



Professional Shop Manual



I Series Riding Tractors

NOTE: These materials are for use by trained technicians who are experienced in the service and repair of outdoor power equipment of the kind described in this publication, and are not intended for use by untrained or inexperienced individuals. These materials are intended to provide supplemental information to assist the trained technician. Untrained or inexperienced individuals should seek the assistance of an experienced and trained professional. Read, understand, and follow all instructions and use common sense when working on power equipment. This includes the contents of the product's Operators Manual, supplied with the equipment. No liability can be accepted for any inaccuracies or omission in this publication, although care has been taken to make it as complete and accurate as possible at the time of publication. However, due to the variety of outdoor power equipment and continuing product changes that occur over time, updates will be made to these instructions from time to time. Therefore, it may be necessary to obtain the latest materials before servicing or repairing a product. The company reserves the right to make changes at any time to this publication without prior notice and without incurring an obligation to make such changes to previously published versions. Instructions, photographs and illustrations used in this publication are for reference use only and may not depict actual model and component parts.

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CHAPTER 1: INTRODUCTION

Professional Shop manual intent

This **Manual** is intended to provide service dealers with an introduction to the mechanical aspects of the new tractor.

This **Professional Shop Manual** covers the I-series tractor more specifically, and in greater depth than the original Shop Handbook.

- The content in this manual supersedes any content in the handbook.
- Detailed service information about the engine will be provided by the engine manufacturer, in most cases.

Disclaimer: This manual was written using first generation tractor. The information contained in this handbook is correct at the time of writing. Both the product and the information about the product are subject to change without notice.

About the text format:

NOTE: is used to point-out information that is relevant to the procedure, but does not fit as a step in the procedure.

CAUTION: Indicates a potentially hazardous situation that, if not avoided, may result in minor or moderate injury. It may also be used to alert against unsafe practices.

DANGER: Indicates an imminently hazardous situation that, if not avoided, will result in death or serious injury. This signal word is to be limited to the most extreme situations.

WARNING: Indicates a potentially hazardous situation that, if not avoided, could result in death or serious injury.

- **Bullet points:** indicate sub-steps or points.

Disclaimer: This Professional Shop Manual is intended for use by trained, professional technicians.

- Common sense in operation and safety is assumed.
- In no event shall MTD or Cub Cadet be liable for poor text interpretation, or poor execution of the procedures described in the text.
- If the person using this manual is uncomfortable with any procedures they encounter, they should

seek the help of a qualified technician or Cub Cadet Technical Support.

Fasteners:

- Most of the fasteners used on the vehicle are sized in fractional inches. Some are metric. For this reason, wrench sizes are frequently identified in the text, and measurements are given in U.S. and metric scales.
- If a fastener has a locking feature that has worn, replace the fastener or apply a small amount of releasable threadlocking compound such as Loctite® 242 (blue).
- Some fasteners like cotter pins are single-use items that are not to be reused. Other fasteners such as lock washers, retaining rings, and internal cotter pins (hairpin clips) may be reused if they do not show signs of wear or damage. This manual leaves that decision to the judgement of the technician.

Assembly:

Torque specifications may be noted in the part of the text that covers assembly, they may also be summarized in tables along with special instructions regarding locking or lubrication. Whichever method is more appropriate will be used. In many cases, both will be used so that the manual is handy as a quick-reference guide as well as a step-by-step procedure guide that does not require the user to hunt for information.

The level of assembly instructions provided will be determined by the complexity and of reassembly, and by the potential for unsafe conditions to arise from mistakes made in assembly.

Some instructions may refer to other parts of the manual for subsidiary procedures. This avoids repeating the same procedure two or three times in the manual.

INTRODUCTION

2. DESCRIPTION OF THE I-SERIES

The I-series is a revolutionary new tractor platform introduced in the 2007 season. This platform combines a traditional lawn tractor with zero-turning capabilities. This is accomplished by using EZT transaxles from Hydro-Gear with an innovative steering system. See Figure 1.1.



Figure 1.1

The Steering gear box operates the control linkages for the transmissions while turning the front wheels. This gives the I-series zero-turning capabilities while using a traditional steering wheel.

The I-series will come with a 46" or 50" deck options and in keeping with the rest of the Cub Cadet line it will be powered by Kohler engines.

These tractors will also have the same Rev-Tec mow in reverse feature as the rest of the Cub Cadet lawn tractors.

3. MODEL AND SERIAL NUMBERS

The model and serial number tag can be found under the seat. See Figure 1.2.

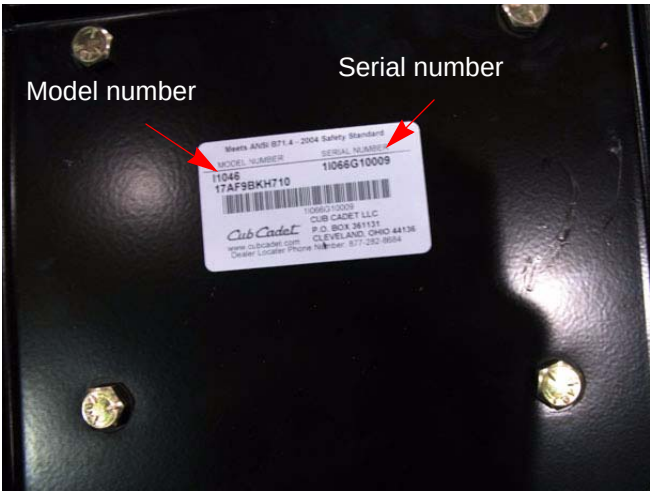


Figure 1.2

The serial number is located to the right of the model number as shown above. See Figure 1.2.

The model number is 17AF9BKH710. The break down of what the number mean is as follows:

- 17.....residential zero turn mower
- ...A.....sales level
- F.....engine code
- 9.....frame
- B.....drive system
- K.....hood style
- H.....deck (H = 46" K = 50")
- 710....customer number

The serial number is 1J056G10005. The serial number reads as follows:

- 1.....engineering level
- ..J.....month of production (J = October)
- 05.....day of the month
- 6.....last digit of the year
- G.....plant it was built in
- 1.....assembly line number
- 0005.....number of unit built

CHAPTER 2: ENGINE RELATED PARTS

This manual will cover the engine accessories that are manufactured by Cub Cadet.

IMPORTANT: The engine is manufactured by Kohler. Refer to the Kohler manual for engine specific service information.

Muffler

To remove the muffler by following these steps:

1. Remove the hood and bumper by following the steps described in chapter 4 BODY/CHASSIS.
2. Remove the two screws on each side that hold the muffler guard bracket. See Figure 2.1.



Figure 2.1

3. Remove the hood pivot brackets by removing the two screws that hold each one on. See Figure 2.2.

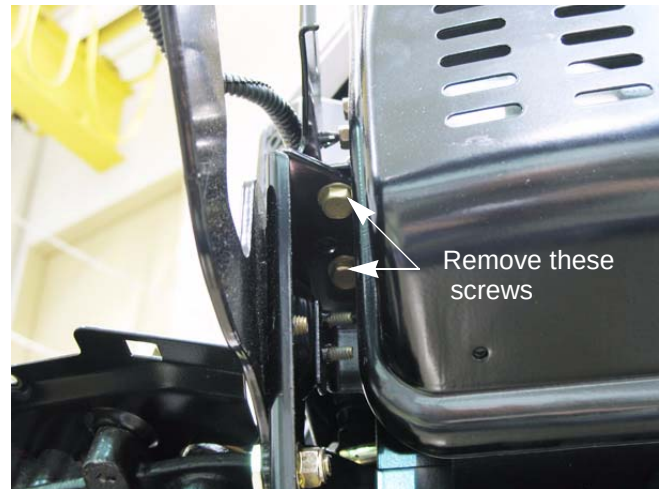


Figure 2.2

4. Pull the muffler cover and muffler out together. See Figure 2.3.

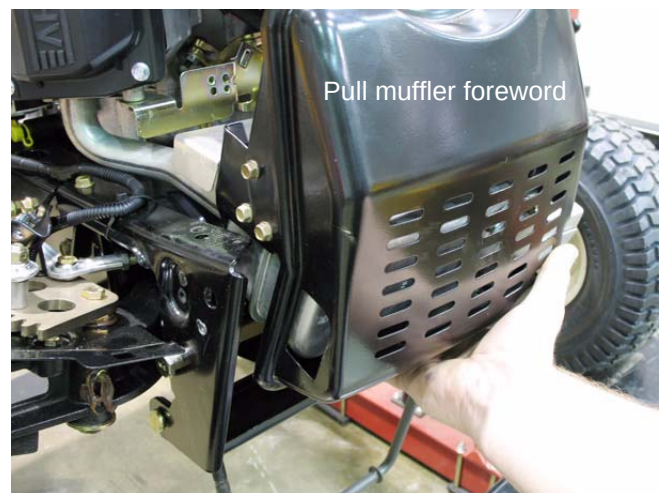


Figure 2.3

NOTE: The muffler slides onto the exhaust pipes. The heat of the exhaust makes the pipes expand and forms a seal with the muffler. Do not weld or place a sealer between the muffler and exhaust pipes.

