injector and MAP sensor.
9. Remove spring clamps securing fuel line (6) and vent hose (5) to throttle body (1) and disconnect vent hose (5).
10. Disconnect fuel line (6) and drain into an appropriate container. **See following WARNING.** Temporarily plug fuel line to prevent fuel leakage.

⚠ WARNING

- **Fuel may be under pressure. Use extreme caution when disconnecting fuel line to prevent the spray of fuel onto hot engine. See Relieving Fuel Pressure on page 23-2.**
- **Carefully drain any fuel into an approved container. Add drained fuel back into fuel tank or dispose of properly.**

11. Loosen air intake hose clamp and disconnect air intake hose.
12. Remove two flange nuts (7) and slide air intake adapter (3), bracket (4), gaskets (8), insulator (9), and throttle body (1) off threaded studs.

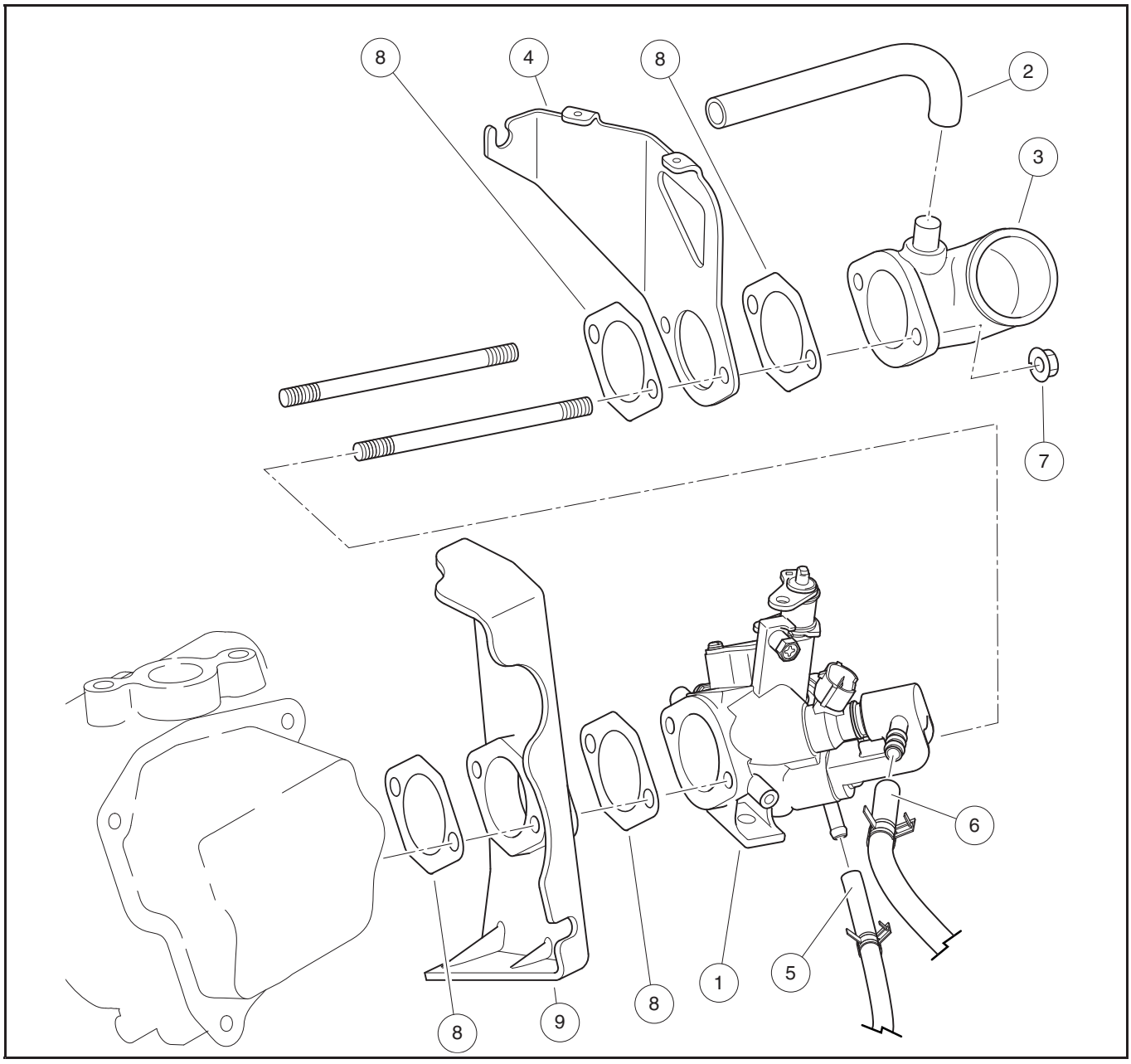

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Figure 23-2 Throttle Body – Exploded View

THROTTLE BODY INSTALLATION

See General Warnings on page 1-1.

1. Install throttle body (1) and its related components onto threaded studs in order as shown **(Figure 23-2, Page 23-4)**.
2. Install two flange nuts (7) and tighten to 53 to 71 in·lb (6 to 8 N·m).
3. Connect fuel line (6) and vent hose (5). Secure with spring clamps.
4. Connect fuel injector and MAP sensor.

5. Connect governor cable to bracket (4).
6. Connect breather hose (2) to air intake adapter (3).
7. Connect air intake hose and secure with hose clamp.
8. If removed, install fuel tank. **See Fuel Tank Installation, Section 23, Page 23-22.**
9. If equipped, install air deflector on top of engine.
10. Clean spilled and remove any drained gasoline from the area.
11. Connect battery. **See Connecting the Battery-Gasoline Vehicles on page 1-5.**
12. Place the Forward/Reverse handle in the NEUTRAL position, chock the wheels, and the neutral lockout switch in the MAINTENANCE position **(Figure 26-1, Page 26-1)**.
13. Turn the key switch to the ON position and check for fuel leaks. Repeat as necessary to build fuel pressure. Any leaks found must be fixed.

⚠ DANGER

- **Repair all fuel leaks before returning the vehicle to service.**

14. If no leaks are found, place the neutral lockout switch in the OPERATE position **(Figure 26-1, Page 26-1)**.
15. Test drive vehicle to ensure proper operation.

ENGINE CONTROL LINKAGES

See General Warnings on page 1-1.

⚠ 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 the wheels prior to servicing the vehicle.**
  - **Disconnect battery cables, negative (–) cable first.**
  - **Disconnect the spark plug wire from the spark plug.**
  - **See Disconnecting the Battery-Gasoline Vehicles on page 1-5.**

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.**

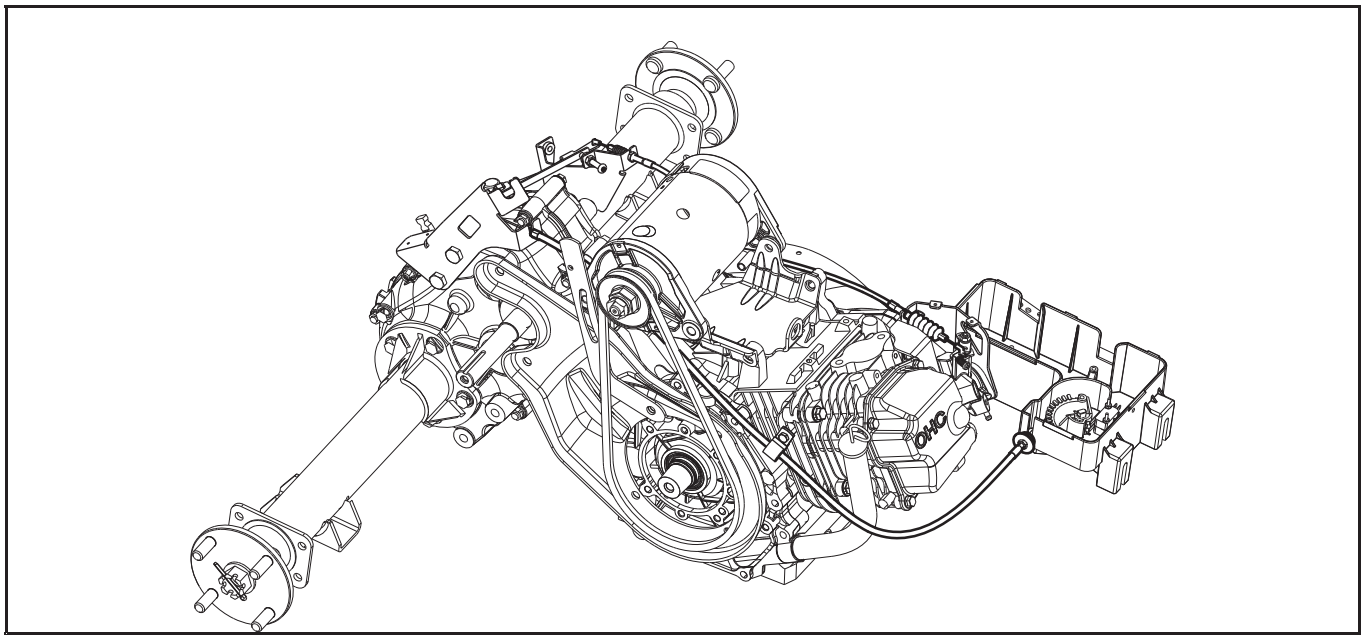

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Figure 23-3 Engine Control Linkages – EFI vehicles

GROUND SPEED

NOTE: *If possible, the manufacturer recommends measuring ground speed when setting engine RPM.*

This vehicle should reach the forward ground speed specified in **Section 2 – Vehicle Specifications**. **See How to Measure Ground Speed on page 23-13.**

ACCELERATOR ROD

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 Warnings on page 1-1.**
2. Remove the accelerator rod by disconnecting the ball joint (1) from the ball stud (2) on the accelerator pedal **(Figure 23-4, Page 23-7)** and from the bell crank at the electrical box **(Figure 23-5, Page 23-7)**.

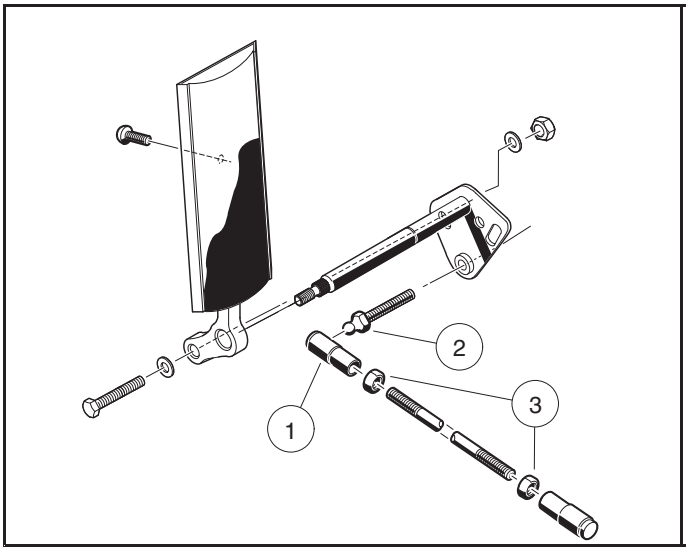

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Figure 23-4 Accelerator Rod

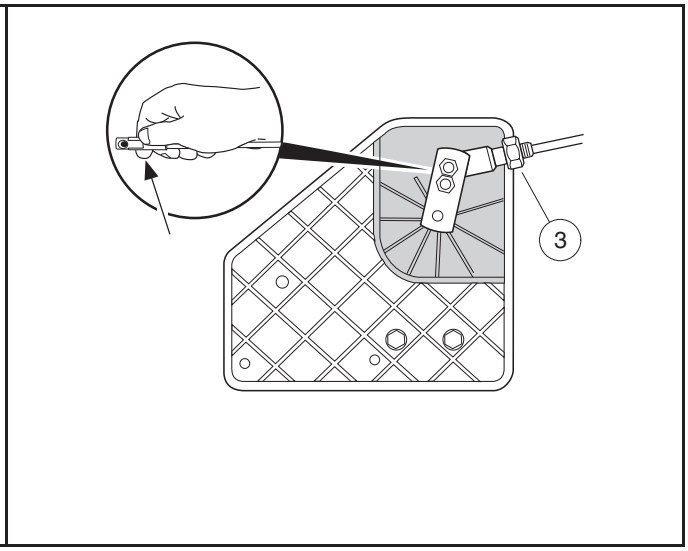

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Figure 23-5 Accelerator Rod – Pull Spring Release to Attach (Bottom View)

Accelerator Rod Installation and Adjustment

1. Before installing the accelerator rod, adjust accelerator pedal position. **See Pedal Group Adjustment – Gasoline Vehicles in the Accelerator and Brake Pedal Group Section.**
2. Install the ball joint (1) on the ball stud (2) at the accelerator pedal **(Figure 23-4, Page 23-7)**.
3. Access the engine compartment.
4. Remove the electrical component box screw and cover **(Figure 23-6, Page 23-8)**.
5. Adjust length of accelerator rod. With the ball joint jam nuts (3) loose **(Figure 23-4, Page 23-7)**, adjust the length of the rod to obtain an accelerator cable cam position of 7° as shown **(Figure 23-6, Page 23-8)**. **See following CAUTION.**

⚠ 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 23-5, Page 23-7)**. **See following CAUTION.**

⚠ CAUTION

- **Inspect the limit switches inside the electrical component box. If a limit switch lever is bent, replace the switch.**

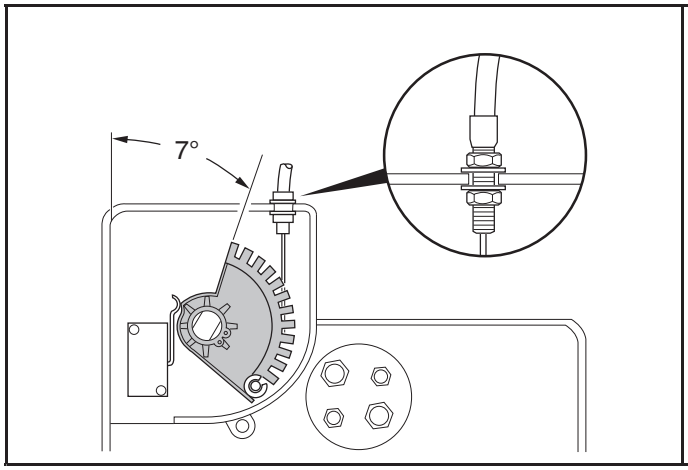

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Figure 23-6 Accelerator Cable Cam Position – 7° (Top View)

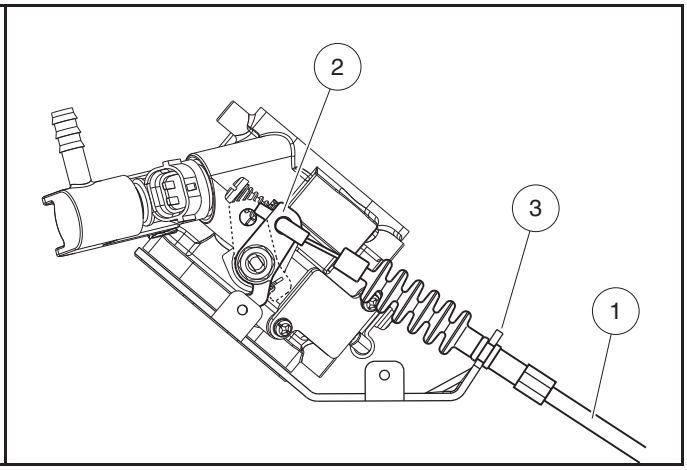

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Figure 23-7 Governor Cable At Throttle Body

7. Before tightening the jam nuts (3), set the park brake to the first latch and pawl position and check for proper activation of switches.
8. While pressing the accelerator pedal, the following events should occur in exactly the order shown:

NOTE: *Always perform a visual check to ensure the starter motor begins rotating the engine prior to the throttle body lever moving.*

EVENT	APPROXIMATE PEDAL TRAVEL
Park brake release	0° to 4°
Solenoid activation and engine start	4° to 15°
Throttle body actuation	15° and greater

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 23-13.**
12. Install the electrical component box cover and tighten retaining screw to 18 in·lb (2.0 N·m).
13. Connect battery and spark plug wire(s). **See Connecting the Battery-Gasoline Vehicles on page 1-5.**

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 battery and spark plug wire(s). **See Disconnecting the Battery-Gasoline Vehicles on page 1-5.**
3. At engine:
   - 3.1. If equipped, remove air deflector from top of engine.
   - 3.2. Disconnect “Z” fitting of governor cable (1) from throttle lever (2) **(Figure 23-7, Page 23-8)**.
   - 3.3. Unsnap governor cable (1) from throttle body bracket (3).
4. At transaxle:
   - 4.1. Disconnect “Z” fitting of governor cable (1) from governor arm (4) **(Figure 23-8, Page 23-10)**.
   - 4.2. Loosen jam nuts at governor bracket (5) and remove cable (1) from vehicle.