ENGINE RELATED PARTS

5. With the muffler on a work bench, remove the four screws that hold the muffler to the muffler bracket. See Figure 2.4.



Figure 2.4

6. Remove the two screws holding the muffler guard to the muffler bracket. See Figure 2.5.

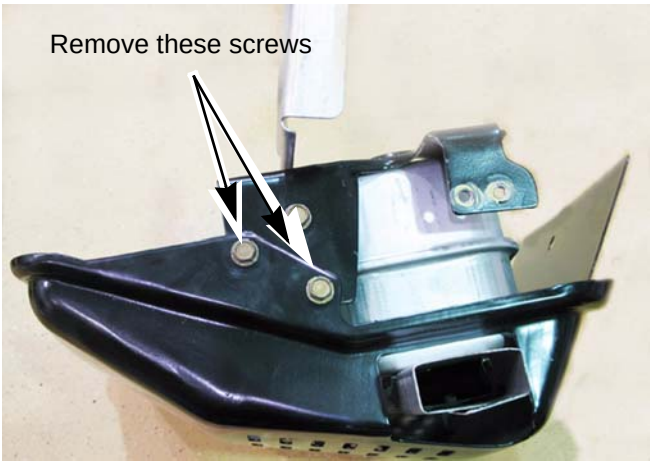


Figure 2.5

7. The muffler, muffler cover and the muffler bracket can now be separated. See Figure 2.6.

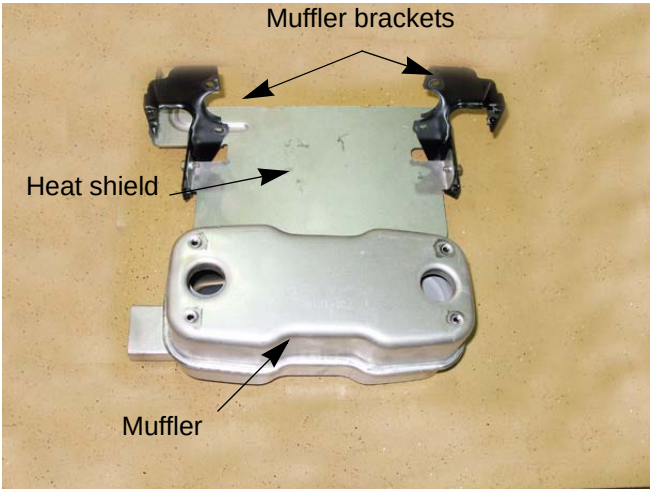


Figure 2.6

- NOTE:** The heat shield and muffler brackets can be left together and handled as one part.
8. Install the muffler by following the above steps in reverse order.

Exhaust pipes

The exhaust pipes are manufactured by Cub Cadet. To remove/replace the exhaust pipes:

1. Remove the muffler following the steps described in the previous section.
2. Remove the two mounting bolts using a 1/2" wrench. See Figure 2.7.

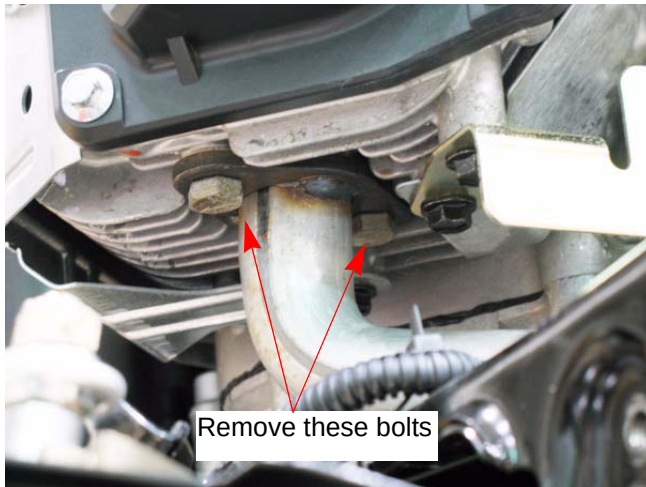


Figure 2.7

3. Discard the old exhaust gaskets. Clean all gasket material from the cylinder head (and exhaust pipe if it is being reused).
4. Using new gaskets, install the exhaust pipes following the above steps in reverse order.

Fuel tank removal/replacement

Remove/replace the fuel tank by following these steps:

1. Remove the deck.
2. Remove the fender by following the steps described in chapter 4 BODY/CHASSIS.
3. Remove the hair pin clips retaining the deck lift cables and disconnect the cables. See Figure 2.8.

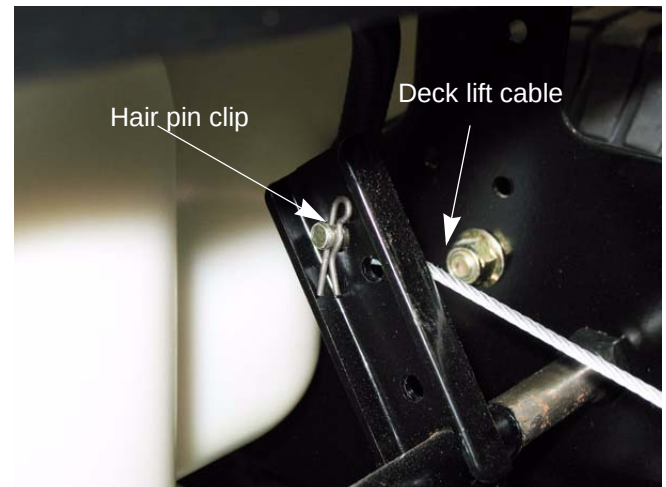


Figure 2.8

4. Unhook the deck lift assist spring. See Figure 2.9.



Figure 2.9

ENGINE RELATED PARTS

5. Remove the two screws and two nuts that fasten the seat box cover. See Figure 2.10.

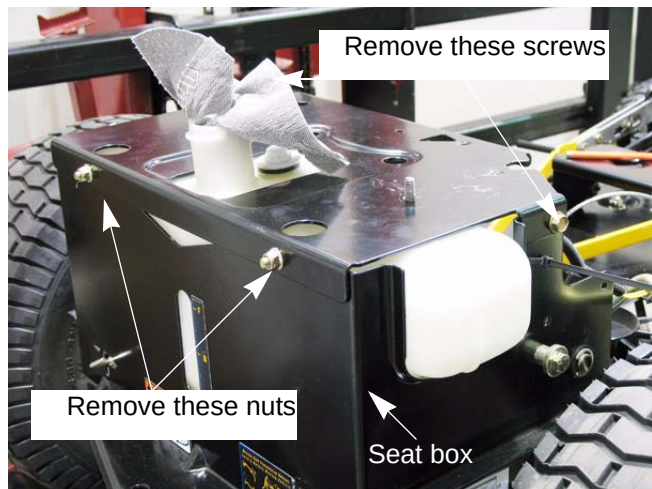


Figure 2.10

6. Remove the seat box cover.
7. Clamp the fuel line. See Figure 2.11.

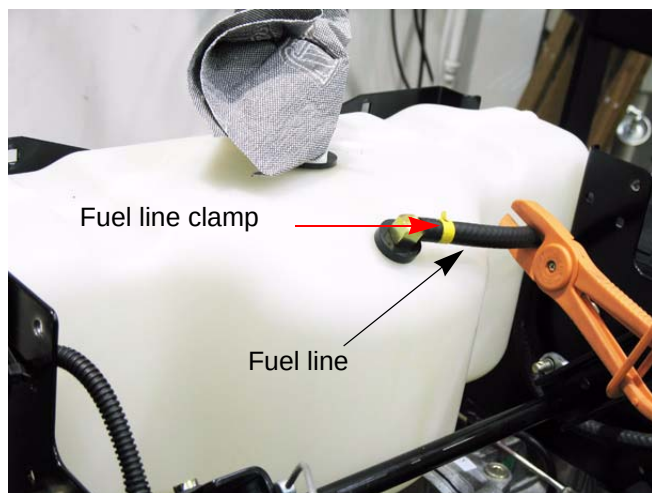


Figure 2.11

8. Remove the fuel line clamp and slide the fuel line off.
- NOTE:** The fuel tank has a barbed fitting. Anytime a fuel line is removed from a barbed fitting it should be replaced because of the damage caused to the fuel line liner.
9. Lift the fuel tank out of the seat box.
 10. Install the fuel tank by following the above steps in reverse order.
 11. Test run the tractor and check for leaks before returning to service.