Governor Cable Installation and Adjustment

1. At engine:
   - 1.1. Snap governor cable (1) into throttle body bracket (3) **(Figure 23-7, Page 23-8)**.
   - 1.2. Connect “Z” fitting of governor cable (1) to throttle lever (2).
   - 1.3. If equipped, install air deflector on top of engine.
2. At transaxle:
   - 2.1. Slide bellows off threaded end of cable housing, separate jam nuts and place threaded end into governor bracket (5) **(Figure 23-8, Page 23-10)**.
   - 2.2. Finger-tighten jam nuts.
   - 2.3. Push bellows back onto threaded end of cable housing.
   - 2.4. Connect “Z” fitting of governor cable (1) to governor arm (4).
3. Rotate governor arm (4) counterclockwise until it stops and hold in this position **(Figure 23-9, Page 23-10)**.
4. Adjust jam nuts until throttle lever (2) is at “wide open throttle” (WOT) **(Figure 23-7, Page 23-8)**. Then, tighten the jam nuts to 36 in·lb (4.0 N·m).
5. Release governor arm (4) and loosen jam nut (6) on throttle stop screw (7) **(Figure 23-9, Page 23-10)**.
6. Adjust gap between governor arm (4) and throttle stop screw (7) to 0.055 in. (±0.039) (1.4 mm (±1)) as shown.
7. Tighten stop screw jam nut (6) to 36 in·lb (4.0 N·m).
8. Check engine RPM adjustment. **See Engine RPM Adjustment on page 23-13.**

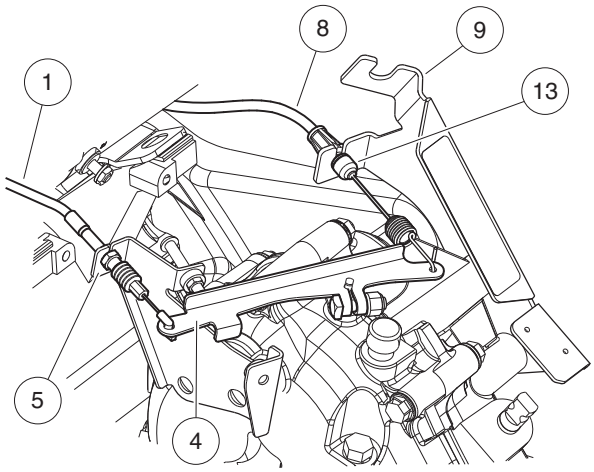

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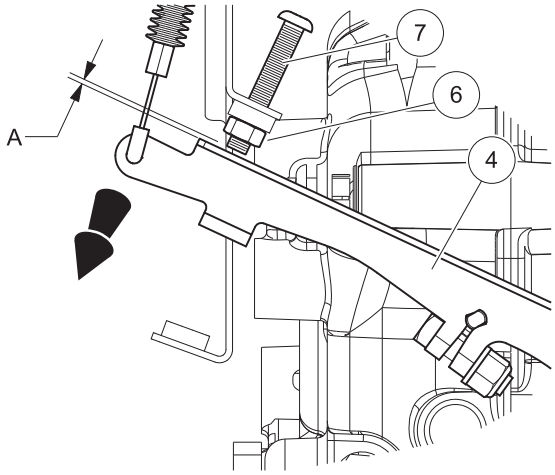
Figure 23-8 Governor and Accelerator Cables At Governor Arm



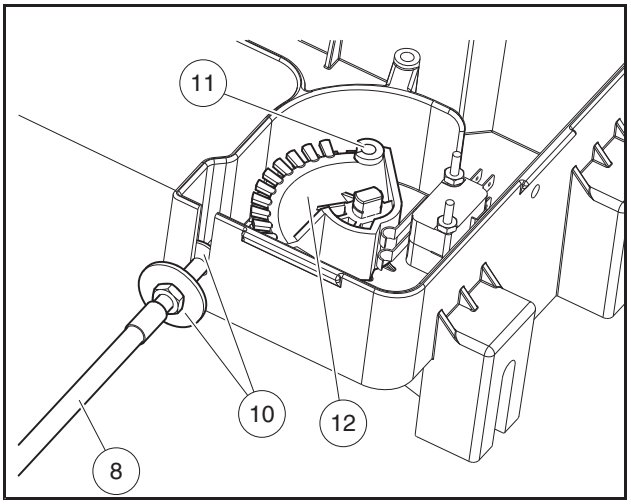
A = 0.055 in. ± 0.039 (1.4 mm ± 1)

3111
Figure 23-9 Throttle Stop Screw Gap

ACCELERATOR CABLE

Accelerator 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 battery and spark plug wire(s). **See Disconnecting the Battery-Gasoline Vehicles on page 1-5.**
3. At transaxle:
   - 3.1. Unhook spring fitting of accelerator cable (8) from governor arm (4) **(Figure 23-8, Page 23-10)**.
   - 3.2. Unsnap accelerator cable (8) from FNR/accelerator cable bracket (9).
4. At electrical component box:
   - 4.1. Remove electrical component box cover and loosen jam nuts (10) on side of electrical component box **(Figure 23-10, Page 23-11)**.
   - 4.2. Disconnect barrel fitting (11) of accelerator cable (8) from cam (12) in electrical component box and remove accelerator cable (8) from vehicle.



3046
Figure 23-10 Accelerator Cable At Electrical Component Box

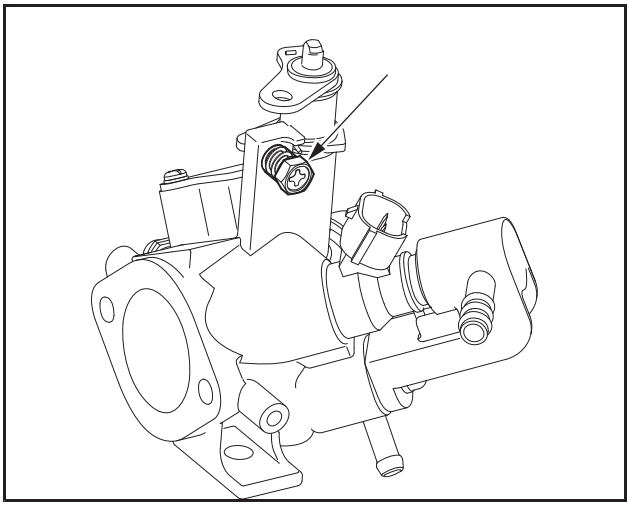
Accelerator Cable Installation

1. At transaxle:
   - 1.1. Hook spring fitting of accelerator cable (8) to governor arm (4) **(Figure 23-8, Page 23-10)**.
   - 1.2. Snap accelerator cable (8) into FNR/accelerator cable bracket (9).
   - 1.3. Push dust shield (13) onto end of cable housing.
2. At electrical component box:
   - 2.1. Insert barrel fitting (11) of accelerator cable (8) into cam (12) in electrical component box **(Figure 23-10, Page 23-11)**.
   - 2.2. Separate jam nuts (10) on cable and place threaded end into slot of electrical component box. Tighten jam nuts (10) finger-tight.
   - 2.3. Before tightening the cable jam nuts (10), make sure the engine RPM adjustment is correct. **See Engine RPM Adjustment on page 23-13.**
   - 2.4. Install electrical component box cover and tighten screw to 18 in·lb (2.0 N·m).
3. Connect battery and spark plug wire(s). **See Connecting the Battery-Gasoline Vehicles on page 1-5.**

CLOSED THROTTLE OR IDLE ADJUSTMENT – PEDAL-START VEHICLES

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 throttle body idle screw so that it is not touching the throttle lever **(Figure 23-11, Page 23-12)**.
2. Slowly tighten the idle screw until it lightly touches the throttle lever, then tighten it an additional 1 whole turn (360 degrees).



3047

Figure 23-11 Idle Screw

CLOSED THROTTLE OR IDLE ADJUSTMENT – KEY-START VEHICLES

Adjust the idle screw until idle RPM is 1200 (±25) **(Figure 23-11, Page 23-12)**.

HOW TO MEASURE GROUND SPEED

Best Method

An easy way to check ground speed is by using a GPS device or smartphone application (app). If these are not available, use the alternate method below.

Alternate Method (Calculated)

Ground speed is easily determined by a known distance travelled, divided by the amount of time it took to travel that known distance (*Rate* = *Distance/Time*).

1. Establish a known distance to travel (example: 100 ft. (30.5 m) in a safe location using cones or other type of marker.
2. Drive vehicle and bring to maximum speed before reaching the first cone.
3. Using a stopwatch, record the amount of time it takes to travel from the first cone to the second cone at maximum speed.
4. With distance and time determined, calculate ground speed:
   - 4.1. **Rate in seconds:** Divide distance (100 ft (30.5 m)) by time (5 seconds) = 20 ft/sec (6.1 m/sec).
   - 4.2. **Convert seconds to hour:** Multiply 20 ft/sec (6.1 m/sec) by 3600 (the number of seconds in an hour) = 72000 ft/hour (21960 m/hour)
   - 4.3. **Convert to MPH:** Divide 72000 ft/hour by 5280 (number of ft in 1 mile) = 13.64 miles/hour

     Convert to KPH: Move the decimal point over three places; 21960 m/hour = 21.96 km/hour

ENGINE RPM ADJUSTMENT

⚠ DANGER

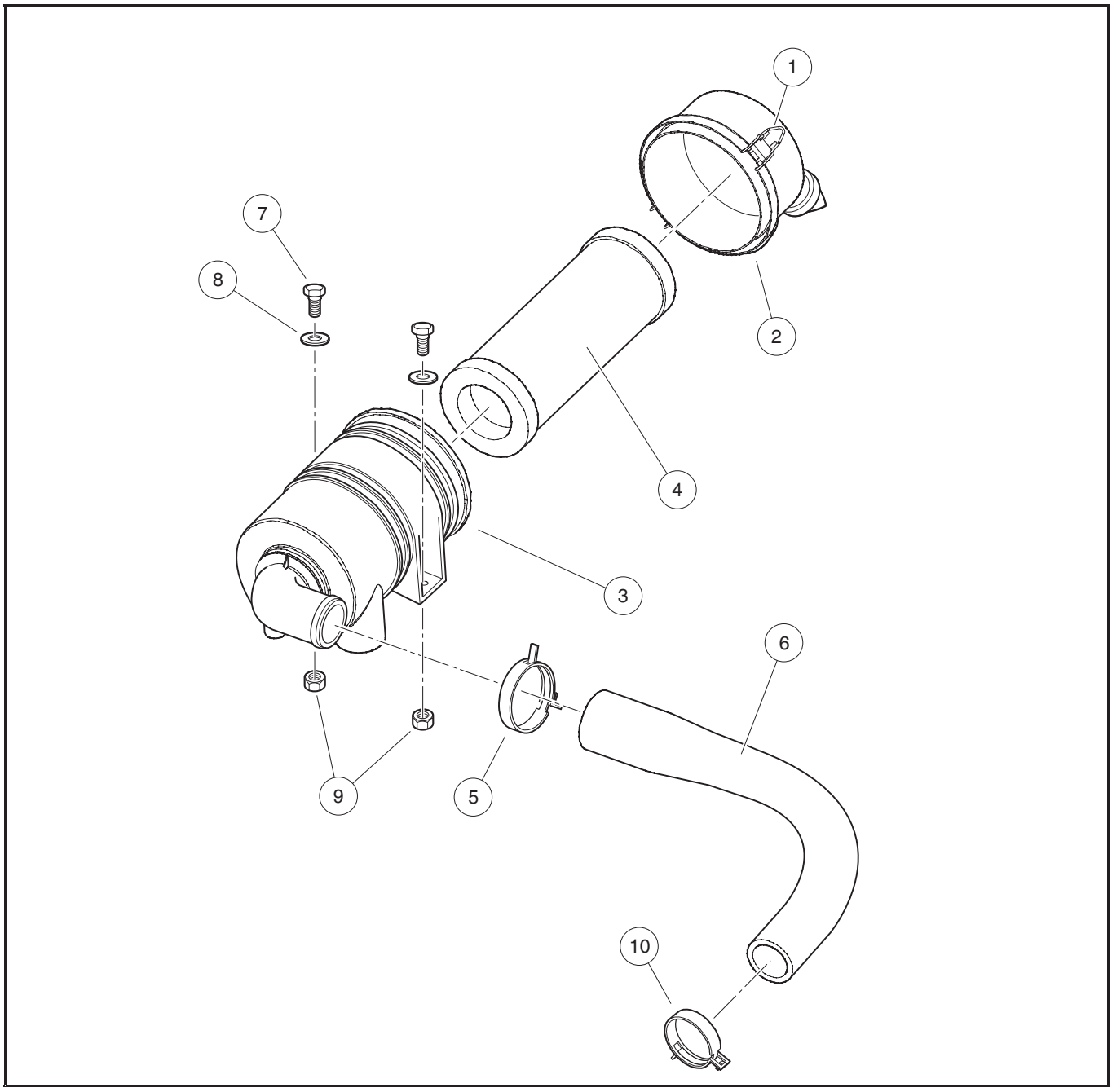
- **Do not operate gasoline vehicle in an enclosed area without proper ventilation. The engine produces carbon monoxide, which is an odorless, deadly poison.**

1. If governor is adjusted, proceed to step 2; otherwise, adjust governor. **See Governor Cable Installation and Adjustment on page 23-9.**
2. Connect battery and spark plug wire(s). **See Connecting the Battery-Gasoline Vehicles on page 1-5.**
3. Measure vehicle ground speed. **See How to Measure Ground Speed on page 23-13.**
4. Compare measured ground speed with forward ground speed specified in **Section 2 – Vehicle Specifications**.
5. If adjustment is necessary, use the following procedures:
   - 5.1. To **reduce** RPM, loosen the accelerator cable jam nut on the outside of the electrical component box and tighten the jam nut on the inside of the box until specified ground speed is reached **(Figure 23-10, Page 23-11)**. **See Section 2 – Vehicle Specifications.**
   - 5.2. To **increase** RPM, loosen the jam nut inside the electrical component box and tighten the jam nut outside the box until specified ground speed is reached.
   - 5.3. Be sure both jam nuts are locked against the electrical component box and check ground speed again. If ground speed needs to be adjusted, repeat previous step. **See following NOTE.**

NOTE: *If more adjustment is required than the cable housing will allow, make sure the spring fitting on the other end of the accelerator cable is properly installed. Excessive drive belt and clutch wear can also prevent proper ground speed adjustment. Check them for excessive wear.* ***Section 25 — Clutches: Gasoline Vehicles***

AIR INTAKE SYSTEM

See General Warnings on page 1-1.



3048

Figure 23-12 Air Intake System – CA 500/550/700/TRANSPORTER/Cafe Express

AIR FILTER

The air filter should be inspected periodically and replaced when necessary. Filter changes should not exceed the recommended interval. **See Periodic Service Schedules, Section 10, Page 10-4.** More frequent service may be required in extremely dirty operating environments. In the event of a loss of power, sluggish acceleration, or a roughly running engine, service the air filter immediately.

Air Filter Replacement

1. Release both wire latches (1) **(Figure 23-12, Page 23-14)**.
2. Pull cap (2) away from air cleaner (3).
3. Remove air filter (4). **See following NOTE.**

NOTE: *The filter is specifically designed for this engine. It fits into the canister only one way. Use only direct replacement part.*

4. Using a clean cloth, wipe away any dust or dirt from inside the air cleaner (3).
5. Push the new filter (4) onto the nozzle inside the air cleaner (3).
6. Position and place cap (2) onto air cleaner (3) so the “TOP” mark is at the 12 o'clock position.
7. Fasten wire latches (1). Make sure latches are securely engage. **See following CAUTION.**

⚠ CAUTION

- **Engine damage will occur if the air cleaner cap is not properly secured.**
- **If air cleaner is extremely dirty, remove air cleaner from vehicle and clean thoroughly.**
- **Use only Club Car replacement air filters. The use of other air filters could result in engine damage and void the warranty.**

AIR CLEANER REMOVAL

1. Turn key switch to the OFF position and remove key, place Forward/Reverse handle in the NEUTRAL position, and chock the wheels.
2. Disconnect battery and spark plug wire(s). **See Disconnecting the Battery-Gasoline Vehicles on page 1-5.**
3. Remove clamp (5) and disconnect air intake hose (6) from air cleaner (3) **(Figure 23-12, Page 23-14)**.
4. Remove hardware (7, 8, and 9) securing air cleaner (3) to vehicle.

AIR CLEANER INSTALLATION

1. Place air cleaner (3) into vehicle and secure with hardware (7, 8, and 9) **(Figure 23-12, Page 23-14)**. Tighten locknuts (9) to 85 in·lb (9.5 N·m).
2. Connect air intake hose (6) to air cleaner (3) and secure with clamp (5).
3. Connect battery and spark plug wire(s). **See Connecting the Battery-Gasoline Vehicles on page 1-5.**

FUEL LINE

See General Warnings on page 1-1.

NOTE: *This EFI gasoline vehicle is equipped with SAEJ30R9 fuel hose rated for high-pressure systems. Always replace the fuel line on this vehicle with approved Club Car replacement part. Do not attempt to repair, patch or splice the fuel line.*

The fuel line must be properly routed from the fuel tank to the throttle body. A small, spring steel band clamp is used on the fuel line connection at the throttle body and must be tight. A plastic, dual-locking connector is used at the fuel tank. **See following WARNING.**

⚠ WARNING

- **Make sure fuel line is the correct length and properly routed. Failure to heed this warning could result in damage to fuel line and fire.**
- **Fuel may be under pressure. Use extreme caution when disconnecting fuel line to prevent the spray of fuel onto hot engine. See Relieving Fuel Pressure on page 23-2.**

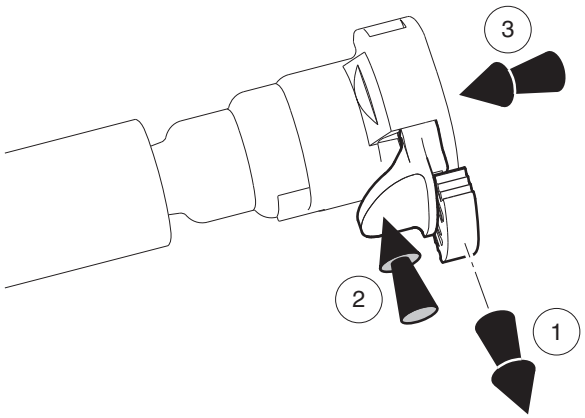
FUEL LINE REMOVAL

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 battery. **See Disconnecting the Battery-Gasoline Vehicles on page 1-5.**
3. Clean the top of the fuel tank and fuel pump module.
4. At engine:
   4.1. Remove spring clamp securing fuel line to throttle body.
   4.2. Disconnect fuel line and drain into an appropriate container. **See following WARNING.**

⚠ WARNING

- **Fuel may be under pressure. Use extreme caution when disconnecting fuel line to prevent the spray of fuel onto hot engine. See Relieving Fuel Pressure on page 23-2.**
- **Carefully drain any fuel into an approved container. Add drained fuel back into fuel tank or dispose of properly.**

5. At fuel tank:
   5.1. Disengage clip as shown **(Figure 23-13, Page 23-17)**.
   5.2. Push in tab to unlock connector and pull fuel line from nipple on fuel pump module and remove line from vehicle.



1. Pull out locking clip.
2. Push in on release tab.
3. While pushing in on release tab, pull fuel line off nipple.

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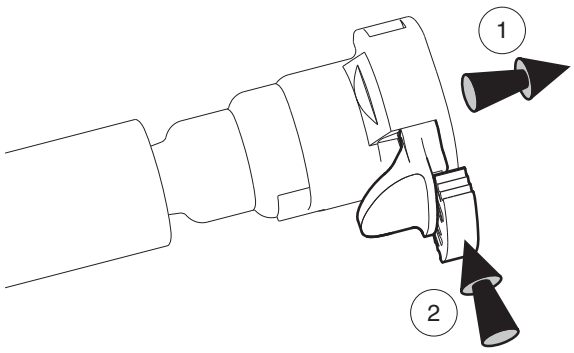
Figure 23-13 Fuel Line Connector – To Disconnect



1. Push fuel line onto nipple until it locks into place.
2. Push in locking clip until fully seated.

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Figure 23-14 Fuel Line Connector – To Connect

FUEL LINE INSTALLATION

1. At fuel tank:
   1.1. Clean the nipple on top of fuel pump module.
   1.2. Push fuel line fully onto nipple until it locks in place **(Figure 23-14, Page 23-17)**.
   1.3. Engage locking clip by pushing in until fully seated and completely prevents the line from being pulled off nipple.
2. At engine:
   2.1. Connect fuel line to throttle body and secure with spring clamp. **See following DANGER.**

⚠ DANGER

- **Ensure line is connected properly to avoid a leak that can cause a fire.**

3. Clean spilled and remove any drained gasoline from the area.
4. Connect battery. **See Connecting the Battery-Gasoline Vehicles on page 1-5.**
5. Place the Forward/Reverse handle in the NEUTRAL position, chock the wheels, and the neutral lockout switch in the MAINTENANCE position **(Figure 26-1, Page 26-1)**.
6. Turn the key switch to the ON position and check for fuel leaks. Repeat as necessary to build fuel pressure. Any leaks found must be fixed.