CHAPTER 3: BRAKES

Brake system description

The I-series tractors use disk type service brakes, one on each transmission. The brakes are located on each transmission.

- They are activated by pressing on the brake pedal.
- The brake pedal is attached to a brake shaft assembly. This will pull on the two brake rods.
- The brake rods are attached to the cam arms, in the brake calipers, by over travel springs.
- When the cam arms are pulled forward they push on the brake pins by a cam action applying pressure to the brake pads.
- The brake shaft assembly also has a link that is connected to the drive belt idler pulley bracket. When the brakes are applied, the idler pulley is pulled away from the drive belt. This de-tensions the belt and allows it to slip. See Figure 3.1.

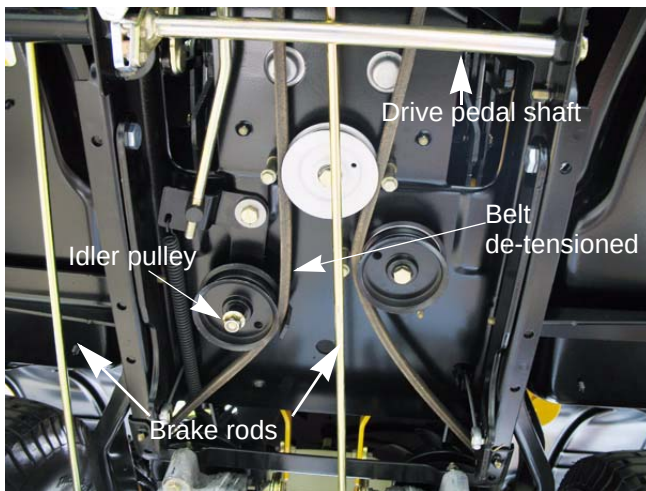


Figure 3.1

Brake adjustment

1. Block the front wheels.
2. Jack up the rear of the tractor and place on jack stands. See Figure 3.2.

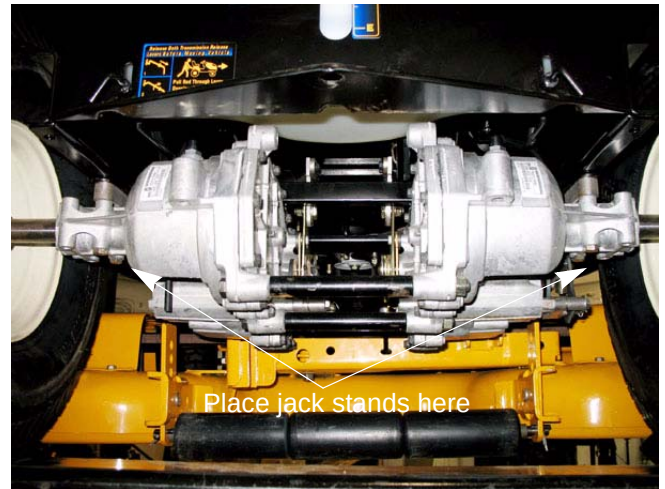


Figure 3.2

NOTE: Make sure the brake and parking brake are released.

3. Remove the rear wheels.
4. Remove the cotter pin locking the castle nut on the brake caliper. See Figure 3.3.

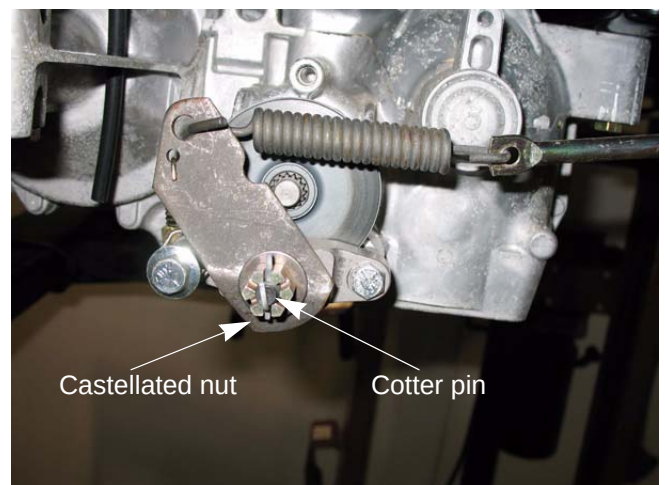


Figure 3.3

BRAKES

5. Back the castle nut off a few turns using a 9/16" wrench.

NOTE: Even if the brakes are set to the correct clearance, inserting a feeler gauge between the rotor and the brake puck can be very difficult. Loosen the castle nut first, then insert the feeler gauge and tighten the nut to set the proper clearances

6. Insert a .030" (0.8 mm) feeler gauge between the brake rotor and the outboard brake puck. See Figure 3.4.



Figure 3.4

NOTE: The tolerance for the brake clearance is .020" - .040" (0.5 - 1.0mm). The .030 feeler gauge will set the clearance at the midpoint.

7. Tighten the nut until there is a slight drag on the feeler gauge when sliding it out.

NOTE: For even braking, both sides should be set to the same clearance.

8. Insert a new cotter pin.
 9. Repeat same procedure on the other side.
 10. Put the wheels back on.
 11. Take the tractor off of the jack stands,
 12. Release the by-pass valves and check the parking brake before returning the tractor to service.
- With the brakes released, the tractor should have only hydraulic drag when it is pushed.
 - With the brakes engaged, the wheels should slide before they rotate when the tractor is pushed.

Brake puck/rotor replacement

The brake pucks are a wearing part that will need to be serviced from time to time. If a tractor is operated with the parking brake dragging, the pucks will wear out rapidly and the brake rotor will develop hot spots. If the tractor is operated long enough, the rotor may have grinding marks on it with excessively worn pucks.

CAUTION: If the rotor shows hot spots or any other signs of damage, including warpage, it must be replaced. Failure to do so can result in the failure of the brakes.

The brake pucks and the rotors are serviced at the same time. to service the brake pucks:

1. Jack up the tractor and remove the rear wheels as described in the previous section.
2. Make sure the brakes are released.
3. Disconnect the brake rod spring. See Figure 3.5.