⚠ DANGER

- **Repair all fuel leaks before returning the vehicle to service.**

7. If no leaks are found, place the neutral lockout switch in the OPERATE position **(Figure 26-1, Page 26-1)**.

FUEL PUMP MODULE

See General Warnings on page 1-1.

GENERAL INFORMATION

NOTE: *The fuel pump and fuel level sending unit themselves are not replaceable. If necessary, the fuel pump module must be replaced as an assembly.*

The fuel pump module can be disassembled to replace the fuel filter.

The EFI gasoline vehicle is equipped with an electric fuel pump. The fuel pump is protected by a filter and pickup screen.

FUEL PUMP MODULE 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 battery. **See Disconnecting the Battery-Gasoline Vehicles on page 1-5.**
3. Clean the top of the fuel tank and fuel pump module (1) **(Figure 23-15, Page 23-20)**.
4. With a marker pen, make a mark across the top of the module (1) and onto the tank to note orientation before removal.
5. Disconnect wire harness plug (2).
6. Disconnect the fuel line (3) and drain into an appropriate container. **See Fuel Line Removal on page 23-16. See following WARNING.**

⚠ WARNING

- **Fuel may be under pressure. Use extreme caution when disconnecting fuel line to prevent the spray of fuel onto hot engine. See Relieving Fuel Pressure on page 23-2.**
- **Carefully drain any fuel remaining in the hose or pump module into an approved container. Add drained fuel back into fuel tank or dispose of properly.**

7. Loosen fuel tank retaining strap (4) to allow tank to move and provide access to all of the fuel pump module hardware (5).
8. Remove hardware (5) securing hold down ring (6) and ground wire (7) to fuel tank.
9. Lift fuel pump module (1) out of fuel tank and drain into an appropriate container. Discard fuel module o-ring (8). **See preceding WARNING and following NOTE.**

NOTE: *If equipped with a fuel level sending unit, carefully maneuver module so as to avoid damaging the float arm mechanism.*

FUEL PUMP MODULE INSTALLATION

1. Clean the groove on top of fuel tank.
2. Place new fuel module o-ring (8) into groove on top of fuel tank **(Figure 23-15, Page 23-20)**.
3. Lower fuel pump module (1) into fuel tank noting correct orientation marked before removal. **See following NOTE and CAUTION.**

NOTE: *If equipped with a fuel level sending unit, carefully maneuver module so as to avoid damaging the float arm mechanism.*

⚠ CAUTION

- **Ensure o-ring stays seated in place during fuel pump module installation.**

4. Install hold down ring (6) and ground wire (7) with hardware (5) and tighten in a crisscross pattern to 66 in·lb (7.5 N·m). **See following WARNING.**

⚠ WARNING

- **Always install ground wires during reassembly.**

5. Tighten fuel tank retaining strap screw (9) to 26.5 in·lb (3 N·m).
6. Connect fuel line (3) to fuel pump module (1). **See Fuel Line Installation on page 23-17. See following DANGER.**

⚠ DANGER

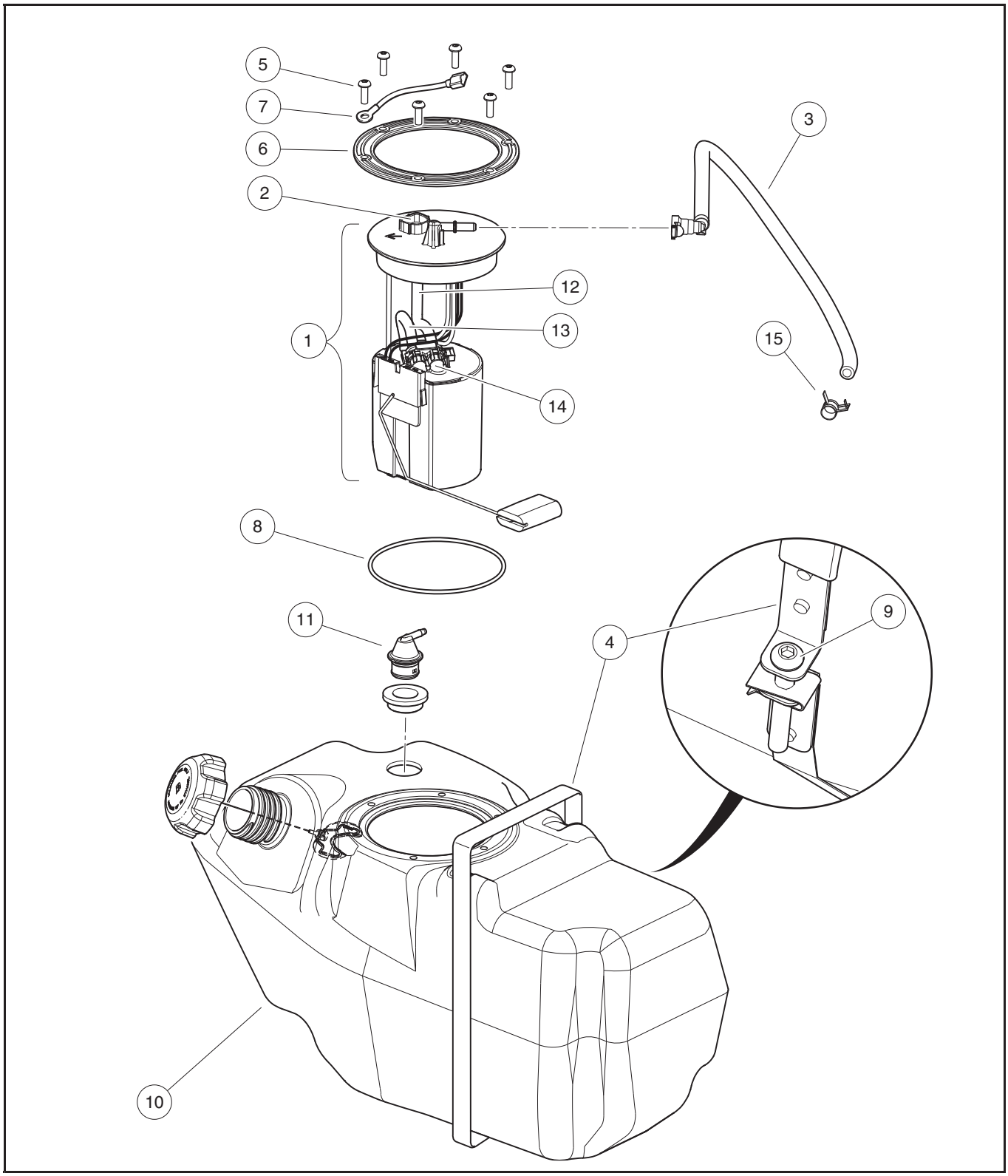
- **Ensure line is connected properly to avoid a leak that can cause a fire.**

7. Connect wire harness plug (2) to fuel pump module (1).
8. Clean spilled and remove any drained gasoline from the area.
9. Connect battery. **See Connecting the Battery-Gasoline Vehicles on page 1-5.**
10. Place the Forward/Reverse handle in the NEUTRAL position, chock the wheels, and the neutral lockout switch in the MAINTENANCE position **(Figure 26-1, Page 26-1)**.
11. Turn key switch to the ON position and check for fuel leaks. Repeat as necessary to build fuel pressure. Any leaks found must be fixed.

⚠ DANGER

- **Repair all fuel leaks before returning the vehicle to service.**

12. If no leaks are found, place the neutral lockout switch in the OPERATE position **(Figure 26-1, Page 26-1)**.



3052

Figure 23-15 Fuel System (Side-Fill) – Exploded View

FUEL TANK

See General Warnings on page 1-1.

GENERAL INFORMATION

The vehicle is equipped with a high impact, plastic 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.**

NOTE: *This gasoline vehicle complies with the California Air Resources Board (CARB) and EPA evaporative emissions regulations when equipped with SAEJ30R9 1/4 in (6.3 mm) fuel vent hose (CC P/N 102865101) and 3/16 in (4.78 mm) fuel vent hose (CC P/N 1015137). To remain in compliance with California and EPA regulations, replace any fuel vent hose on this vehicle with Club Car P/N's 102865101, 1015137, or equivalent.*

FUEL TANK REMOVAL

1. Place the Forward/Reverse handle in the NEUTRAL position, chock the wheels, and the neutral lockout switch in the MAINTENANCE position.
2. Turn key switch to OFF position and remove key.
3. Disconnect battery. **See Disconnecting the Battery-Gasoline Vehicles on page 1-5.**
4. Clean the top of the fuel tank (10) and fuel pump module (1) **(Figure 23-15, Page 23-20)**.
5. Remove gas cap and siphon all fuel from tank 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.**

6. Disconnect wire harness plug (2) from fuel pump module (1).
7. Disconnect vent hose from fuel tank vent (11).
8. Disconnect the fuel line (3) from the fuel pump module (1) and drain into an appropriate container. **See Fuel Line Removal on page 23-16. See following WARNING.**

⚠ WARNING

- **Fuel may be under pressure. Use extreme caution when disconnecting fuel line to prevent the spray of fuel onto hot engine. See Relieving Fuel Pressure on page 23-2.**
- **Carefully drain any fuel remaining in the hose or pump module into an approved container. Add drained fuel back into fuel tank or dispose of properly.**

9. Disconnect fuel pump module ground wire (7).
10. Loosen screw (9) securing fuel tank retaining strap (4) and remove fuel tank (10).

FUEL TANK DISPOSAL

1. Remove gas cap and fuel pump module from tank. **See Fuel Pump Module Removal on page 23-18.** 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.**

FUEL TANK STORAGE

1. Remove gas cap and fuel pump module from tank. **See Fuel Pump Module Removal on page 23-18.**
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. Completely drain gas from fuel pump module and allow to module to dry.
5. After module is completely dry, install in fuel tank. **See Fuel Pump Module Installation on page 23-18.**
6. Store the tank upside down, with the cap installed, in a well-ventilated area.

FUEL TANK INSTALLATION

NOTE: *This gasoline vehicle complies with the California Air Resources Board (CARB) and EPA evaporative emissions regulations when equipped with SAEJ30R9 1/4 in (6.3 mm) fuel vent hose (CC P/N 102865101) and 3/16 in (4.78 mm) fuel vent hose (CC P/N 1015137). To remain in compliance with California and EPA regulations, replace any fuel vent hose on this vehicle with Club Car P/N's 102865101, 1015137, or equivalent.*

1. Place fuel tank (10) in vehicle.
2. Secure tank with retaining strap (4).
   2.1. Position the strap (4) in the indention of the tank (10) **(Figure 23-15, Page 23-20)**.
   2.2. Install the screw (9) into retaining strap (4) and tighten to 26.5 in·lb (3 N·m).
3. Connect fuel pump module ground wire (7) to main wire harness. **See following WARNING.**

⚠ WARNING

- **Always install ground wires during reassembly.**

4. Connect fuel line (3) to fuel pump module (1). **See Fuel Line Installation on page 23-17. See following DANGER.**

⚠ DANGER

- **Ensure line is connected properly to avoid a leak that can cause a fire.**

5. Connect wire harness plug (2) to fuel pump module (1).
6. Clean spilled and remove any drained gasoline from the area.
7. Connect battery. **See Connecting the Battery-Gasoline Vehicles on page 1-5.**
8. Add fuel to tank.
9. Place the Forward/Reverse handle in the NEUTRAL position, chock the wheels, and the neutral lockout switch in the MAINTENANCE position **(Figure 26-1, Page 26-1)**.
10. Turn key switch to the ON position and check for fuel leaks. Repeat as necessary to build fuel pressure. Any leaks found must be fixed.

⚠ DANGER

- **Repair all fuel leaks before returning the vehicle to service.**

11. If no leaks are found, place the neutral lockout switch in the OPERATE position **(Figure 26-1, Page 26-1)**.

FUEL FILTER

See General Warnings on page 1-1.

GENERAL INFORMATION

The fuel filter is located in the fuel tank. It is part of the fuel pump module assembly and should last the life of the vehicle; however, it is replaceable if the need should arise. In addition, the module assembly features a fuel pickup screen to catch larger particles before entering the fuel filter.

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 battery. **See Disconnecting the Battery-Gasoline Vehicles on page 1-5.**
3. Remove fuel pump module (1). **See Fuel Pump Module Removal on page 23-18.**
4. Disconnect flex hoses (12 and 13) from filter (14) **(Figure 23-15, Page 23-20)**.
   4.1. Pull hose retainer clip straight up and out of filter (14). Do not discard clip.
   4.2. Pull flex hoses (12 and 13) straight out of filter inlet and outlet.
5. Remove filter (14) from module (1) and dispose of properly.

FUEL FILTER INSTALLATION

⚠ CAUTION

- **Fuel filter flex hoses are keyed to aid proper installation into fuel pump module.**

NOTE: *The fuel filter is keyed to the fuel pump module to prevent incorrect assembly.*

The inlet and outlet flex hoses are keyed to the fuel filter ports to prevent incorrect assembly.

1. Orient fuel filter (14) and insert into fuel pump module (1) until fully seated **(Figure 23-15, Page 23-20)**.
2. Connect flex hoses (12 and 13) to the fuel filter (14).
   2.1. Orient flex hoses (12 and 13) with matching port in filter (14) and push each hose end straight into filter until fully seated.
   2.2. Push hose retainer clip straight into filter (14) until fully seated.
3. Install fuel pump module (1). **See Fuel Pump Module Installation on page 23-18.**
4. Connect battery and spark plug wire(s). **See Connecting the Battery-Gasoline Vehicles on page 1-5.**
5. Place the Forward/Reverse handle in the NEUTRAL position, chock the wheels, and the neutral lockout switch in the MAINTENANCE position **(Figure 26-1, Page 26-1)**.
6. Start the engine and check for fuel leaks. **See following DANGER.**

⚠ DANGER

- **Repair all fuel leaks before operating the vehicle.**

7. If no leaks are found, place the neutral lockout switch in the OPERATE position **(Figure 26-1, Page 26-1)**.

FUELING INSTRUCTIONS – GASOLINE VEHICLE

See General Warnings on page 1-1.

⚠ DANGER

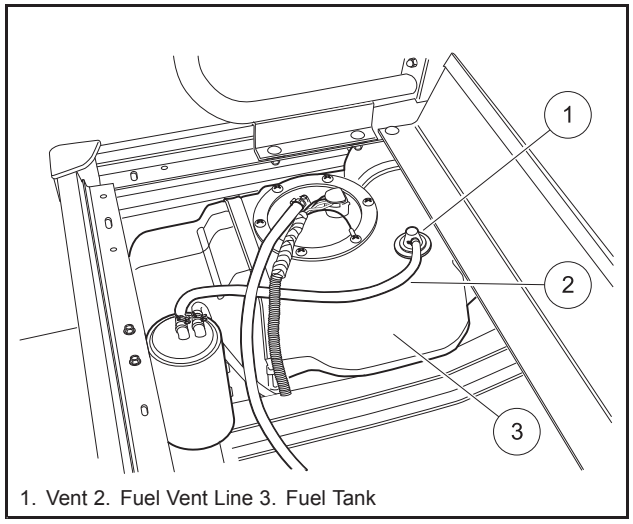
- **Turn the key switch to the OFF position before fueling.**
- **Do not pour fuel into the fuel tank when the engine is hot or while it is running.**
- **Be sure the fuel tank ground wire on the tank is properly connected before fueling the vehicle.**
- **To avoid electric arc caused by static electricity, 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 in Figure 23-16.**
- **To avoid the possibility of fire, clean up any spilled fuel before operating the vehicle.**

CAUTION

- **Use unleaded gasoline only.**
- **Whenever possible, avoid using oxygenated and blended fuels.**
- **Do not use any fuel with an alcohol content that exceeds 10% by volume (such as E15 and E85). Ethanol is an alcohol that readily absorbs moisture, causing corrosion of fuel system components. It also damages neoprene and other plastic and rubber components. Use of these fuels in this vehicle will void the warranty.**
- **Do not repeatedly attempt to start a vehicle when the fuel pump is dry (no gas in tank). Doing so can damage the fuel pump.**

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 Storage on page 3-4.***

1. Remove the fuel cap located on the passenger-side panel and fill the fuel tank with fresh unleaded gasoline only. **See preceding CAUTION and NOTE.**
2. Replace fuel cap on tank. Ensure cap is tightened securely (tighten until it clicks).



1. Vent 2. Fuel Vent Line 3. Fuel Tank

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Figure 23-16 Fuel Tank

Pagination Page

SECTION 24 — EXHAUST SYSTEM: GASOLINE VEHICLES

⚠ DANGER

- **See General Warnings on page 1-1.**

⚠ WARNING

- **See General Warnings on page 1-1.**

MUFFLER

MUFFLER REMOVAL

1. Disconnect battery and spark plug wire(s). **See Disconnecting the Battery-Gasoline Vehicles on page 1-5.**
2. If equipped, remove air deflector from top of engine.
3. Remove the locknut (1) securing the muffler (2) to its mounting bracket **(Figure 24-1, Page 24-2)**.
4. Remove the hex nuts (3) and lock washers (4) at the cylinder head and remove muffler (2) from vehicle.

MUFFLER INSTALLATION

NOTE: *Any time the muffler is removed from the vehicle, install a new exhaust gasket (5) (CC P/N 47539957001).*

Two different exhaust gaskets have been used; one with a raised port opening, that has since been replaced by the other; a flat, metal-reinforced, graphite gasket. Follow instructions below for proper orientation of the exhaust gasket with raised port opening.

1. If muffler bracket (6) was loosened or removed, tighten bolts (9) to 17 ft·lb (23 N·m) and then bolts (7) to 50 ft·lb (68 N·m) **(Figure 24-1, Page 24-2)**.
2. Replace exhaust gasket (5) on the cylinder head exhaust port studs with a new gasket. For exhaust gasket with raised port opening, orient gasket (5) with raised section of gasket up against the flange of the muffler.
3. Place muffler (2) into position and loosely secure it to mounting bracket with locknut (1) and to cylinder head with lock washers (4) and hex nuts (3).
4. Tighten hardware in the following order:
   - 4.1. At the cylinder head, tighten passenger-side hex nut (3) to 15 ft·lb (20 N·m).
   - 4.2. At the cylinder head, tighten driver-side hex nut (3) to 15 ft·lb (20 N·m).
   - 4.3. At the mounting bracket, tighten locknut (1) to 34 ft·lb (46 N·m).
5. If equipped, install air deflector on top of engine.
6. Connect battery and spark plug wire(s). **See Connecting the Battery-Gasoline Vehicles on page 1-5.**
7. Place the shifter handle in NEUTRAL, the neutral lockout switch in MAINTENANCE, and chock the wheels.
8. 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.**

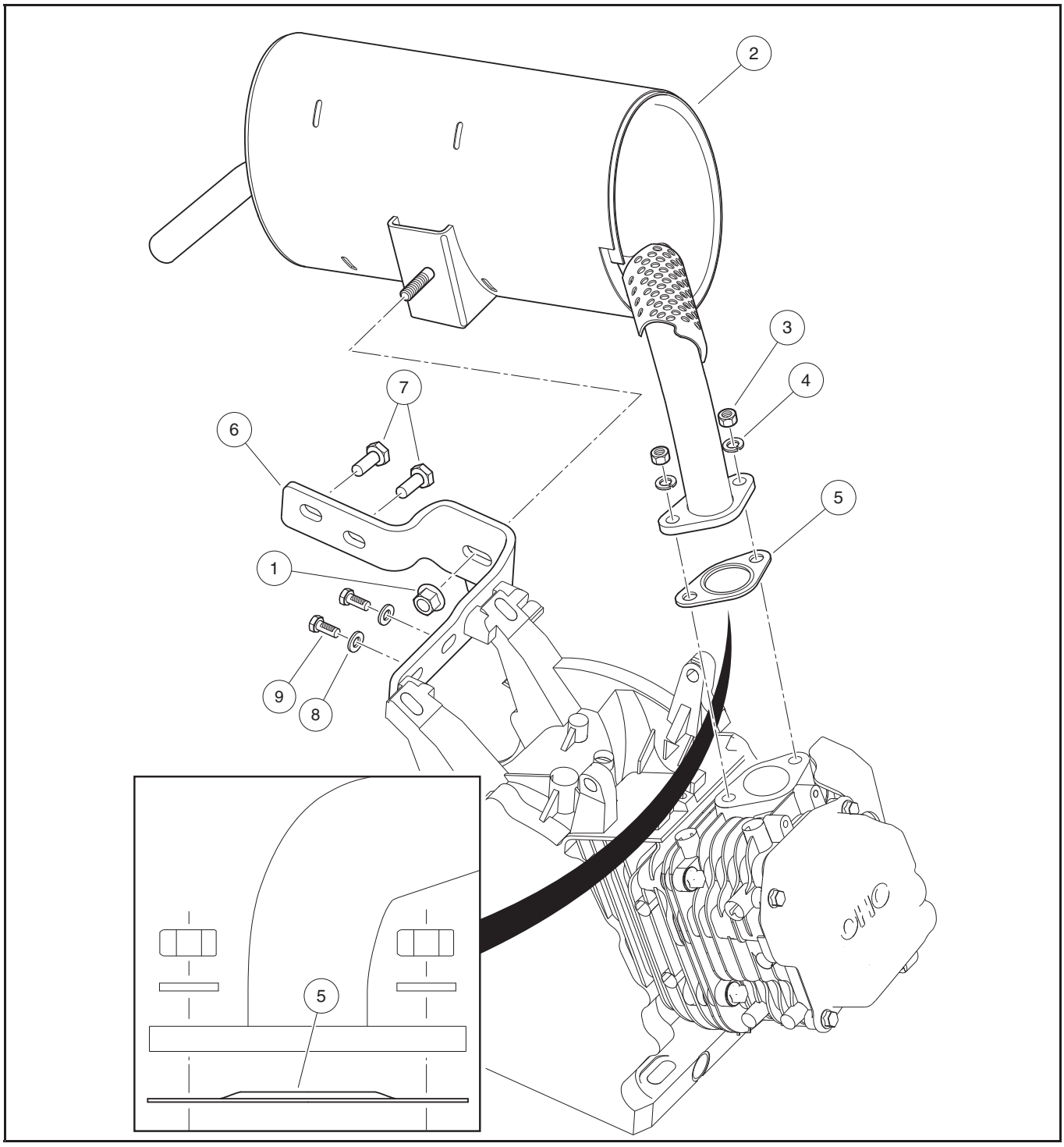

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Figure 24-1 Exhaust System

SECTION 25 — CLUTCHES: GASOLINE VEHICLES

⚠ DANGER

- **See General Warnings on page 1-1.**

⚠ WARNING

- **See General Warnings on 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 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.

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 counter-clockwise as viewed from the clutch side of the engine.

To provide optimum performance for the 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:

- Clutch Tools **(Figure 25-1, Page 25-2)**.
- Scribe or small pick (not included with clutch tools).

TROUBLESHOOTING

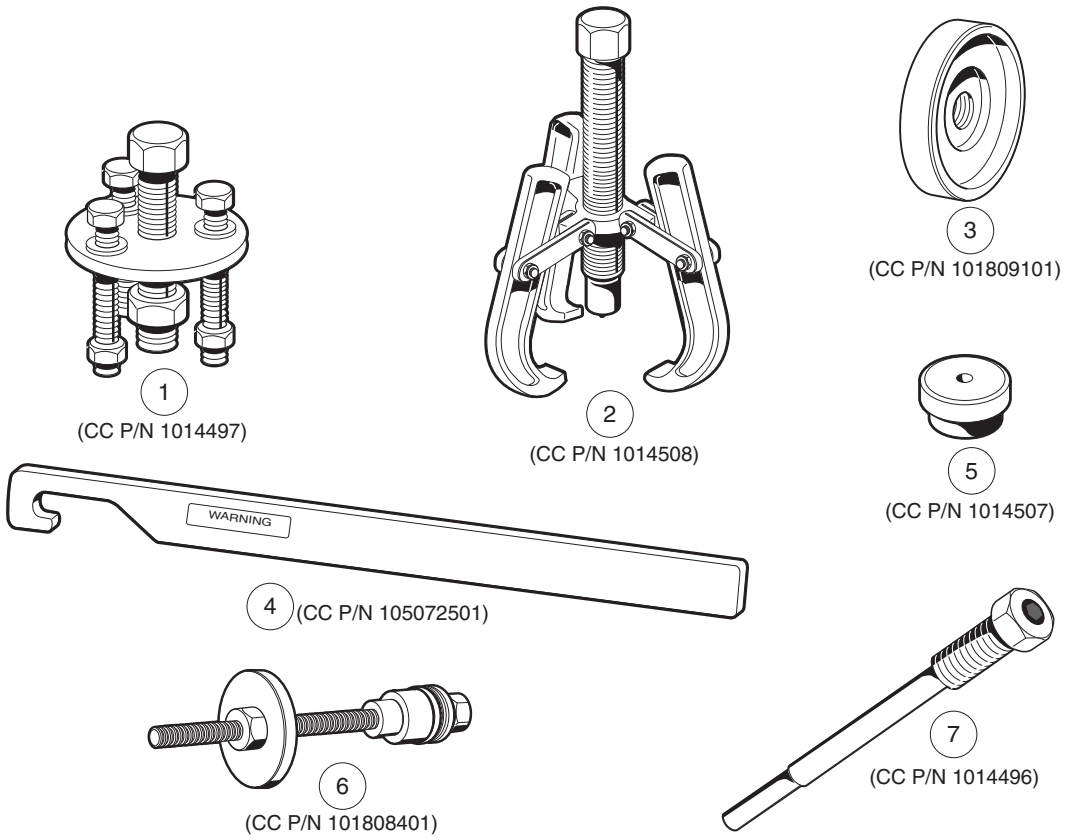
See General Warnings on page 1-1.

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, perform the following steps:

1. Check the governor and throttle settings. **See Engine Control Linkages on page 23-6.**
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 (7) **(Figure 25-3, Page 25-4)**.



1. Drive Clutch Hub Puller 2. Driven Clutch Cam Puller 3. Driven Clutch Cam Press Tool 4. Drive Clutch Holder Tool 5. Driven Clutch Puller Plug 6. Cam Installation Tool 7. Drive Clutch Puller

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Figure 25-1 Clutch Tools

DRIVE BELT

See General Warnings on 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. **Section 2 — Vehicle Specifications**

DRIVE BELT REMOVAL

1. Disconnect battery and spark plug wire(s). **See Disconnecting the Battery-Gasoline Vehicles on page 1-5.**
2. Grasp the belt midway between the drive (2) and driven (1) clutches. Lift upward on the belt to force the sheaves of the driven clutch (1) apart, then roll the belt off the driven clutch by rotating the clutch counterclockwise **(Figure 25-2, Page 25-3)**. **See following CAUTION.**

⚠ CAUTION

- **Make sure fingers are not underneath the belt when rolling the belt off the driven clutch.**

3. Remove the belt from the drive clutch (2).

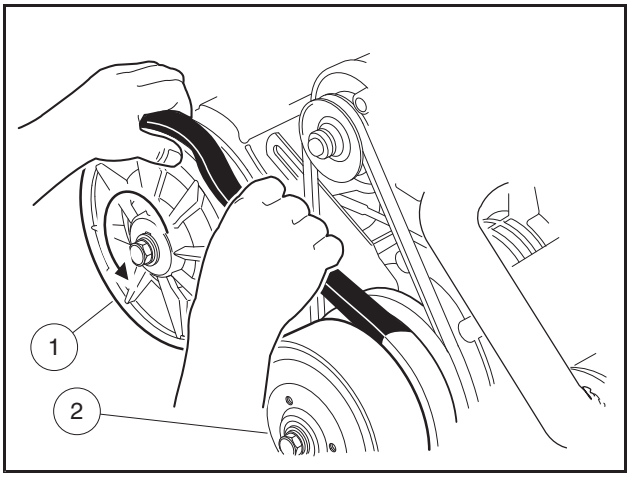

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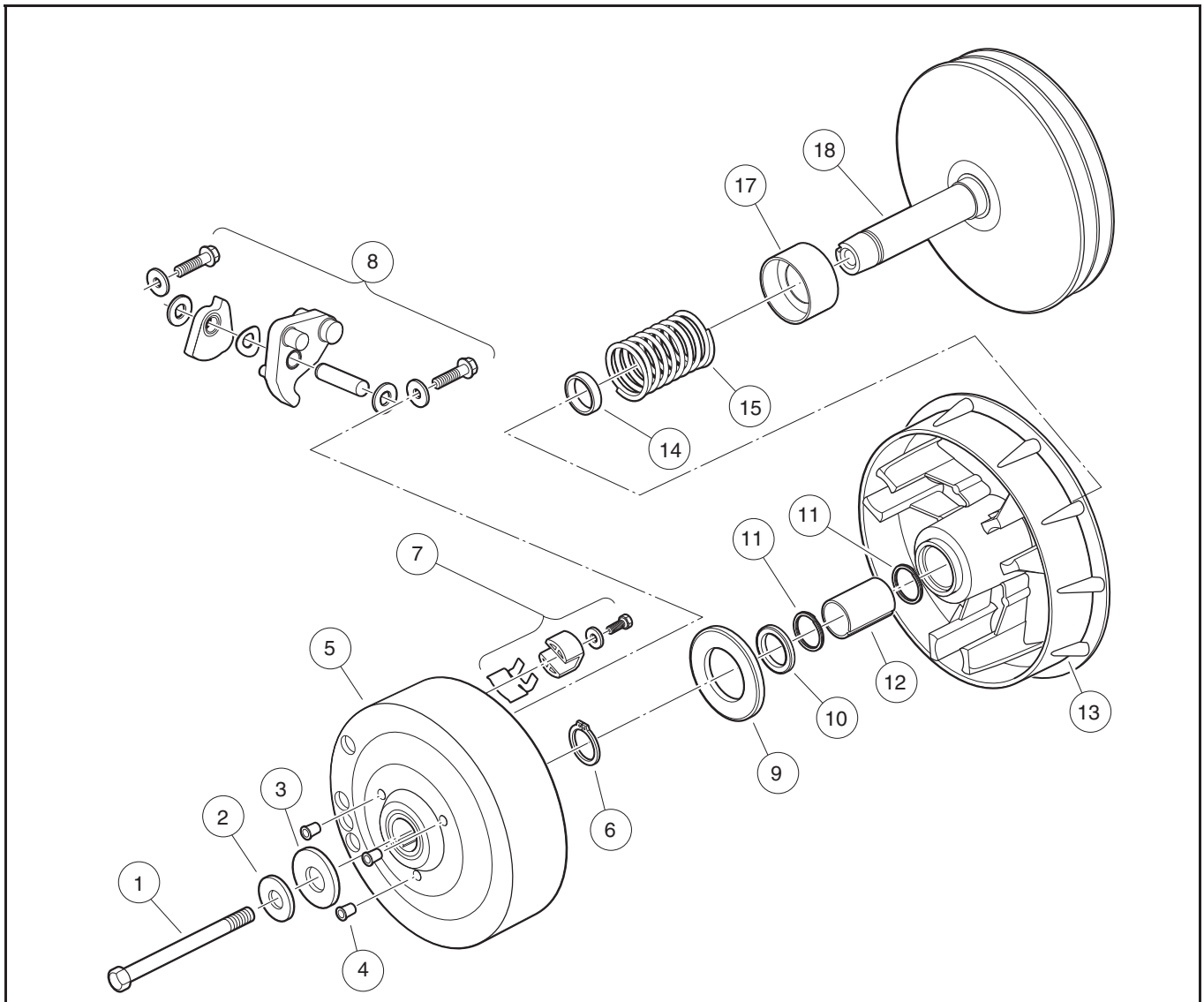
Figure 25-2 Drive Belt Removal

DRIVE BELT INSTALLATION

1. Position the new belt on the drive clutch (2), then start the belt over the top of the driven clutch (1).
2. With the belt started onto the driven clutch (1), rotate the driven clutch counterclockwise and roll the belt over the outer, moveable sheave.
3. Connect battery and spark plug wire(s). **See Connecting the Battery-Gasoline Vehicles on page 1-5.**

DRIVE CLUTCH

See General Warnings on page 1-1.



1. Screw, 3/8-24 x 5.75, Patch	10. Retainer
2. Washer, Hard, M10	11. Ring, Spiral Backup
3. Washer, 3/8, Type A, Flat	12. Bushing, Split, Drive Clutch
4. Cap Plug	13. Sheave, Moveable, Drive
5. Drive Hub Assy, Drive Clutch	14. Spacer, Fixed Face Shaft
6. Ring, 0.810 in. (20.5 mm) Internal Retaining	15. Spring, Drive Clutch
7. Drive Clutch Button	16. No Item to Show

8. Drive Clutch Weight	17. Spacer, Idler, Drive
9. Thrust Washer	18. Sheave, Fixed, Drive

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Figure 25-3 Drive Clutch – Exploded View

⚠ 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 25-3.**
2. Loosen starter/generator mounting and adjusting hardware and remove starter belt. **See WARNING "Moving parts! Do not..." in General Warnings on page 1-1.**

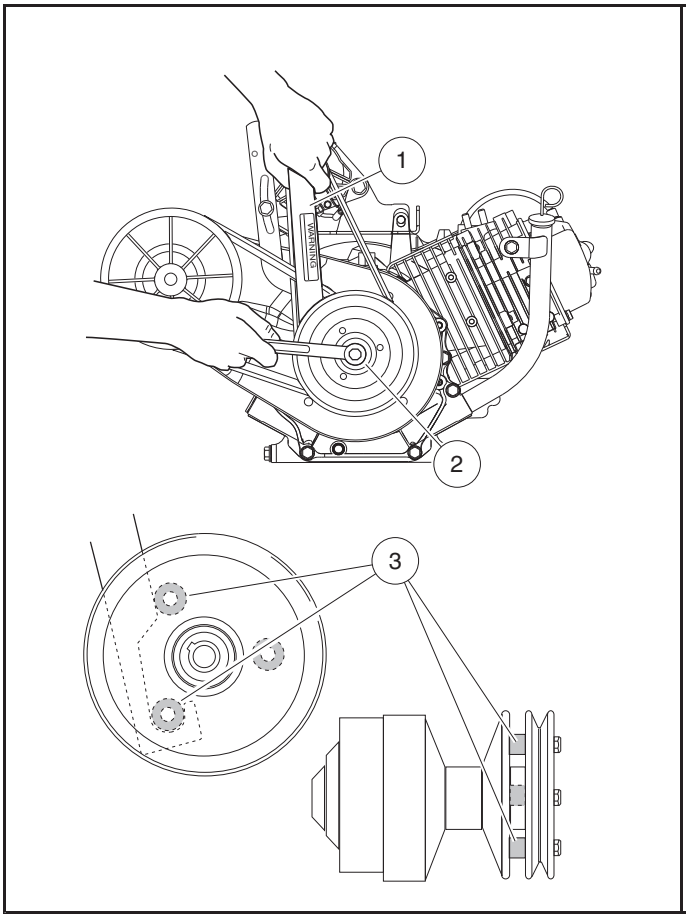

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Figure 25-4 Loosen Retaining Bolt

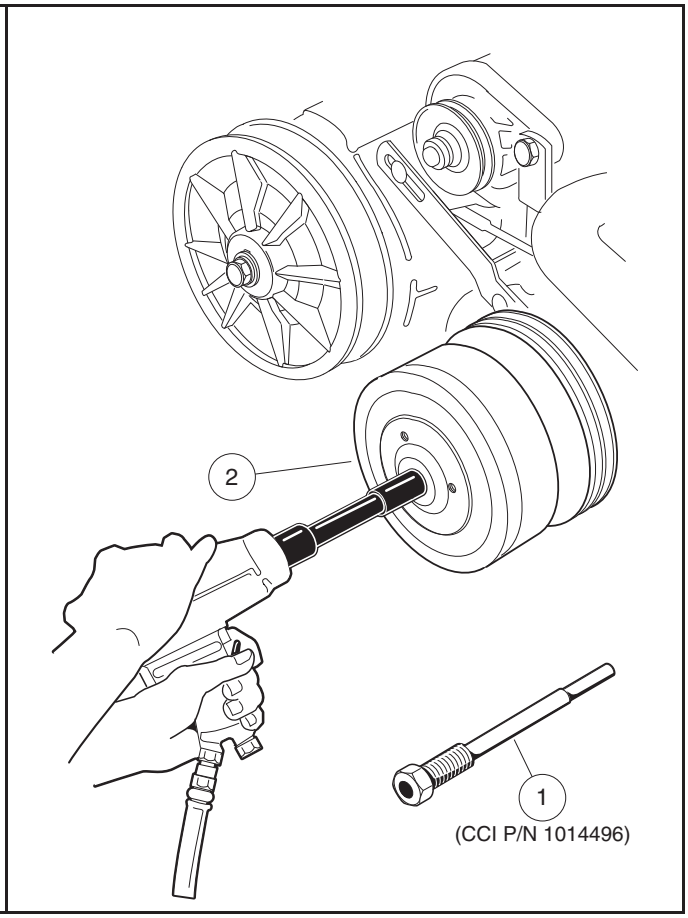

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Figure 25-5 Drive Clutch Removal

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 chassis to support the vehicle. The weight of the powertrain will allow 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 bolt (1) and mounting washers (2 and 3) **(Figure 25-3, Page 25-4)**. **See also Figure 25-4, Page 25-5. See following NOTE.**

NOTE: *The drive clutch mounting bolt has right-hand threads.*

The crankshaft has right-hand threads at the clutch mounting hole.