Figure 3.5

4. Loosen the rear mounting bolt. See Figure 3.6.

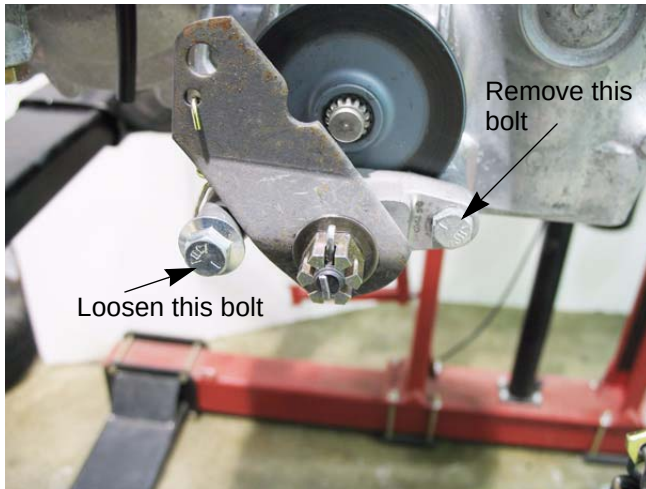


Figure 3.6

5. Remove the front mounting bolt, allowing the caliper to swing down. See Figure 3.7.

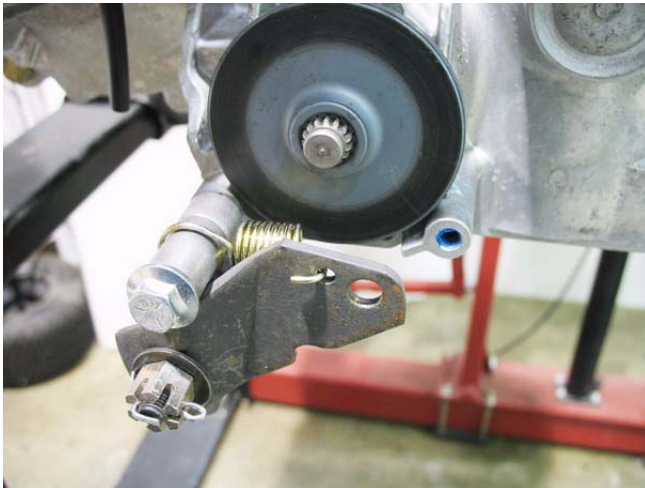


Figure 3.7

6. The outboard brake puck should fall out when the brake caliper swings down. If it did not, it can be removed now.

7. Slide the brake rotor off to reach the inboard brake puck. See Figure 3.8.

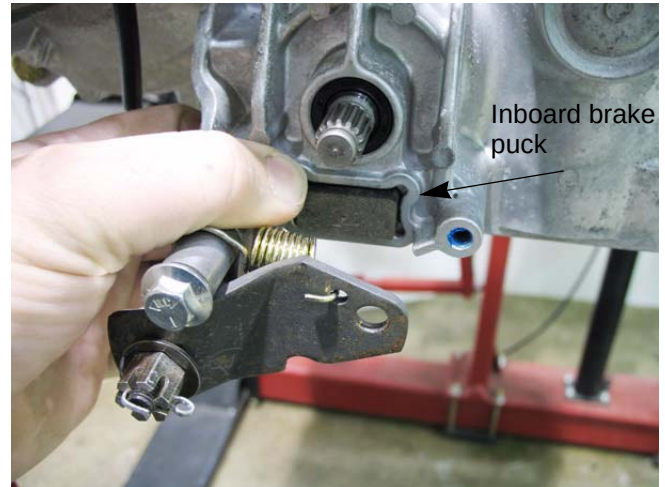


Figure 3.8

8. Remove the caliper for inspection when servicing the brake pucks. To do this remove the rear bolt loosened in step 4.
9. With the caliper on a work bench, remove the brake puck, backing plate and the two brake pins. See Figure 3.9.

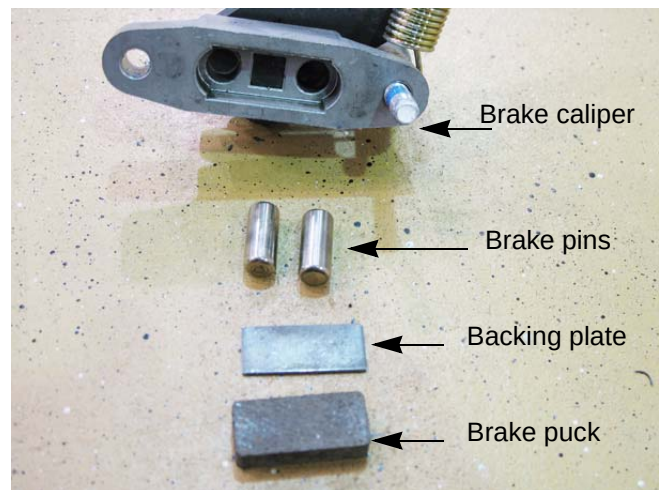


Figure 3.9

10. Check for free movement of the brake pins. A dry lubricant can be used on the brake pins sparingly.

CAUTION: Never put grease or anti-seize on brake pins. It can migrate to the brake pucks, preventing the braking action of the pucks.

BRAKES

11. Slide the brake pins into the caliper.
12. Place the backing plate in the caliper.
13. Place a new puck into the caliper. See Figure 3.10.

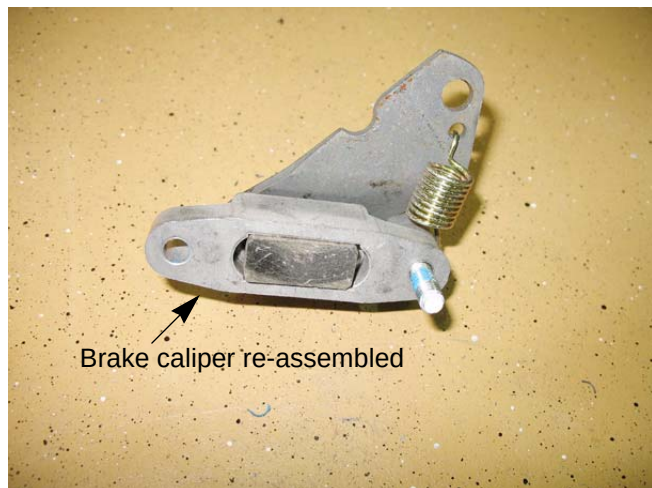


Figure 3.10

NOTE: A piece of scotch tape may be used to hold the new brake pucks in place for assembly. The tape will grind away when the brakes are applied.

14. Place a new brake puck into the recess in the transmission. use a piece of scotch tape to hold it in place.
 15. Slide the brake rotor in place, shoulder out.
 16. Mount the brake caliper to the transmission. Apply a small amount of releasable thread locking compound such as Loctite® 242 (blue) to the mounting bolts and tighten to a torque of 80 - 120 in-lbs (9 - 13.5Nm).
 17. Reconnect the brake rod spring.
 18. Adjust the brakes as described in the previous section.
 19. Put the wheel on.
 20. Repeat steps 4-19 on the other side.
 21. When both sides are completed and both wheels are back on, take the tractor off of the jack stands.
 22. Release the by-pass valves and check the parking brake before returning the tractor to service.
- With the brakes released, the tractor should have only hydraulic drag when it is pushed.
 - With the brakes engaged, the wheels should slide before they rotate when the tractor is pushed.

Brake shaft assembly

To replace the brake shaft bushings:

1. Remove the cotter pins that retain the three brake rods. Slide the brake rods out of the Brake shaft assembly. See Figure 3.11.

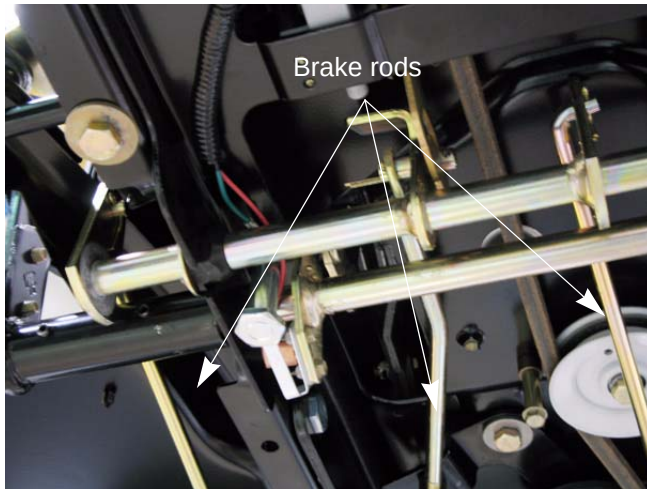


Figure 3.11

2. Remove the cotter pins on each end of the brake shaft. See Figure 3.12.

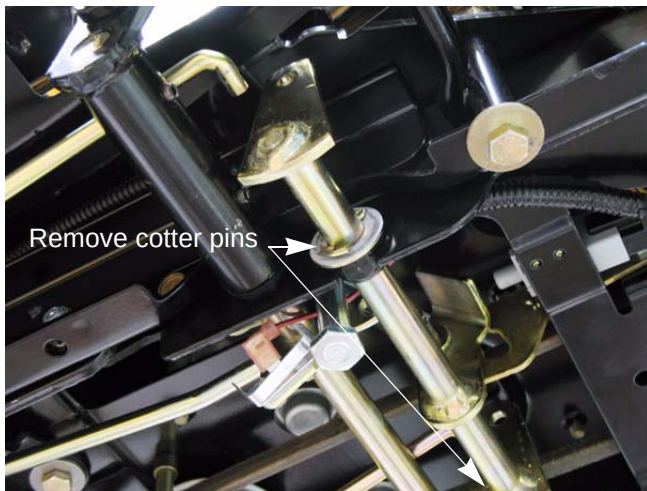


Figure 3.12

3. Remove the right side bushing first. This will allow the shaft to slide far enough to the left to let the other bushing come out.
4. Install new bushings by following the above steps in reverse order.
5. Check the operation of linkage and test drive the tractor in a safe area before returning to service.

To remove/replace the brake shaft assembly:

1. Remove the brake pedal by removing the two screws using a 1/2" wrench.
2. Remove the cotter pins that retain the three brake rods. Slide the brake rods out of the brake shaft assembly. See Figure 3.13.

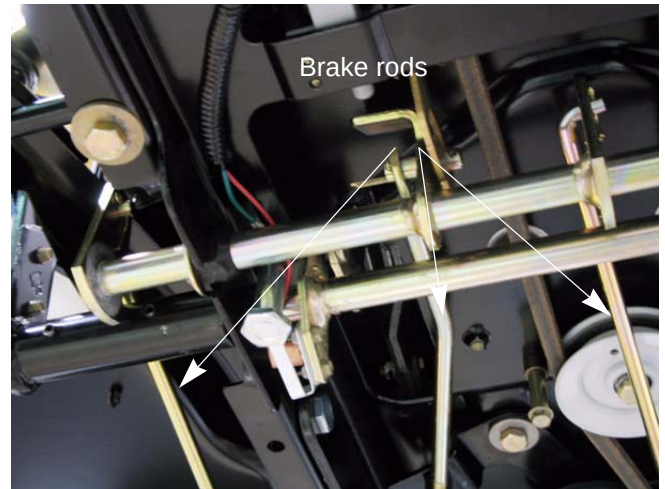


Figure 3.13

3. Remove the four screws, two on each side, that hold the sub frame in place and slide it down. See Figure 3.14.

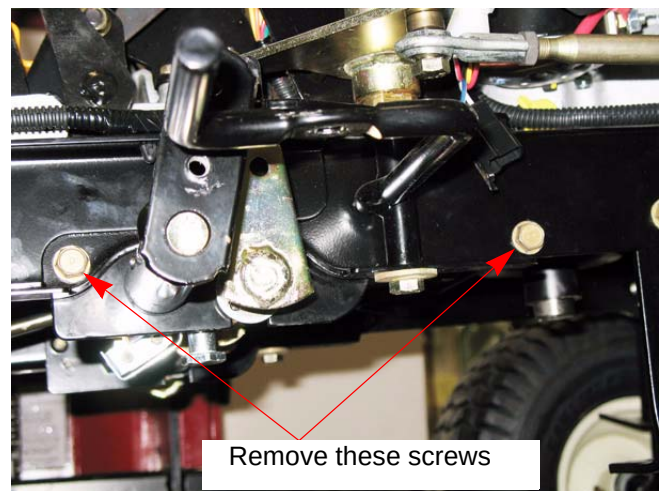


Figure 3.14

BRAKES

4. Loosen the shoulder bolt that the parking brake plate pivots on. See Figure 3.15.

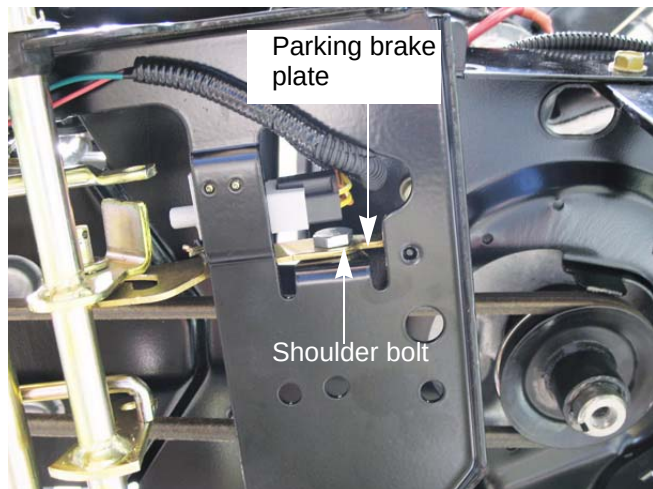


Figure 3.15

5. Remove the cotter pin on each end of the brake shaft. See Figure 3.16.



Figure 3.16

6. Remove the split bushings. See Figure 3.17.

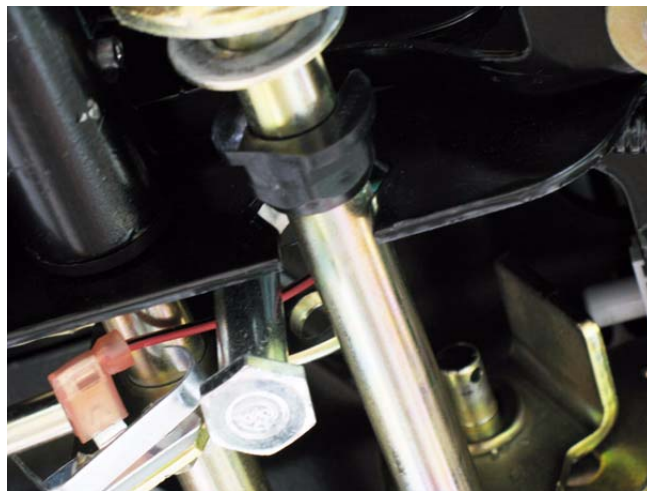


Figure 3.17

7. Work the brake shaft out of the sub frame.

NOTE: Take care not to bend the parking brake plate while working the brake shaft out. Make sure the shoulder bolt is loose enough to give the shaft clearance. The plate can be removed if necessary. See Figure 3.18.

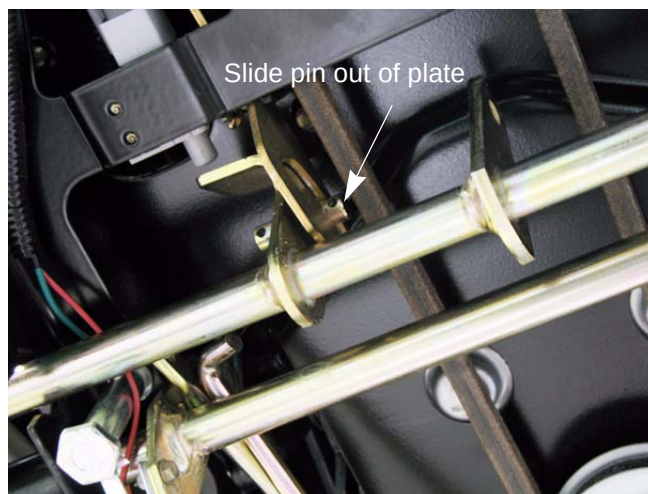


Figure 3.18

8. Replace the brake shaft by following the above steps in reverse order.
9. Test drive the tractor in a safe area before returning to service.

CHAPTER 4: BODY/CHASSIS

The hood

The I-1000 Series hood uses the same hood pivot system as the 1000 series for easy removal. See Figure 4.1.



Figure 4.1

To remove the hood:

1. Disconnect the headlight wires
2. Align the bolts in the hood with the slots in the hinge by opening it partially.
3. Lift the hood off of the tractor.
4. Install the hood by following the above steps in reverse order.

Bumper

The I-series tractors come equipped with a fast attach bumper. To remove the bumper:

1. Remove the two screws, one on each side, on the bumper bracket. See Figure 4.2.

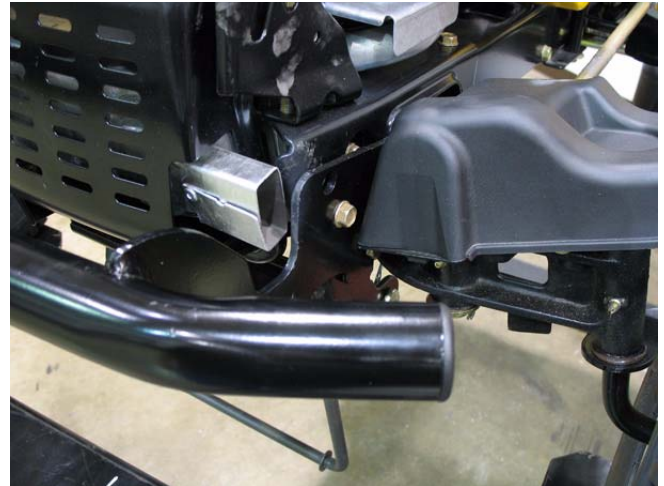


Figure 4.2

2. Pull the bumper straight forward, sliding the bumper off of the shoulder bolts. See Figure 4.3.

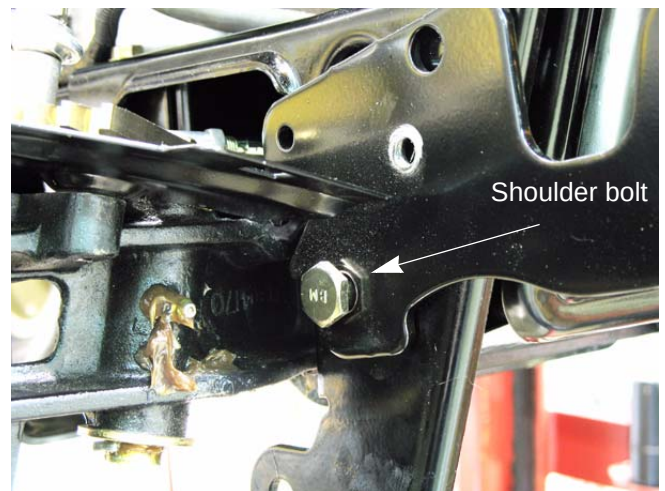


Figure 4.3

3. Install the bumper following the above steps in reverse order.

BODY/CHASSIS

Dash Removal

The dash for the I-series is easy to remove. There are a few repair procedures that require the dash to be removed. The steps to remove it are as follows:

1. Remove the steering wheel by:

1a. Remove the center cover. See Figure 4.4.