4.1. Use the drive clutch holder tool (1) while tightening or loosening the drive clutch retaining bolt (2) **(Figure 25-4, Page 25-5)**.

4.2. Hook clutch holder on boss (3) of pulley located behind drive clutch and push against the adjacent boss with holder.

5. Lubricate the threaded portion of the clutch puller tool (1) with a light oil and thread the clutch puller tool into the clutch retaining bolt hole **(Figure 25-5, Page 25-5)**.
6. Use a 1/2-in. drive air wrench to tighten the clutch puller tool. The drive clutch (2) will pull free of the crankshaft.
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 sheave (18) (Figure 25-3, Page 25-4). 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 in. (1.52 mm) or more, the clutch should be replaced.

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 sheave so they can be reassembled in the same positions (Figure 25-6, Page 25-7).**

1. Make match marks on the drive clutch hub and on the moveable face **(Figure 25-6, Page 25-7)**.
2. Remove the drive clutch hub (5) **(Figure 25-3, Page 25-4)**:
   2.1. Remove the three plugs (4) from the clutch puller attachment holes.
   2.2. Thread the center bolt of the Drive Clutch Hub Puller (1) (CC P/N 1014497) into clutch until the stop nut touches the clutch, then back the bolt out one-half turn **(Figure 25-7, Page 25-7)**.
   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 25-7, Page 25-7)**.
   2.4. Unscrew the puller center bolt out of the clutch to pull drive clutch hub off.

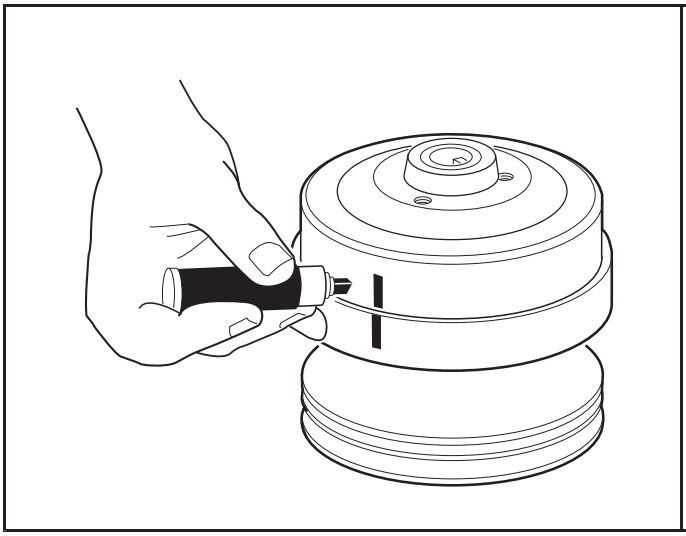

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Figure 25-6 Mark Drive Clutch Hub

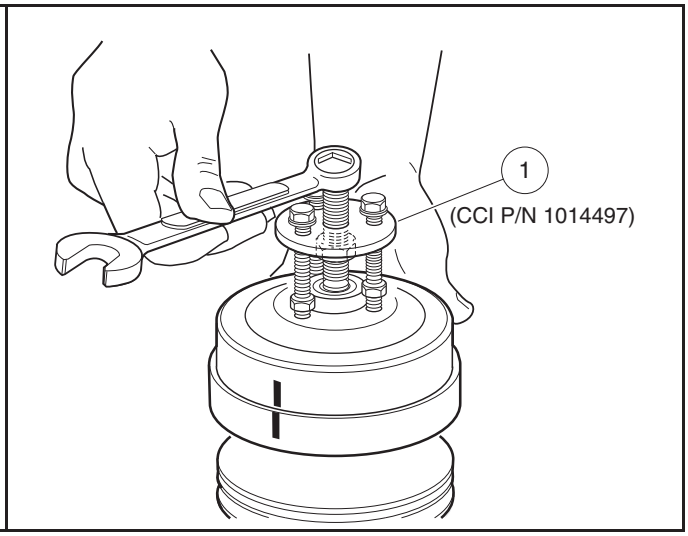

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Figure 25-7 Remove Drive Clutch Hub

3. Remove the thrust washer (9) from the moveable sheave (13) **(Figure 25-3, Page 25-4)**.
4. Remove the drive buttons (3) by removing the screws (1), flat washers (2), and drive button take-up springs (4) as shown **(Figure 25-8, Page 25-8)**.

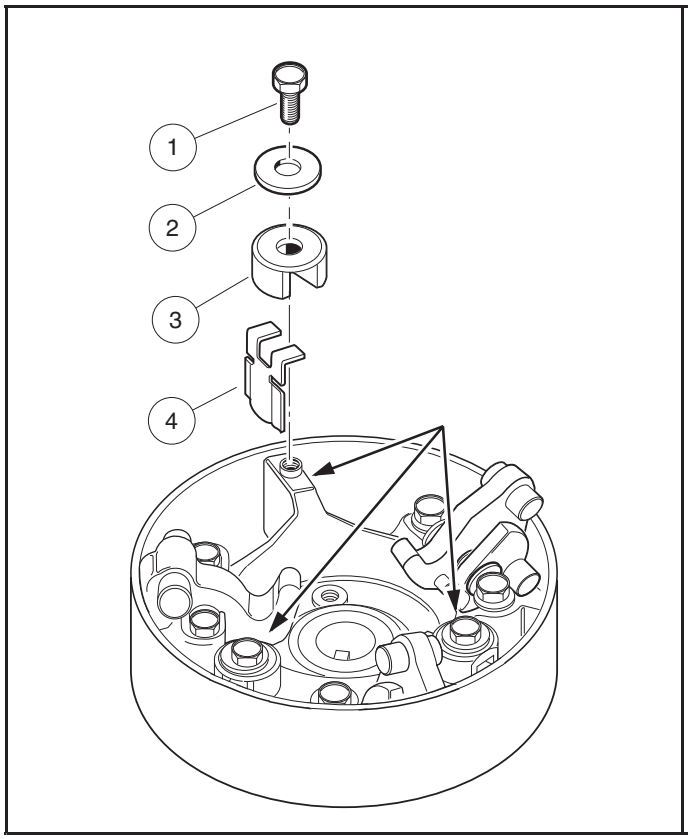

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Figure 25-8 Drive Button Mounting

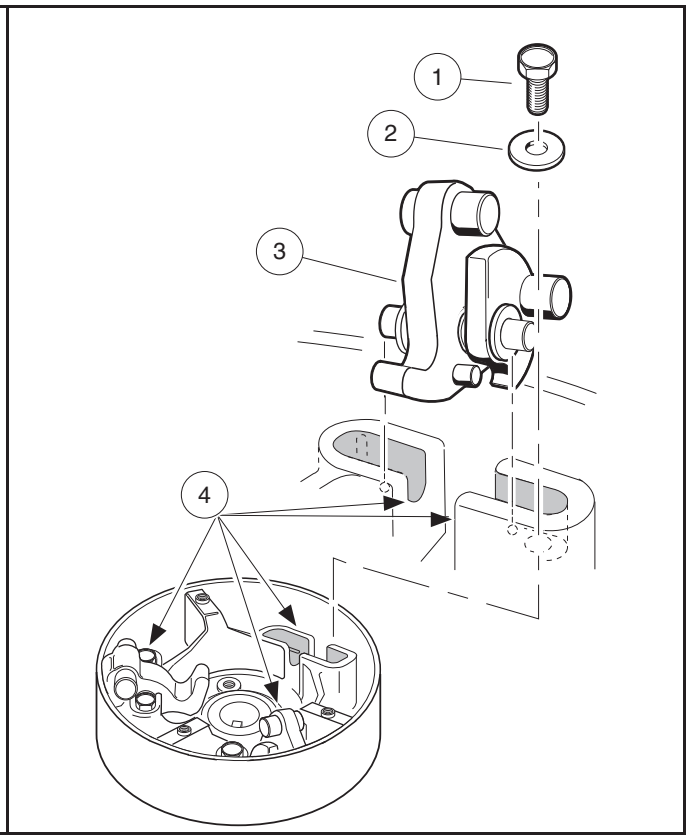

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Figure 25-9 Weight Position

5. Remove the clutch weights:
   5.1. Remove the screws (1) and flat washers (2) attaching the weights (3) as shown **(Figure 25-9, Page 25-8)**.
   5.2. Pull the weight assemblies (3), with pins, from slots (4) in the clutch. **See following NOTE.**

NOTE: *Before removing, note the orientation of the wave washer (1) and secondary weight (2) on the primary weight (3)* ***(Figure 25-10, Page 25-9)****.*

   5.3. Remove the plastic washers, weights (2 and 3) and wave washer (1) from the pin (4). Retain all parts.

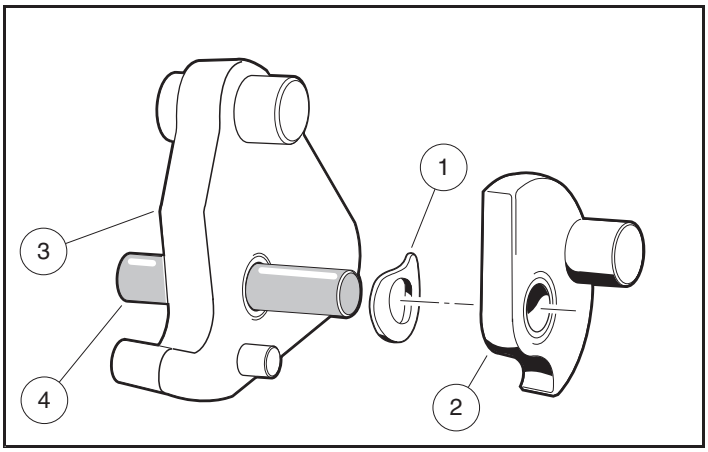

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Figure 25-10 Primary and Secondary Weights, Wave Washer and Pin

6. Remove the retaining ring (6) from the shaft of the fixed sheave (18) and slide the moveable sheave (13) off the shaft **(Figure 25-3, Page 25-4)**. **See following NOTE.**

NOTE: *If the moveable sheave is removed from the hub of the fixed sheave, the spiral back-up rings (11) must be replaced with new rings* ***(Figure 25-3, Page 25-4)****.*

7. Remove the spacer (14) and spring (15) **(Figure 25-3, Page 25-4)**.
8. Use a scribe or small pick to remove the spiral backup rings (11) from each end of the bore in the fixed sheave **(Figure 25-3, Page 25-4)**. **See also Figure 25-11, Page 25-9.** Discard the rings.

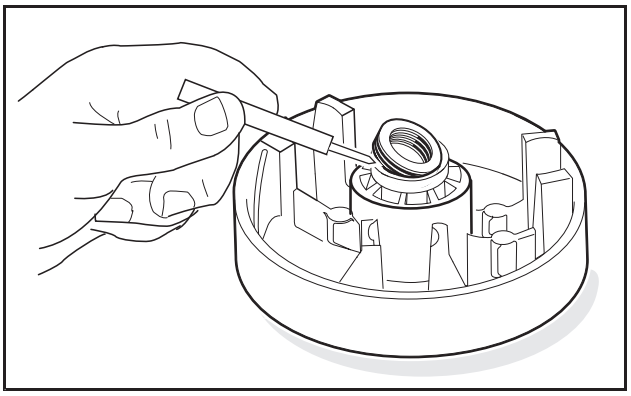

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Figure 25-11 Spiral Back-up Rings

INSPECTION OF DRIVE CLUTCH PARTS

1. Inspect the idler spacer (17) for smoothness **(Figure 25-3, Page 25-4)**.
2. Inspect the bore of the moveable sheave (13) for scarring or wear. The moveable sheave must be replaced if the bore is worn to a diameter of 0.883 in. (22.4 mm) or larger **(Figure 25-3, Page 25-4)**.
3. Inspect the steel shaft on the fixed sheave (18). 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 (9) for wear. If it is worn more than 0.030 in. (0.76 mm), turn it over or replace it with a new one.

5. Inspect the primary weights (8) 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.
6. Inspect the pins on the primary weights (8). 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 sheave.

DRIVE CLUTCH ASSEMBLY

1. Install the spring (15) into the cup of the idler spacer (17).
2. Install the spacer (14) onto the shaft of the fixed sheave.
3. Install a new spiral backup ring (11) in each end of the bore of the moveable sheave (13).
4. Install the moveable sheave (13) onto the shaft of the fixed sheave (18).

⚠ CAUTION

- **To avoid damaging the spiral back-up rings, be very careful when installing the moveable sheave.**

4.1. Rotate the moveable sheave clockwise while installing it onto the shaft.

4.2. Install the retaining ring (6) **(Figure 25-3, Page 25-4)**.

5. Install the primary weights (3) on the mounting pins (4) **(Figure 25-10, Page 25-9)**.
6. Install a wave washer (1) on each mounting pin (4). Make sure that the concave side of the washer faces the side of the primary weight (3) with the small guide pin protruding from it **(Figure 25-10, Page 25-9)**.
7. Install the secondary weights (2) onto the mounting pins (4) with the weight pins on the secondary weights pointing away from the primary weights (3). The wave washers should be between the primary and secondary weights **(Figure 25-10, Page 25-9)**.
8. 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 25-12, Page 25-10)**.
9. Install the weight assemblies into the slots (4) in the hub casting **(Figure 25-9, Page 25-8)**. Make sure the mounting pin protrudes an equal amount on each side of the weights when the assemblies are in position **(Figure 25-12, Page 25-10)**.

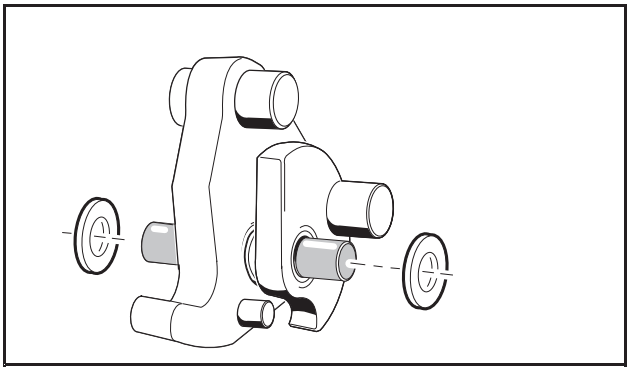

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Figure 25-12 Install White Washers

10. Install the 1/4-20 bolts (1) and washers (2) and tighten them to 10 ft·lb (13 N·m) **(Figure 25-9, Page 25-8)**. **See following NOTE.**

NOTE: *Make sure there is at least a (minimum) gap of 0.020 in. (0.51 mm) between each end of the mounting pin and the mounting bolt.*

11. Install three drive button take-up springs.
    11.1. 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 25-13, Page 25-11)**.
12. Compress each take-up spring and install the drive button over the rib and take-up spring **(Figure 25-8, Page 25-8)**.
13. Install a drive button retaining bolt (1) with flat washer (2) through each button (3) and into the rib. Tighten the bolts to 34 in·lb (3.8 N·m) **(Figure 25-8, Page 25-8)**.
14. Install the thrust washer (9) onto the moveable sheave (13) **(Figure 25-3, Page 25-4)**.
15. Install the hub assembly (5) on the moveable sheave (13) and align the match marks made before disassembling the clutch. Press the hub assembly on by hand.
16. Replace the three plastic plugs (4) into the holes **(Figure 25-3, Page 25-4)**.