Figure 4.4

1b. Remove the bolt with a 1/2" wrench. See Figure 4.5.



Figure 4.5

NOTE: There is no puller needed for the steering wheel. Once the bolt is removed it will lift off of the steering shaft.

NOTE: When replacing the steering wheel, lock the steering gear box in neutral as described in chapter 6 STEERING. This will make it easier to center the steering wheel.

2. Remove the dash by:

2a. Disconnect the key switch, module, PTO switch and the hour meter. See Figure 4.6.

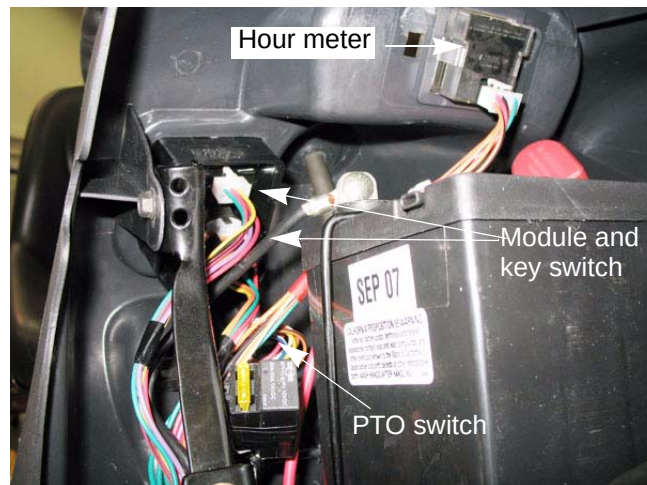


Figure 4.6

2b. Disconnect the parking brake by removing the hair pin clip and sliding the rod out of the lever. See Figure 4.7.

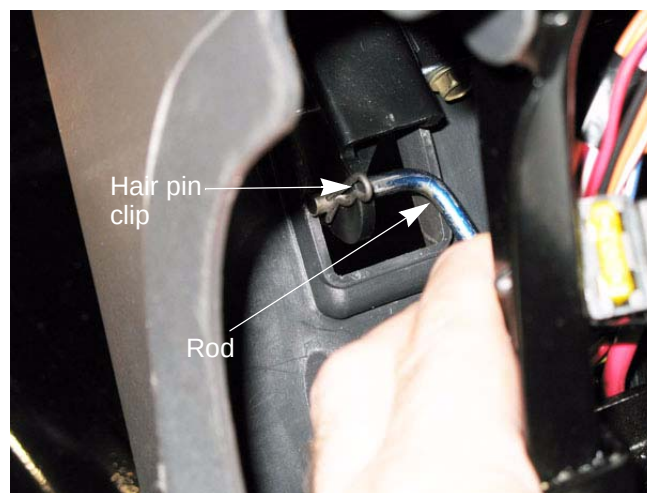


Figure 4.7

- 2c. Remove the two screws attaching the dash to the dash support. See Figure 4.8.



Figure 4.8

- 2d. Remove the two screws in the cargo net area, at the bottom of the dash. See Figure 4.9.



Figure 4.9

NOTE: The cargo net was removed for a clearer picture. Do not remove the net to remove the dash.

- 2e. Remove the screws at the bottom of the dash, on the sides. See Figure 4.10.



Figure 4.10

- 2f. The dash can now be lifted over the steering shaft and placed to the side or on top of the engine.

NOTE: The throttle and choke cable are still attached to the dash. Care should be taken to prevent damage to them when lifting the dash.

NOTE: If replacing the dash, remove the throttle and choke cables at this point.

3. Install the dash by following the above steps in reverse.

BODY/CHASSIS

Remove the fender

1. Remove the dash by following the steps described in the previous section of this chapter.
2. Disconnect the wires to the seat switch. See Figure 4.11.

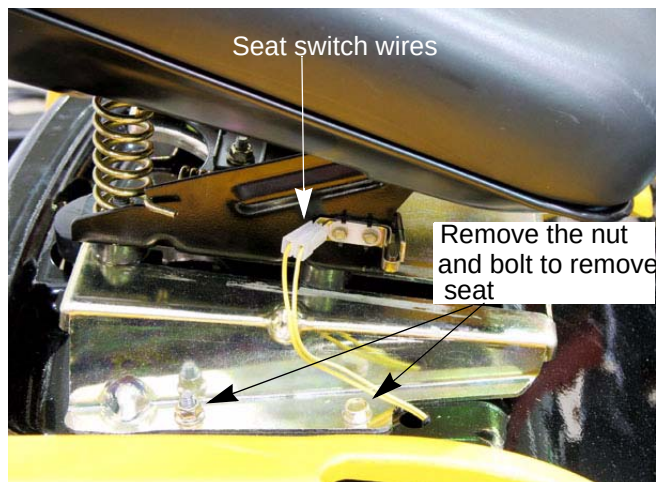


Figure 4.11

NOTE: When reconnecting the wires, the position of the two yellow wires does not affect the operation of the tractor.

3. Remove the seat bracket and seat as one piece. See Figure 4.11.
4. Remove the grip from the deck lift handle.
5. Remove the nuts from the under side of the foot rests. See Figure 4.12.



Figure 4.12

6. Remove the brake and drive pedals.

7. Remove the screw from the center of the fender. See Figure 4.13.

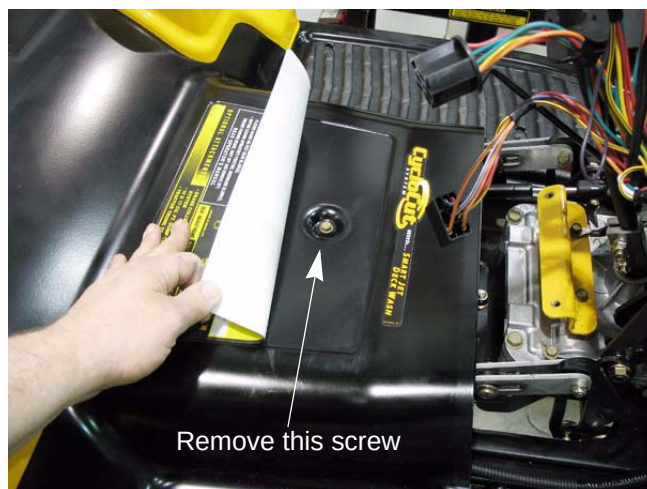


Figure 4.13

NOTE: If the label needs to be replaced the part number is 777S32771.

8. Remove the fuel cap.
9. Standing behind the tractor, lift the fender up till it clears the studs for the seat.
10. Place the steering wheel on the steering shaft. Turn the wheels to the left and right to allow the fenders to clear the steering arm assembly. See Figure 4.14.

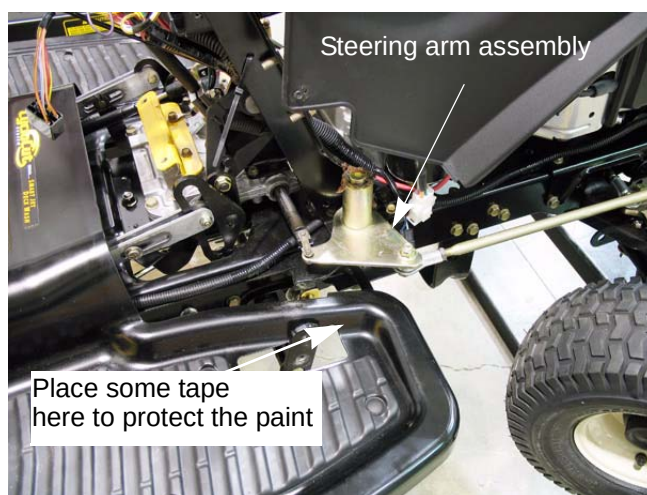


Figure 4.14

NOTE: When lifting the fender off of the tractor, clear the left side first and rotate the fender to clear the deck lift lever.

11. Install the fender by following the previous steps in reverse.

CHAPTER 5: DRIVE SYSTEM

The I-series tractor uses two Hydro-gear EZT transmissions. The transmission control linkages work in unison with the steering linkage to create the zero-turn feature. The neutral adjustments for the transmissions and the transmission links will be covered in chapter 6 STEERING.

The Hydro-gear shop manual for the EZT transmissions is included with this manual. If the tractor is within the warranty period, contact Cub Cadet service at 1-800-422-3381 before opening the transmission or the warranty may be voided.

Drive belt

The drive belt is the most common drive system component that will need attention. To remove/replace the drive belt:

1. Remove the deck as described in chapter 8 CUTTING DECKS AND LIFT SHAFT.
2. Set the parking brake.
3. Unplug the electric PTO harness. See Figure 5.1.

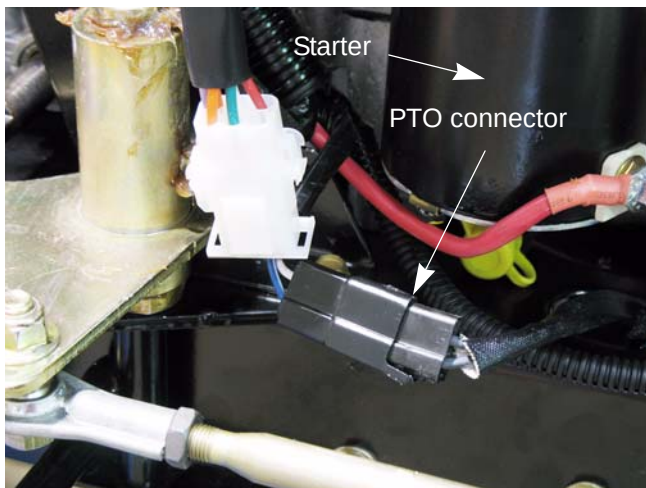


Figure 5.1

4. Unbolt the electric PTO using an impact wrench and a 5/8" socket. See Figure 5.2.

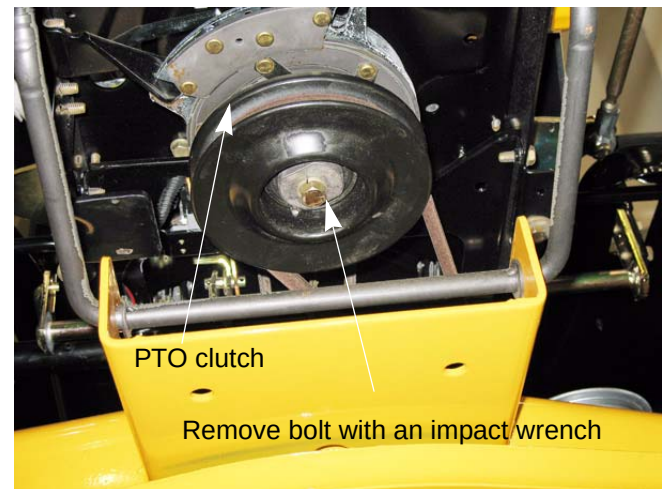


Figure 5.2

NOTE: If the PTO clutch will not slide off of the crank shaft, thread the bolt half way into the crank shaft. Start the engine and turn the PTO on and off several times to shake it loose.

NOTE: If the PTO will not come off using the steps above, remove the engine mounting bolts and slide the engine back. This will give enough clearance to slide the belt off of the engine pulley.

CAUTION: Cub Cadet belts are design to fit our equipment and are not standard lengths. Use of a non-OEM belt may prevent the de-clutching mechanism from working properly when the brakes are applied.

DRIVE SYSTEM

5. Slide the engine pulley down far enough to slip the belt off of the pulley. See Figure 5.3.

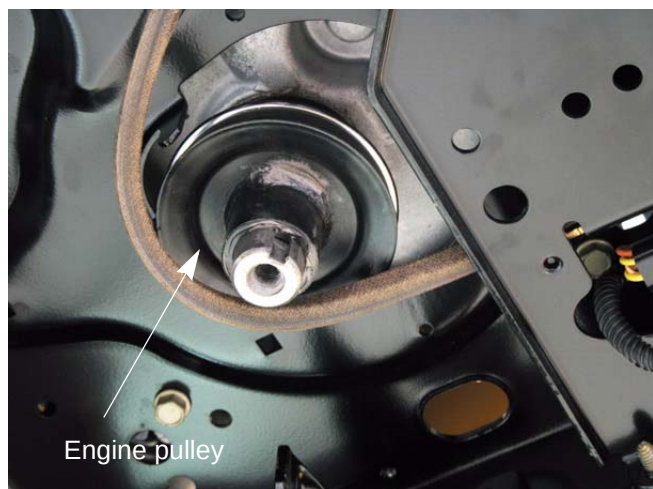


Figure 5.3

NOTE: Note the direction of the key in the engine pulley. It should be facing down. If the pulley is installed upside down, the belt alignment will be off.

NOTE: When installing the engine pulley and electric PTO, coat the crank shaft with anti-seize. This will ease pulley and clutch removal in the future.

6. Remove the three belt guides near the idler pulleys. See Figure 5.4.

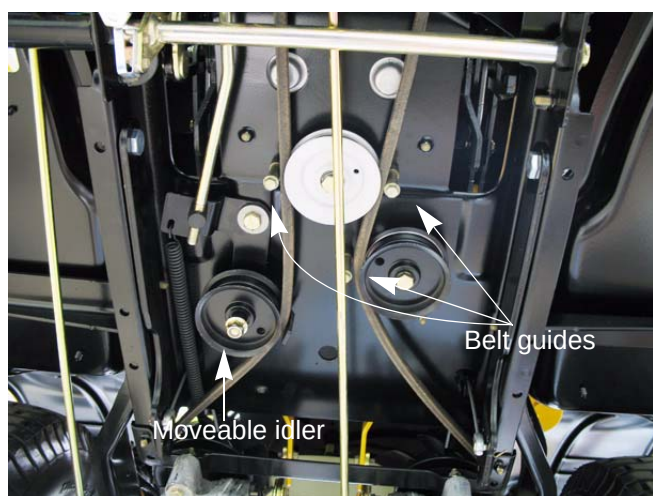


Figure 5.4

7. Work belt off of the idler pulleys.

NOTE: It may be necessary to loosen the moveable idler pulley to get the belt to clear the belt guide on the idler bracket. See Figure 5.4.

8. Remove the two screws holding the transmission brace that surrounds the rear of the transmission drive belt. Slide the brace to the rear of the tractor to make enough clearance to remove the belt. See Figure 5.5.



Figure 5.5

9. Work belt around the transmission pulleys and fans.

NOTE: Use care to prevent damage to the fans when working the belt off.

10. Remove the two screws that hold the transmission links to the shifter plate. See Figure 5.6.

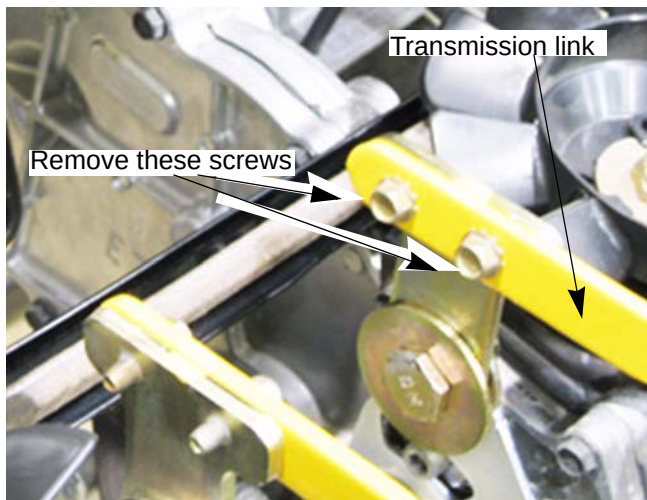


Figure 5.6

11. The belt can now be snaked out of the tractor.
12. Install the belt following the above steps in reverse order.

NOTE: Tighten the electric PTO clutch bolt to a torque of 450 - 600 in-lbs (51 - 68 Nm).

13. Test drive the tractor before returning to service.

Belt adjustment

The drive belt is tensioned by a spring loaded moveable idler pulley. When the brakes are applied, the drive belt is de-clutched. An adjustable linkage connects the tensioner pulley to the brake shaft. A brake link that is out of adjustment will prevent the moveable idler from correctly tensioning and de-tensioning the belt.

As the belt wears and stretches, the moveable idler needs to push the belt in further to keep proper belt tension. To do this, the ferrule at the end of the brake link needs to be at the middle of the slot in the idler pulley bracket. To adjust this brake link:

NOTE: The belt must be on when performing this adjustment.

1. Release the parking brake.
2. Remove the deck as described in chapter 8 CUTTING DECKS AND LIFT SHAFT.
3. Remove the cotter pin and washer from the ferrule. See Figure 5.7.