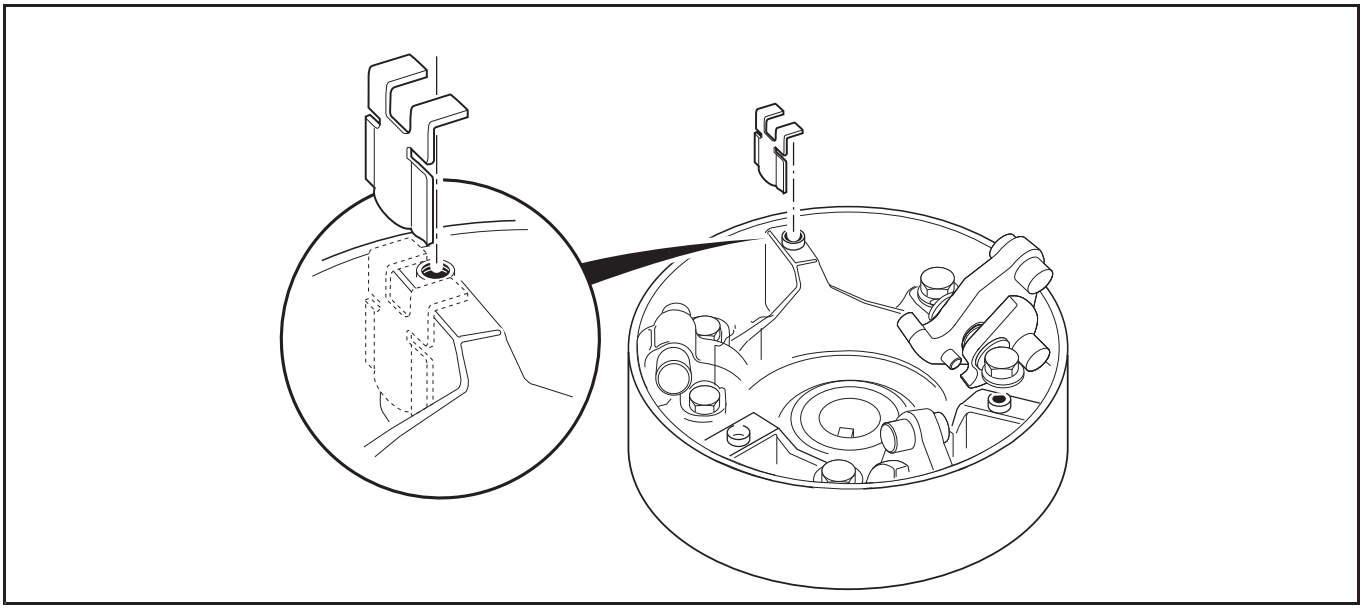

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Figure 25-13 Correct Orientation of Drive Button Take-up Springs

DRIVE CLUTCH INSTALLATION

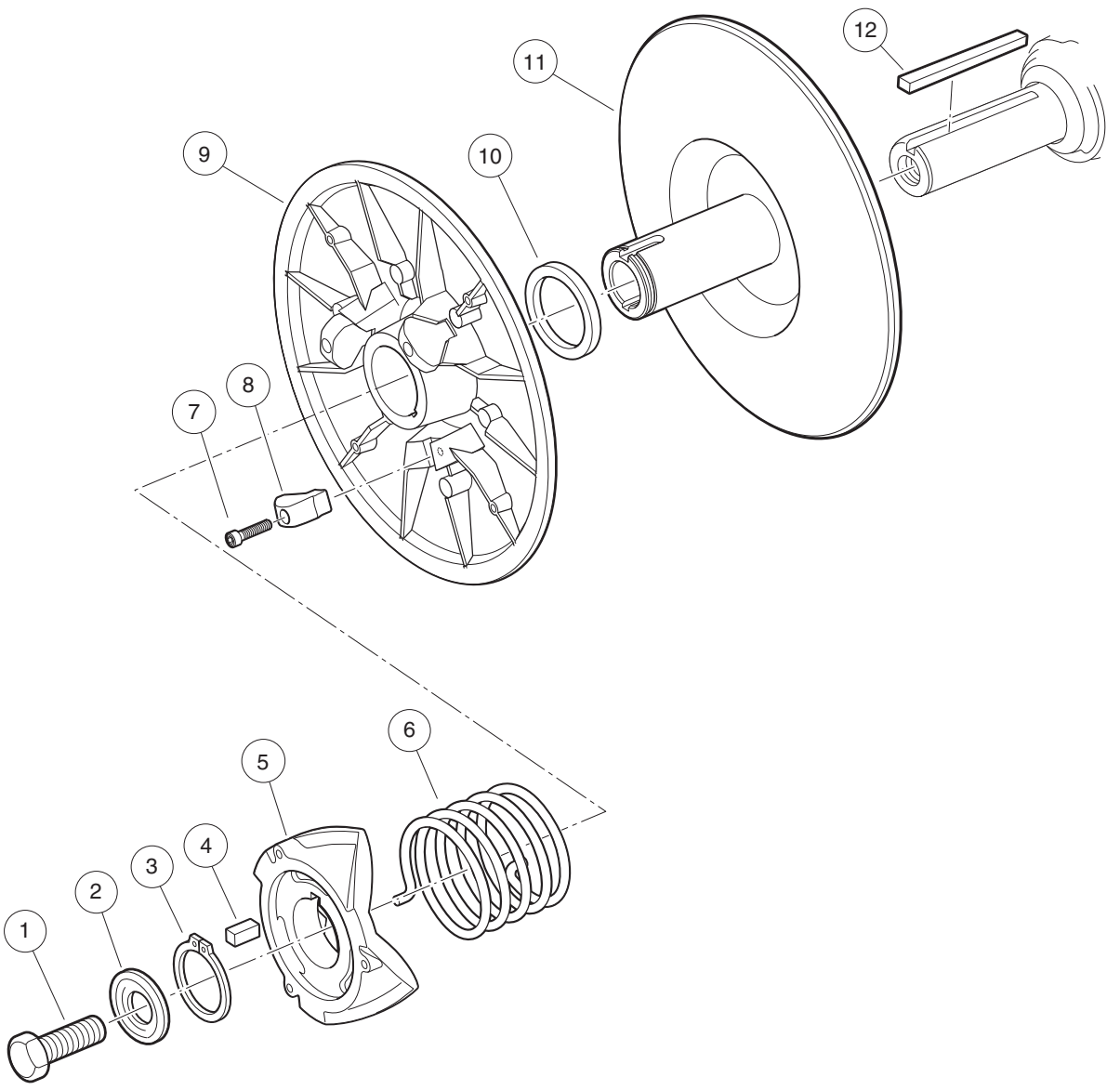
1. Place the drive clutch assembly on the crankshaft taper. Position the mounting washers (2 and 3) on the bolt (1) and start the bolt into the crankshaft **(Figure 25-3, Page 25-4)**. **See following NOTE.**

NOTE: *The drive clutch retaining bolt has right-hand threads. The manufacturer recommends replacing the drive clutch retaining bolt (CC PN 103976101) when installing the drive clutch. If a new bolt is not available, clean the threads of the original bolt and apply Loctite® 242 to the threaded end prior to installation.*

2. Tighten the drive clutch retaining bolt (1) to 35 ft·lb (47.5 N·m) **(Figure 25-3, Page 25-4)**.
3. Install the starter/generator belt and adjust belt tension as instructed. **See Belt Tension Adjustment for EFI Engines, Section 20, Page 20-13.**
4. Install the drive belt as instructed. **See Drive Belt Installation on page 25-3.**
5. Connect battery and spark plug wire(s). **See Connecting the Battery-Gasoline Vehicles on page 1-5.**
6. Drive the vehicle and check for proper operation.

DRIVEN CLUTCH

See General Warnings on page 1-1.



1. Screw, 5/16-18 X 3/4 Hex-Head with Patch	7. Screw, #8-32 X 3/4, Socket-Head Cap
2. Washer, Driven Clutch	8. Button, Drive
3. Ring, Retaining	9. Sheave, Movable, Driven
4. Key, Driven Clutch	10. Washer, Acetal, Driven Clutch

5. Cam, Driven Clutch	11. Sheave, Fixed, Driven
6. Spring, Driven Clutch, 55 Degree	12. Key, 3/16 in. (4.7 mm) Square X 1.50 in. (38 mm) Long

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Figure 25-14 Driven Clutch – Exploded View

DRIVEN CLUTCH REMOVAL

1. Remove the drive belt as instructed. **See Drive Belt Removal on page 25-3.**
2. Remove the bolt (1) and mounting washer (2) from the transaxle input shaft **(Figure 25-14, Page 25-12)**.
3. Grasp the driven clutch assembly and slide it off the shaft.
4. Leave the key (12) in the keyway.

DRIVEN CLUTCH DISASSEMBLY

⚠ CAUTION

- **The driven clutch is balanced as an assembly. Before disassembly, make match marks on the driven clutch fixed sheave and moveable sheave so they can be reassembled in the same positions.**

1. Make match marks on the driven clutch fixed sheave and on the moveable sheave to maintain balance upon reassembly.
2. Using external snap ring pliers, remove the retaining ring (4) **(Figure 25-15, Page 25-14)**. **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.**

3. Insert a puller plug (2) (CC P/N 1014507) **(Figure 25-16, Page 25-14)** into the shaft bore and use a driven clutch cam puller (1) (CC P/N 1014508) to remove the cam (3) from the fixed sheave.
4. Remove the spring (6) **(Figure 25-14, Page 25-12)**.
5. Retain the key (4).
6. Slide the moveable sheave (9) off the fixed sheave (11).

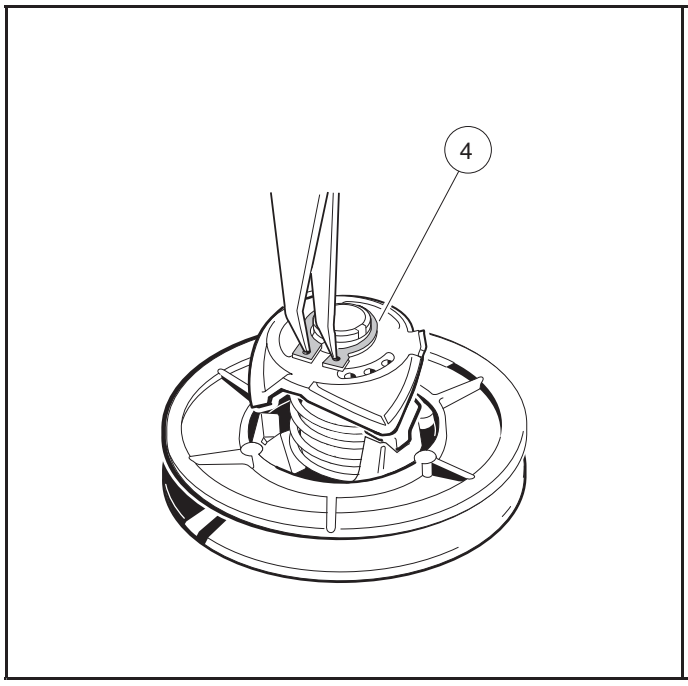

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Figure 25-15 Remove Retaining Ring

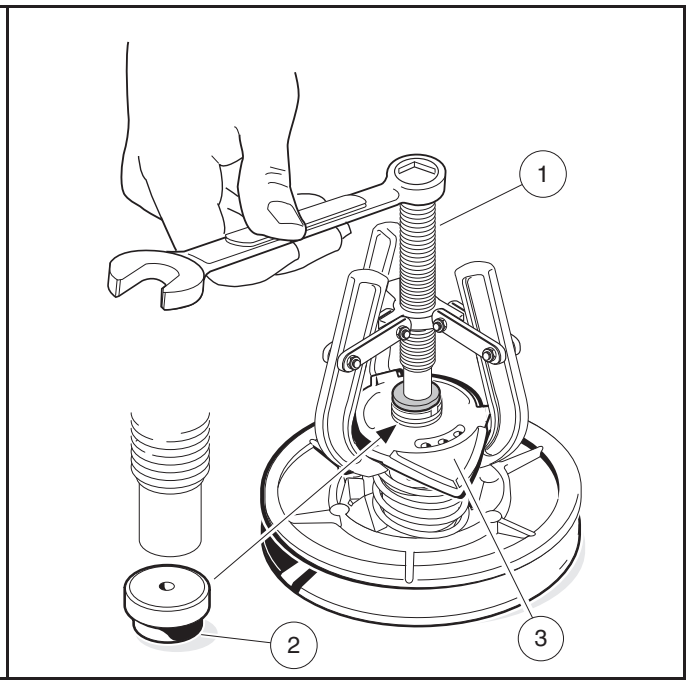

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Figure 25-16 Driven Clutch Disassembly

DRIVEN CLUTCH INSPECTION

1. Inspect the cam (5) for excessive wear **(Figure 25-14, Page 25-12)**. Replace it if necessary.
2. Inspect the drive buttons (8) for excessive wear. Replace if necessary. To remove the drive buttons (8), remove the socket-head cap screws (7) and then the buttons.
3. Inspect the smooth surface on the fixed and moveable sheaves. Sheaves must be replaced if surfaces are worn more than 0.060 in. (1.5 mm).
4. Inspect the bronze bearing in the moveable sheave. If the bearing bore diameter is more than 1.384 in. (35.15 mm), the entire moveable sheave must be replaced.
5. Inspect the shaft of the fixed sheave. There should be no noticeable wear. Replace the fixed sheave if it is worn, scratched or damaged.

DRIVEN CLUTCH ASSEMBLY

1. Place the three drive buttons (8) in position. Apply one drop of Loctite® 222 to each of the socket-head cap screws (7) and then install and tighten them to 8 in·lb (0.9 N·m) **(Figure 25-14, Page 25-12)**.
2. Slide the acetal washer (10) and moveable sheave (9) onto the fixed sheave (11).
3. Place the end of the spring (6) into the hole in the moveable sheave (9).
4. Install the key (4) into the keyway of the fixed sheave (11) shaft.
5. Holding the cam (5) in position for assembly on the shaft, install the other end of the spring (6) into the center spring hole of the cam. Rotate the cam until the keyway is aligned with the key (4) on the fixed sheave, and then start the cam onto the shaft approximately 1/4 to 3/8 in. (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 (CC P/N 101809101) on the cam (2) as shown **(Figure 25-17, Page 25-15)**.

5.1.2. Hold the fixed sheave (3) and rotate the moveable sheave (1) one-third turn counterclockwise, then press the cam (2) onto the fixed sheave **(Figure 25-17, Page 25-15)**. The match marks made before disassembly should now align.

5.1.3. Install the retaining ring (4) **(Figure 25-15, Page 25-14)**. **See following NOTE.**

NOTE: *The retaining ring (4) can be reused if the O.D. does not exceed 1.607 in. (40.82 mm); otherwise, it must be replaced with a new ring (CC P/N 1014080).*

5.1.4. While holding onto the cam, tap the end of the fixed sheave lightly with a plastic mallet until the cam seats against the retaining ring (4). **See following CAUTION.**

⚠ CAUTION

- **Do not use a metal hammer to tap the fixed sheave. A metal hammer will damage the shaft.**

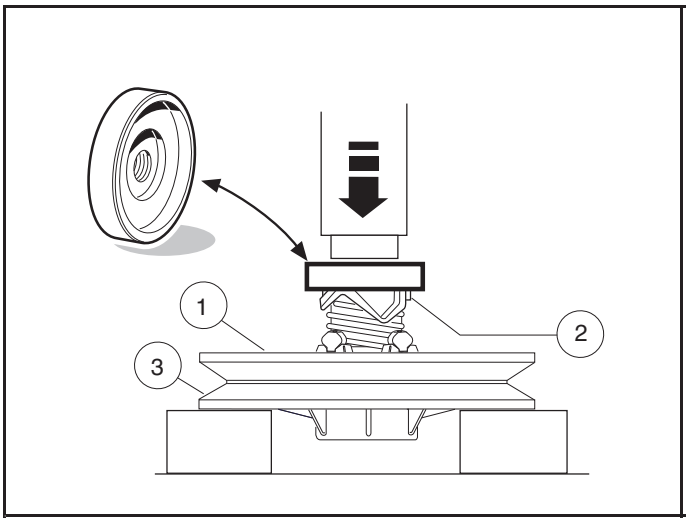

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Figure 25-17 Cam Press Tool

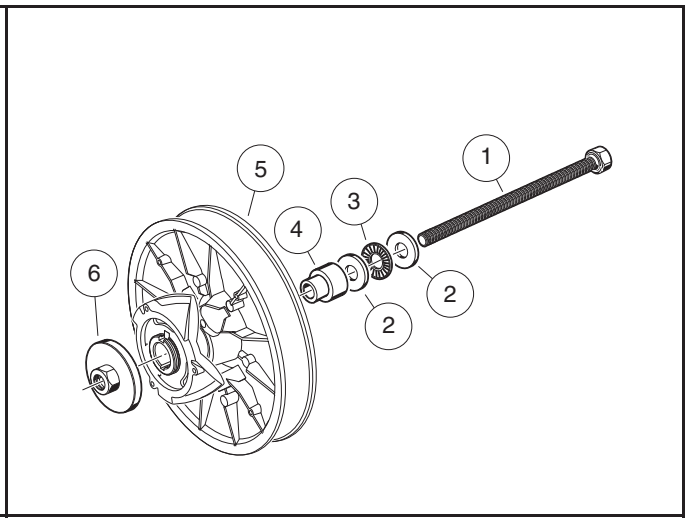

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Figure 25-18 Cam Installation Tool

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 (CC 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 25-18, Page 25-15)**.

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.*

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 sheave **(Figure 25-18, Page 25-15)**.

5.2.4. Hold the clutch assembly and cam installation tool together and place the fixed sheave down on spaced blocks **(Figure 25-17, Page 25-15)**.

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 sheave of the clutch (5) and rotate the moveable sheave of the clutch one-third turn counterclockwise **(Figure 25-18, Page 25-15)**. The match marks made before disassembly should now align.

5.2.7. Use two wrenches and hold the bolt head (1) while tightening the cam press hub (6) to press the cam onto the keyed shaft. Advance the press hub (6) until it is firm against the shaft end.

5.2.8. Remove the cam press hub (6) and installation tool.

5.2.9. Install the retaining ring (4) **(Figure 25-15, Page 25-14)**.

NOTE: *The retaining ring (4) can be reused if the O.D. does not exceed 1.607 in. (40.82 mm); otherwise, it must be replaced with a new ring (CC P/N 1014080).*

DRIVEN CLUTCH INSTALLATION

1. To install the driven clutch, reverse the removal procedure. Make sure that the washer (2) is mounted with the flat portion of the washer against the driven clutch **(Figure 25-14, Page 25-12)**. Secure with a new bolt (1). **See following NOTE.**

NOTE: *The bolt (1) must be replaced with a new bolt (CC P/N 102242101) containing a locking patch that will prevent the bolt from loosening.*

2. Tighten the bolt (1) to 18 ft·lb (24.4 N·m).
3. Connect battery and spark plug wire(s). **See Connecting the Battery-Gasoline Vehicles on page 1-5.**

SECTION 26 — TRANSAXLE (ED65): GASOLINE VEHICLES

⚠ DANGER

- **See General Warnings on page 1-1.**

⚠ WARNING

- **See General Warnings on page 1-1.**

GENERAL INFORMATION

The vehicles addressed in this manual are equipped with heavy-duty transaxles. The transaxle utilizes internal gearing to change vehicle direction. Because the transaxle is used to reverse vehicle direction, the engine, drive clutch, belt, and driven clutch rotate in the same direction; therefore, the engine and clutches are not subjected to reversing loads. This reduces maintenance requirements on the engine and clutches. With the transaxle, power is transferred from the engine through the drive clutch, the drive belt, the driven clutch, and then through the transaxle to the wheels.

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). Bring the vehicle to a complete stop before changing FORWARD or REVERSE direction.

NEUTRAL LOCKOUT

For the convenience of the trained technician, there is a neutral lockout switch located on the seat support panel under the seat **(Figure 26-1, Page 26-1)**. The neutral lockout switch has two positions, MAINTENANCE and OPERATE, which are clearly marked.

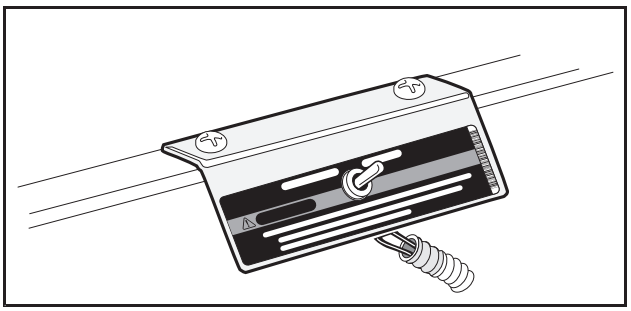

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Figure 26-1 MAINTENANCE/OPERATE Switch

Pedal-Start Vehicles

During normal vehicle operation, the neutral lockout switch in the OPERATE position prevents the engine from running when the Forward/Reverse handle is in the NEUTRAL position. If a vehicle is started in FORWARD or REVERSE and then shifted to NEUTRAL, the engine will stop running.

When the switch is in the MAINTENANCE position, it will allow the technician to run the engine in the NEUTRAL position to perform certain maintenance and/or repair functions. With the switch in this position, the vehicle will not operate if the Forward/Reverse handle is placed in either the FORWARD or REVERSE position. **See following WARNING and NOTE.**

⚠ WARNING

- **With the switch in the MAINTENANCE position and the engine running, the vehicle may move suddenly if the Forward/Reverse handle is shifted or accidentally bumped. To prevent this, chock the front and rear wheels and firmly set the park brake before servicing or leaving the vehicle.**

NOTE: *Be sure to return the switch to the OPERATE position after servicing the vehicle, or it will not run with the Forward/Reverse handle in either the FORWARD or REVERSE position.*

Key-Start Vehicles

During normal vehicle operation, the neutral lockout switch in the OPERATE position allows the engine to start only when the Forward/Reverse handle is in the NEUTRAL position. In addition, it allows the engine to run and increase RPM's with the Forward/Reverse handle in any position.

With the switch in the MAINTENANCE position, it allows the technician to start, run, and increase the engine RPM's only in the NEUTRAL position to perform certain maintenance and/or repair functions. With the switch in this position, the engine will shut off if the Forward/Reverse handle is placed in either the FORWARD or REVERSE position. **See preceding WARNING and NOTE.**

GOVERNOR SYSTEM

The governor system regulates vehicle ground speed. It is mounted inside the 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 on page 23-9.**

TRANSAXLE SERVICE

The 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 Lubrication on page 26-2.** Under normal operating conditions, adjustment to the system should not be required.

LUBRICATION

There are two oil port plugs located on the right (driven clutch) side of the transaxle **(Figure 26-2, Page 26-3)**. 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. **See following NOTE.**

NOTE: *Observe the following for transaxles equipped with a limited-slip differential:*

- *Uses a magnetic drain plug.*
- *Unlike most limited-slip differentials, this unit **does not** use a friction modifier added to the gear oil.*

Oil Change – Transaxle

1. When draining transaxle oil, remove both plugs to allow the oil to drain faster.
2. Clean and reinstall the drain plug and gasket before filling the transaxle with new lubricant. Tighten drain plug to 17 ft·lb (23 N·m).

3. Use a funnel when filling the transaxle through the lubricant level indicator hole. Fill with 67.6 fl-oz (2 L) 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).
4. Install upper plug and gasket and tighten to 17 ft·lb (23 N·m).

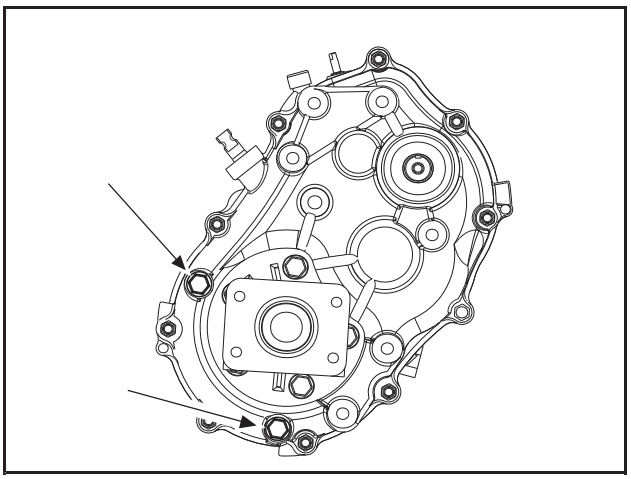

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Figure 26-2 Lubricant Level Plug and Drain Plug

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 (.0.047- in. tip)	1/2-in. socket, 3/8-in. drive	Medium flat blade screwdrivers (2)
90° Internal snap ring pliers (0.090-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 (CC P/N 1014162)	5/16-in. nut driver
Ratchet wrench, 3/8-in. drive	7/16-in. combination wrench	

REAR HUBS

REAR HUB REMOVAL

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 battery and spark plug wire(s). **See Disconnecting the Battery-Gasoline Vehicles on page 1-5.**
3. Place chocks at the front wheels and loosen lug nuts on both rear wheels.
4. Remove the rubber dust cap (1).
5. Remove and discard the cotter pin (2) **(Figure 26-3, Page 26-4)**.
6. Remove nut locking cap (3) and loosen the hub nut (4) on the axle shaft.
7. Lift and support the rear of vehicle.
8. Remove the lug nuts and wheel.
9. Slide brake drum off hub.
10. Remove hub nut (4) and large flat washer (5) and pull hub (6) off axle shaft. **See following NOTE.**

NOTE: *If the hub (6) does not slide easily off the axle shaft, use a two or four-jaw wheel puller to remove the hub.*

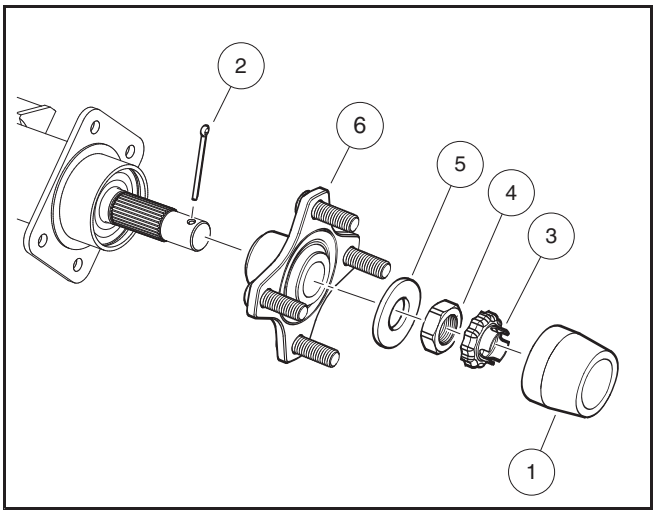

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Figure 26-3 Rear Hub Exploded View

REAR HUB INSTALLATION

1. Inspect brake shoes for wear and replace if necessary. **See Wheel Brake Assemblies section.**

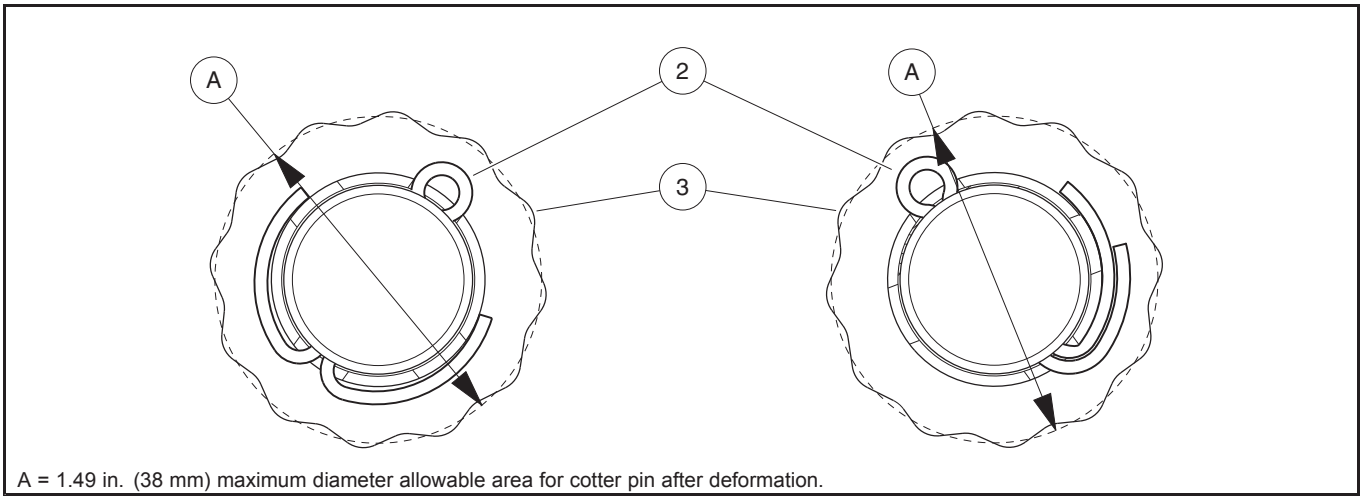
NOTE: *If brake shoes are replaced on one side, replace the opposite side also.*

2. Clean the splines and threaded portion of the axle shaft.
3. Apply anti-seize compound to both the axle shaft splines and hub (6) splines. **See following CAUTION.**

CAUTION

- **Do not allow anti-seize compound to contact the brake drum or shoes.**

4. Slide hub (6) onto axle shaft **(Figure 26-3, Page 26-4)**.
5. Install the large flat washer (5) onto the threaded portion of the axle.
6. Install hub nut (4) and advance the nut to the large flat washer.
7. Install brake drum onto hub.
8. Install the tire and wheel and finger-tighten the lug nuts.
9. Lower the rear of the vehicle.
10. Tighten the hub nut (4) to 147 ft·lb (200 N·m) initially. If possible, position the locking cap (3) on hub nut (4) and install new cotter pin (2). If necessary, tighten hub nut (4) further (177 ft·lb (240 N·m) max.) until the locking cap (3) and new cotter pin (2) can be installed.
11. Deform cotter pin (2) as shown **(Figure 26-4, Page 26-5)**. Either way is acceptable. No part of the cotter pin (2) should protrude beyond the perimeter of the locking cap (3).
12. Install rubber dust cap (1).
13. Tighten lug nuts to 65 ft·lb (88 N·m) using a crisscross pattern.
14. Connect battery and spark plug wire(s). **See Connecting the Battery-Gasoline Vehicles on page 1-5.**



A = 1.49 in. (38 mm) maximum diameter allowable area for cotter pin after deformation.

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Figure 26-4 Cotter Pin Deformation

AXLE TUBES, AXLE SHAFTS AND WHEEL BEARINGS

Removal of the transaxle is not required for servicing or replacing axle shafts, axle bearings, or axle shaft oil seals. If the transaxle is to be removed from the vehicle, do not remove the wheels, axle shafts, or axle tubes first. Instructions for removing the transaxle from the vehicle begin on page 26-9.

NOTE: *The axle shaft oil seals (7) are located in the transaxle gearcase (4), not the axle tubes (2)* ***(Figure 26-5, Page 26-6)****. The axle tubes must be removed in order to replace these oil seals.*

AXLE TUBE AND AXLE SHAFT REMOVAL

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

The transaxle has two axle shafts. If only a tube or shaft is to be serviced, it can be done one side at a time without removing the transaxle.

1. Clean debris from drain plug and area around it at the bottom of the transaxle. Drain oil. Install plug after draining.
2. If removing entire transaxle from vehicle, remove the transaxle and clean it in preparation for disassembly. **See Transaxle Removal on page 26-9. See following NOTE.**

NOTE: *After cleaning, move transaxle to a clean location before disassembly.*

3. If removing only one axle tube or shaft from vehicle, clean that tube and hub in preparation for disassembly.
4. Remove hub. **See Rear Hub Removal on page 26-4.**
5. Remove the five flange-head bolts (1) securing axle tube (2) to transaxle **(Figure 26-5, Page 26-6)**.
6. Avoiding damage caused by dragging splines across lip of oil seal (7) in transaxle gearcase, carefully pull axle tube (2) and shaft (3) from transaxle.

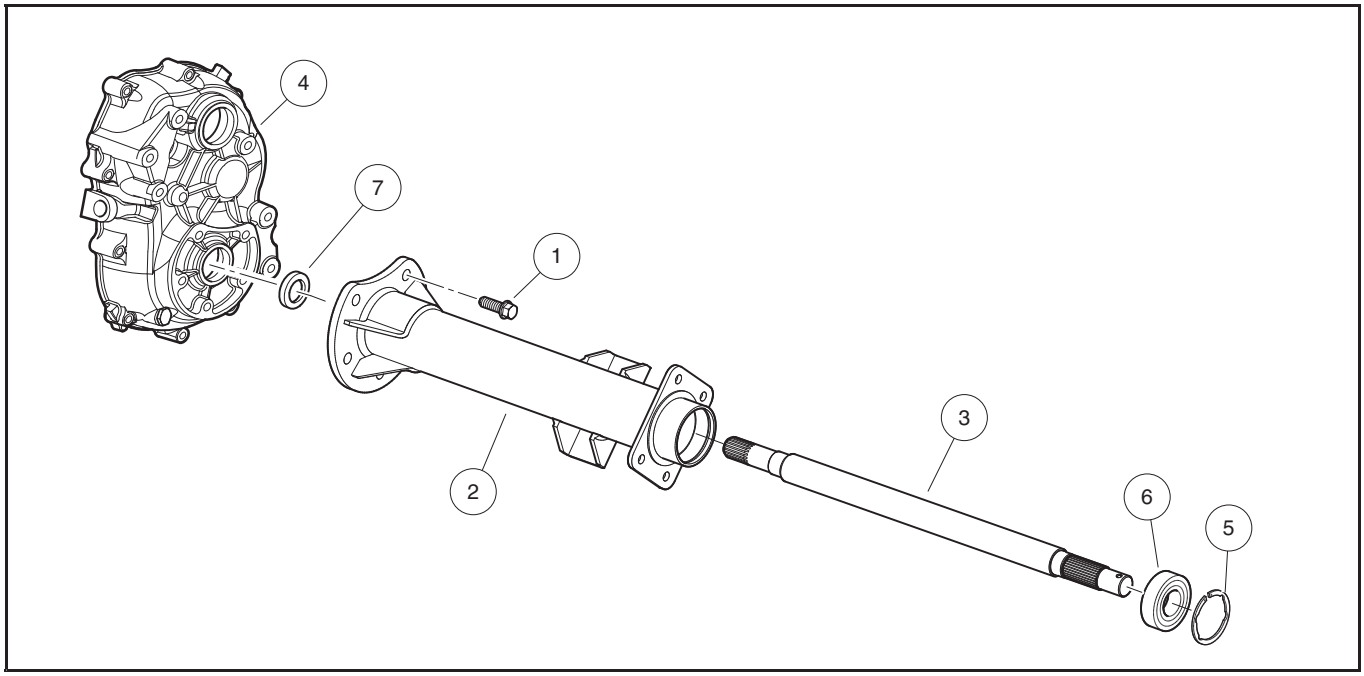

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Figure 26-5 Axle Tube, Shaft, Bearing and Oil Seal

AXLE TUBE AND AXLE SHAFT INSTALLATION

1. Clean mating surfaces of axle tube (2) flange and transaxle gearcase (4). Also clean the threads of the five axle tube mounting holes in the gearcase. **See following CAUTION.**

CAUTION

- **If necessary. clean each mounting hole with a thread tap (M10 x 1.25 pitch) before installing flange bolts.**

2. Clean and lubricate the oil seal (7) in the transaxle gearcase (4) with oil **(Figure 26-5, Page 26-6)**.
3. Clean inner end of axle shaft (3). Avoiding damage caused by dragging splines across lip of oil seal (7) in transaxle gearcase (4), carefully install axle shaft (3) and tube (2). **See following NOTE.**

NOTE: *It may be necessary to rotate each shaft (3) slightly to engage the splines in the differential.*

4. Secure axle tube (2) to gearcase (4) with flange bolts (1). Use a crisscross pattern to tighten flange bolts to 28 ft·lb (38 N·m).
5. Install hub. **See Rear Hub Installation on page 26-4.**
6. If entire transaxle was removed from vehicle, install transaxle. **See Transaxle Installation on page 26-13.**
7. Refill transaxle with appropriate type and volume of oil. **See Oil Change – Transaxle on page 26-2.**

REAR WHEEL BEARING REMOVAL

1. Remove hub. **See Rear Hub Removal on page 26-4.**
2. Remove axle tube (2) from transaxle. **See Axle Tube and Axle Shaft Removal on page 26-6.**
3. Remove the snap ring (5) that is in front of the bearing (6) and discard **(Figure 26-5, Page 26-6)**.
4. Drive axle shaft (3) and bearing (6) from outer end of axle tube (2) as an assembly.
5. Use a puller to remove bearing (6) from axle shaft (3). **See following CAUTION.**

CAUTION

- **To prevent damaging the threads on end of axle shaft (3), install hub nut to cover initial threads prior to using puller.**

REAR WHEEL BEARING INSTALLATION

1. Press new bearing (6) onto axle shaft (3) until fully seated.
2. Clean inside axle tube (2) where new bearing (6) will sit and lightly lubricate the bore **(Figure 26-5, Page 26-6)**.
3. Using an appropriate sized bearing driver that fits the outer race, drive in bearing/shaft assembly (3 and 6) until fully seated in tube (2).
4. Install new snap ring (5).
5. Install axle tube (2). **See Axle Tube and Axle Shaft Installation on page 26-7.**
6. Install hub. **See Rear Hub Installation on page 26-4.**

AXLE SHAFT OIL SEAL REMOVAL

The rear axle tubes (2) must be unbolted from the transaxle to replace oil seals (7) **(Figure 26-5, Page 26-6)**.

1. Clean debris from drain plug and area around it at the bottom of the transaxle. Drain oil. Install plug after draining.

2. Remove axle tube (2) from gearcase (4) **(Figure 26-5, Page 26-6)**. **See Axle Tube and Axle Shaft Removal on page 26-6.**
3. Pull oil seal (7) from gearcase (4).

AXLE SHAFT OIL SEAL INSTALLATION

1. Clean bore in gearcase (4) where new oil seal (7) will sit **(Figure 26-5, Page 26-6)**.
2. Using an appropriate sized seal driver, drive in new oil seal (7) until 0.0393 in. (1 mm) below surface, not fully seated.
3. Clean end of axle shaft (3) and carefully install axle tube (2) to avoid damaging new oil seal (7) with splines of axle shaft. **See Axle Tube and Axle Shaft Installation on page 26-7.**
4. Refill transaxle with appropriate type and volume of oil. **See Oil Change – Transaxle on page 26-2.**

TRANSAXLE REMOVAL

See General Warnings on 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 battery and spark plug wire(s). **See Disconnecting the Battery-Gasoline Vehicles on page 1-5.**
3. Place chocks at the front wheels and loosen lug nuts on both rear wheels.
4. Disconnect air intake hose, vent hose, and fuel line from throttle body and accelerator cable from electrical component box. **See Fuel System: Gasoline Vehicles, Section 23, Page 23-1.**
5. Disconnect gray 18-pin connector from ECU.
6. Disconnect braided ground cable from engine **(Figure 18-8, Page 18-21)**.
7. **Pedal-Start Vehicles Only:** Disconnect 3-wire plug from limit switch on transaxle.
8. Disconnect three wires of main wire harness from starter/generator **(Figure 20-14, Page 20-13)**.
9. Loosen jam nuts (1) securing shifter cable (2) to FNR/accelerator cable mounting bracket. Then, remove bowtie clip (3) to disconnect shifter cable end (4) from transaxle shift lever (5) and set shifter cable (2) aside **(Figure 26-14, Page 26-14)**.
10. Remove bolts (1) securing governor cable bracket (2) and FNR/accelerator cable bracket (3) to transaxle **(Figure 26-6, Page 26-9)**. Do not disconnect cables (4 and 5).
11. Unhook governor cable (4) and accelerator cable (5) from the governor arm (7).

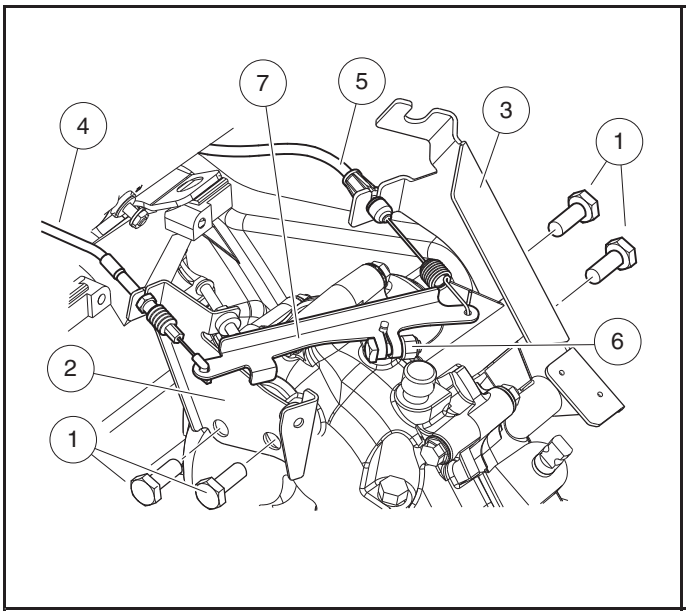

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Figure 26-6 Governor Arm, Cable and Brackets

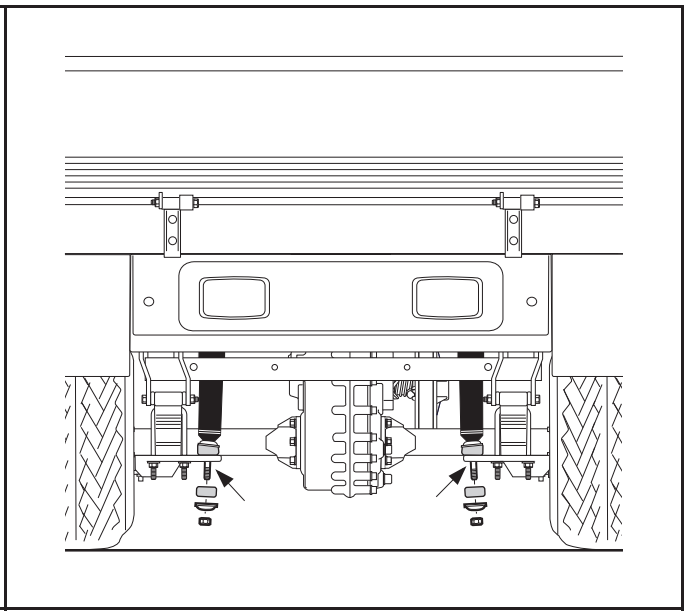

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Figure 26-7 Disconnect Shock Absorbers

12. Disconnect brake cables from brake assemblies. **See Wheel Brake Assemblies section.**
13. Remove lower shock mounting hardware from both rear shocks **(Figure 26-7, Page 26-9)**.

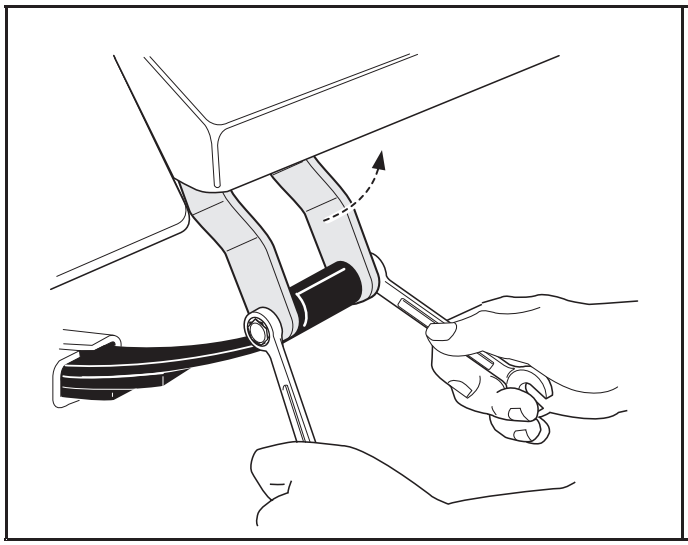

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Figure 26-8 Disconnect Rear Shackles

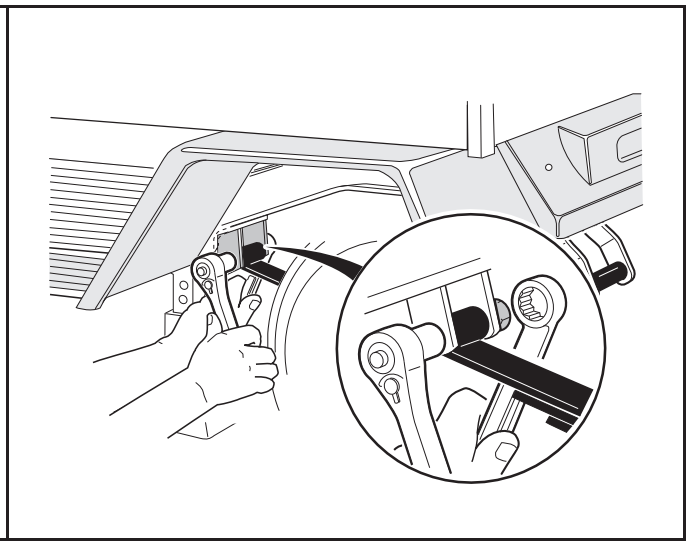

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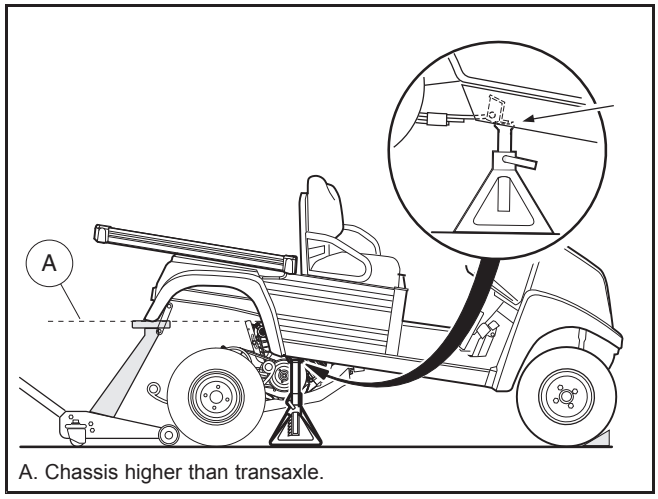
Figure 26-9 Disconnect Front of Leaf Spring

14. Position floor jack under rear crossmember of chassis or trailer hitch mount (if equipped) **(Figure 26-10, Page 26-10)**. **See WARNING "Lift only one end of the vehicle..." in General Warnings on page 1-1.**
15. Raise vehicle just enough to relieve weight on leaf springs, then remove bolts securing leaf springs to shackles **(Figure 26-8, Page 26-10)**.
16. Remove bolts securing front of leaf springs **(Figure 26-9, Page 26-10)**.



A. Chassis higher than transaxle.

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Figure 26-10 Raise Vehicle and Support On Jack Stands

17. Continue raising vehicle until chassis is higher than the top of the transaxle (i.e. enough to allow powertrain to be rolled out from under vehicle) **(Figure 26-10, Page 26-10)**. 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.
18. Remove floor jack from beneath vehicle.
19. Grasp ends of leaf springs at rear of vehicle and carefully pull the powertrain until snubber at front of engine pan is free of the chassis. Gently lower front of powertrain to the floor **(Figure 26-11, Page 26-11)**. The powertrain should be completely disconnected from vehicle and resting on floor.

20. Roll powertrain out from under vehicle.
21. Place blocks under the engine pan so they will completely support the engine and keep it **level to the floor (Figure 26-11, Page 26-11)**. **See following NOTE.**

NOTE: *Place the blocks so they will support the engine when the transaxle is detached and moved away from the powertrain.*

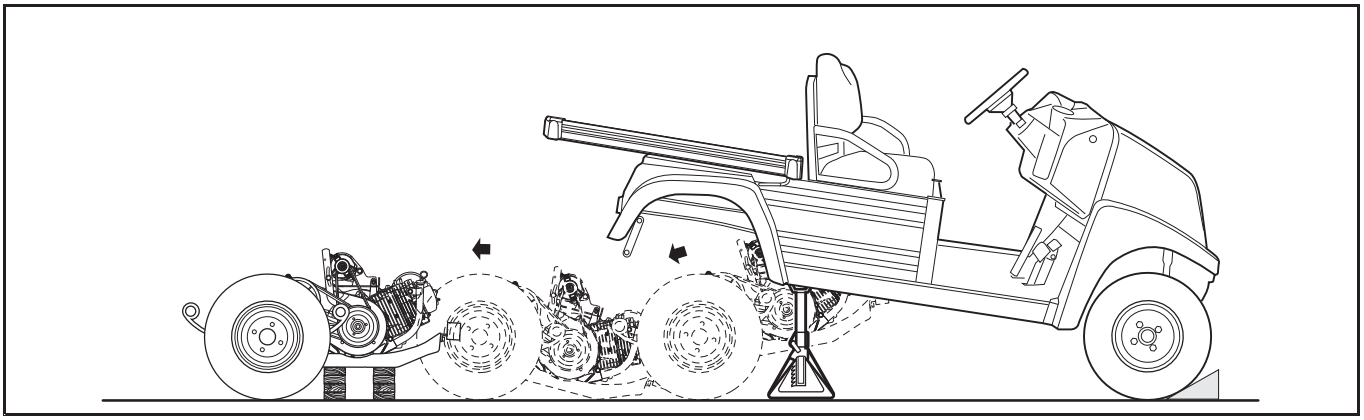

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Figure 26-11 Remove Powertrain and Place Wood Blocks Under Engine Pan

22. Remove oil drain plug and drain all oil from transaxle. Dispose of gear oil properly.
23. Remove driven clutch. **See Driven Clutch Removal, Section 25, Page 25-13.**
24. Remove eight bolts (1) total that secure transaxle to powertrain **(Figure 26-12, Page 26-12)** at the following locations:
    – Four bolts (1) at engine pan (2).
    – Two bolts (1) at clutch plate (3).
    – Two bolts (1) at muffler bracket.
25. Roll transaxle from engine pan (2). **See following NOTE.**

NOTE: *The transaxle weighs approximately 58 lb (26.2 kg).*

26. If replacing transaxle, remove leaf springs, wheels, hubs and brake assemblies and retain for installation on new transaxle. **See Rear Suspension section. See Wheel Brake Assemblies section.**

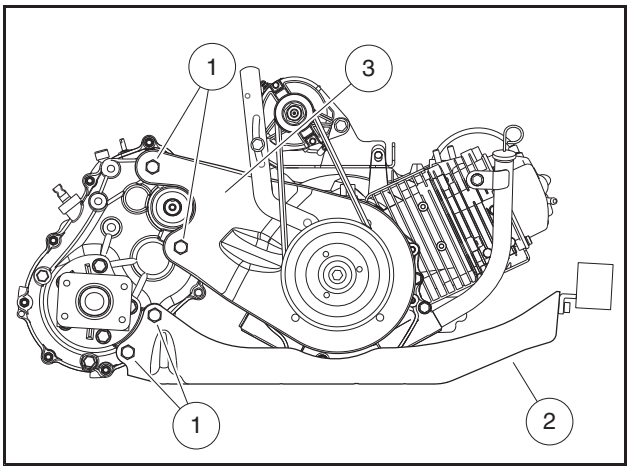

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Figure 26-12 Transaxle Mounting Bolts

TRANSAXLE INSTALLATION

See General Warnings on page 1-1.

1. Installation is reverse of removal procedure. When attaching transaxle to powertrain, initially install the eight bolts (1) finger-tight **(Figure 26-12, Page 26-12)**. Then, tighten fasteners in the following order:
   1.1. Tighten the two bolts (1) at clutch plate (3) to 50 ft·lb (68 N·m).
   1.2. Tighten the four bolts (1) at engine pan (2) to 50 ft·lb (68 N·m).
   1.3. Tighten the two bolts (1) at muffler bracket to 50 ft·lb (68 N·m).
   1.4. Tighten the governor cable bracket (2) and FNR/accelerator cable bracket (2) bolts to 50 ft·lb (68 N·m) **(Figure 26-6, Page 26-9)**.
   1.5. Tighten leaf spring hardware to 19 ft·lb (26 N·m) at chassis and shackle. **See Rear Suspension section.**
   1.6. Tighten lower nuts of shock absorbers until cushions expand to be the same diameter as the mounting washers.
   1.7. Tighten transaxle drain plug to 17 ft·lb (23.5 N·m).
2. Fill transaxle with appropriate type and volume of oil. **See Oil Change – Transaxle on page 26-2.**
3. Ensure that all wires and cables are secured properly with wire ties. **See following WARNING.**

⚠ WARNING

- **If wires and cables are removed or replaced make sure they are properly routed and secured to vehicle frame. Failure to properly route and secure wires and cables could result in vehicle malfunction, property damage or personal injury.**

4. Connect battery and spark plug wire(s). **See Connecting the Battery-Gasoline Vehicles on page 1-5.**
5. Check governor adjustment and correct if necessary. **See Governor Cable Installation and Adjustment, Section 23, Page 23-9.**
6. Check engine RPM setting. Adjust if necessary. **See Engine RPM Adjustment, Section 23, Page 23-13.**

SHIFTER CABLE

See General Warnings on page 1-1.

If the Forward/Reverse shifter cable is damaged in any way, it must be replaced.

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 battery and spark plug wire(s). **See Disconnecting the Battery-Gasoline Vehicles on page 1-5.**
3. Push the cable end socket (1) off the stud (3) on the Forward/Reverse shifter handle **(Figure 26-13, Page 26-14)**.
4. Press in tangs (4) anchoring shifter cable (2) to chassis and push out of mounting hole.
5. Loosen jam nuts (1) securing shifter cable (2) to FNR/accelerator cable bracket (3) **(Figure 26-14, Page 26-14)**. Then, remove bowtie clip (3) to disconnect shifter cable end (4) from transaxle shift lever (5).

6. Cut wire ties securing shifter cable to chassis.
7. Make note of cable routing, then remove shifter cable from vehicle.

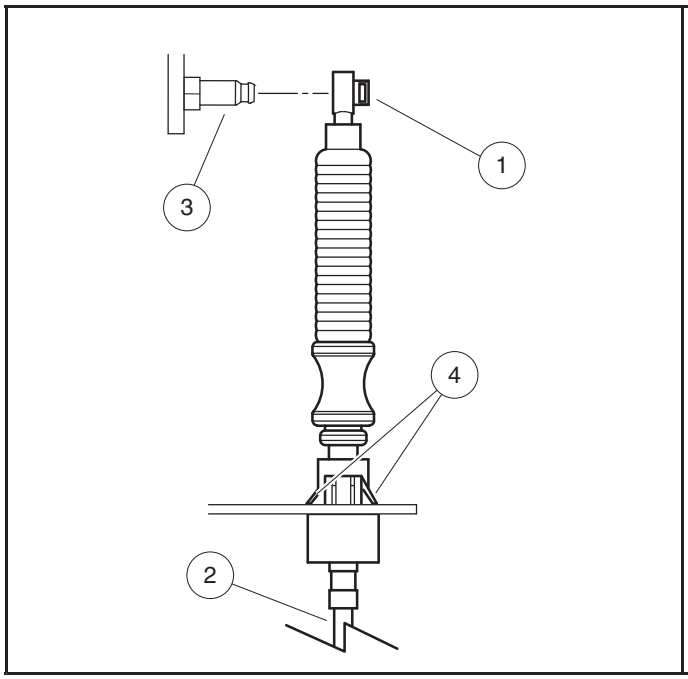

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Figure 26-13 Shifter Cable at FNR Handle

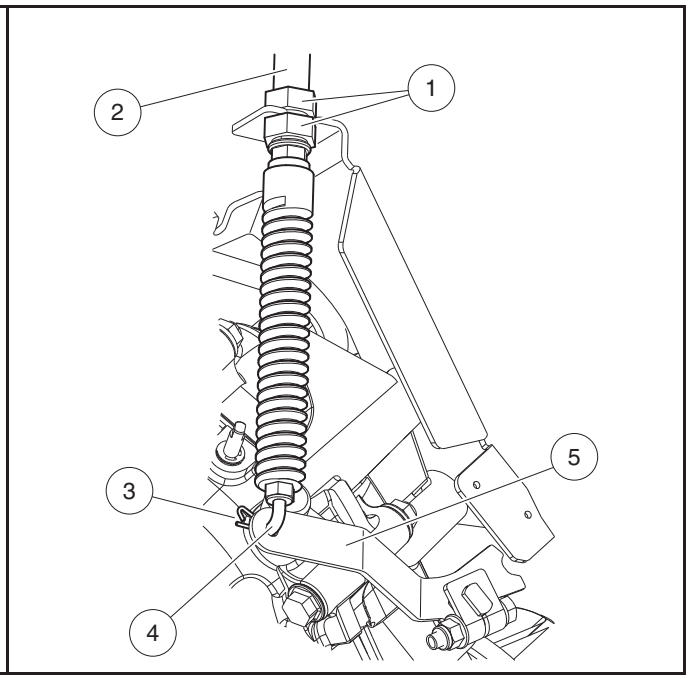

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Figure 26-14 Shifter Cable at Transaxle

SHIFTER CABLE INSTALLATION

1. Install shifter cable (2), routing it exactly as it was originally, from instrument panel to transaxle.
2. Place rear of cable (2) in FNR/accelerator cable bracket with a jam nut (1) on each side of bracket **(Figure 26-14, Page 26-14)**. Tighten jam nuts (1) to 22 ft·lb (29.8 N·m).
3. Hook shifter cable end (4) into transaxle shift lever (5) and secure with bowtie clip (3).
4. Feed front of cable (2) through its mounting hole and push the plastic anchor into hole until tangs (4) snap into place **(Figure 26-13, Page 26-14)**.
5. Snap cable end socket (1) onto stud (3) of Forward/Reverse shifter handle.
6. Secure shifter cable along chassis with wire ties.
7. Connect battery and spark plug wire(s). **See Connecting the Battery-Gasoline Vehicles on page 1-5.**

SHIFTER CABLE ADJUSTMENT

Cable is properly adjusted when both the Forward/Reverse handle at instrument panel and shift lever on transaxle are in the NEUTRAL position at the same time.

To adjust, the jam nuts (6) at the FNR/accelerator cable bracket must be loosened and moved forward or backward as required **(Figure 26-14, Page 26-14)**. Tighten jam nuts (6) to 22 ft·lb (29.8 N·m).

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