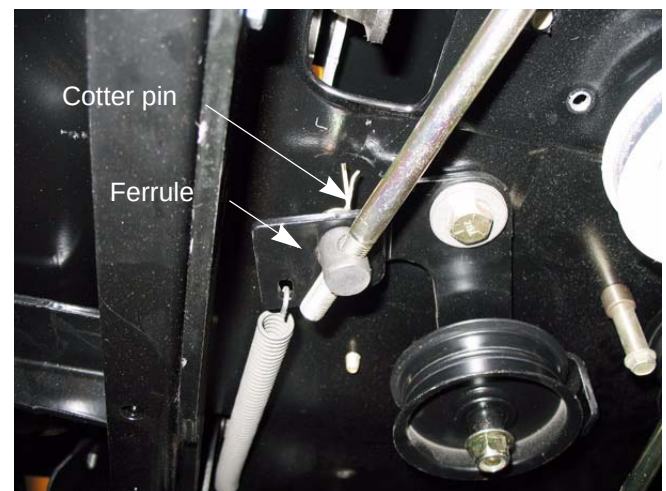


Figure 5.7

DRIVE SYSTEM

- Slide the ferrule out of the idler bracket.
See Figure 5.8.

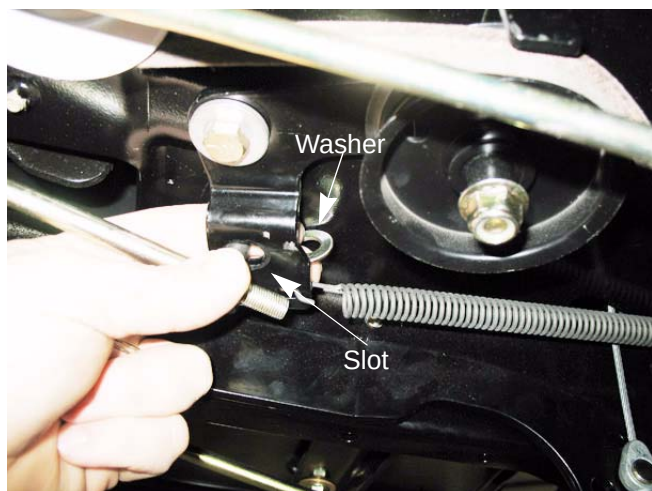


Figure 5.8

- Adjust the ferrule so that it lines up with the middle of the slot and slides in without pulling on the spring. See Figure 5.8.
- Install the washer and a new cotter pin.
- Re-attach the deck.
- Test drive the tractor before returning to service.

Transmissions

IMPORTANT: If the tractor is within the warranty period, contact Cub Cadet service at 1-800-422-3381 before opening the transmission or the warranty may be voided.

The I-series tractor uses two EZT transmissions from Hydro-gear. The transmissions can be removed separately. To remove a transmission:

NOTE: The transmission model and serial number tags are located on the frame channel next to the transmission that they refer to.

- Remove the deck as described in chapter 8 CUTTING DECKS AND LIFT SHAFT.
- Remove the drive belt as described previously in this chapter.

NOTE: Leave the transmission links and the transmission brace disconnected.

- Lift the rear of the tractor and support it on jack stands placed under the frame of the tractor.
- Remove the rear wheel.
- Unhook the by-pass rod. See Figure 5.9.



Figure 5.9

- Disconnect the brake rod by following the steps described in chapter 3 BRAKES.

7. Remove the two bolts that thread into the cross tubes. See Figure 5.10.

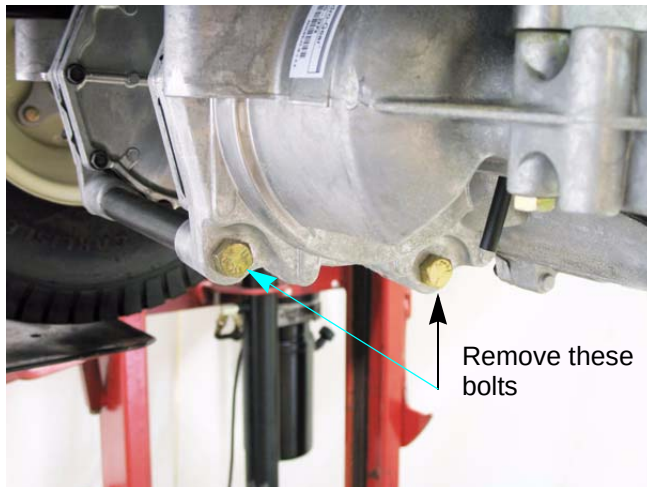


Figure 5.10

8. Support the transmission to prevent it from falling while the mounting bolts are removed.
9. Remove the bolt holding the transmission to the torque bracket. See Figure 5.11.

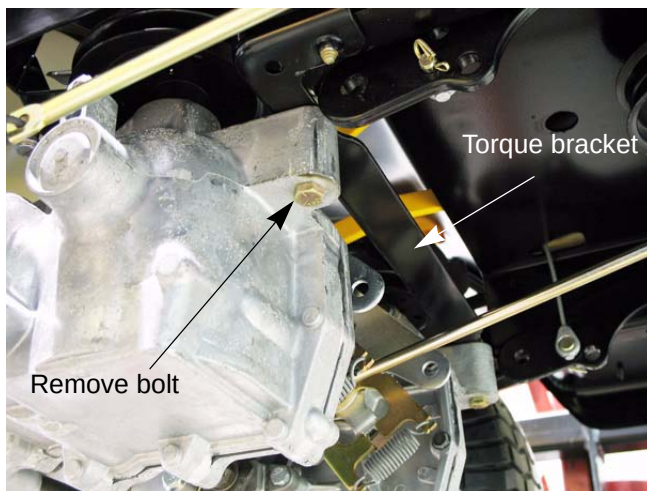


Figure 5.11

NOTE: There is a nut on the top side of the torque bracket. use a 7/16" wrench to hold it while removing the bolt.

10. Remove the two bolts that fasten the transmission to the frame. See Figure 5.12.



Figure 5.12

11. The transmission can now be removed from the tractor.
12. If replacing the transmission, remove the transmission pulley and fan assembly.
13. Remove the wheel hub assembly.
14. Install the hub on the new transmission and tighten to a torque of 420 - 480 in-lbs (47.5 - 54Nm).
15. Install the transmission pulley and fan assembly on the new transmission and tighten to a torque of 300 - 460 in-lbs (34 - 52Nm).
16. Install the transmission by following steps 1 - 11 in reverse order.
17. Perform a neutral adjustment and wheel alignment by following the steps described in chapter 6 STEERING.
18. Test drive the tractor in a safe area before returning to service.

CHAPTER 6: STEERING

Introduction

The steering on the I-series tractor works in two phases. First it will steer like any other tractor by turning the front wheels. Second and more importantly, the steering linkage will control the two hydro transmission to make the tractor turn at a sharper radius until the tractor reaches a zero point turning radius.

The steering gear box is attached to the front wheels by drag links. When the steering wheel is turned, the gear box will turn the wheels. When the angle of the wheels reaches around a 55° angle from straight ahead, the gear box will start to slow the transmission on the inside of the turn and continue turning the front wheels. When the inside wheel reaches an angle of 90° the rear wheel on that side will stop driving. Turning the wheel past that point will make the inside rear wheel go in reverse. The front wheels can reach a 108° angle and with the transmission on the side of the turn going in reverse the tractor will be in a zero turn.

Because the steering gear box is linked to the transmissions, the transmission adjustments and the wheel alignment must be addressed together. A transmission that is out of adjustment can make the steering look out of adjustment just as a front end that is out of adjustment will affect the adjustment of the transmissions.

Neutral and Transmission Links Adjustment

Because the steering gear box is linked to the transmissions, it is important to make sure the transmission is adjusted for neutral first. The transmission links will self adjust when the neutral adjustment and wheel alignment are done. To establish neutral:

1. Lock Steering Gear Box in Neutral Position:
 - 1a. Reaching in from the left side of the engine, remove the 1/4"-20 plug screw from the steering gear box centering port using a 3/8" wrench. See Figure 6.1.



Figure 6.1

ELECTRICAL SYSTEM

- 1b. Using a 1/4"-20 bolt having a minimum of 1.5" of threaded length, thread the bolt into the steering box centering port until you feel it touch the steering rack. While trying to gently thread the bolt further, slowly rotate the steering shaft back and forth until the bolt seats into the detent in the steering rack. Finger tighten the screw to set the screw fully into the detent. The steering gear box is now centered and locked. See Figure 6.2.

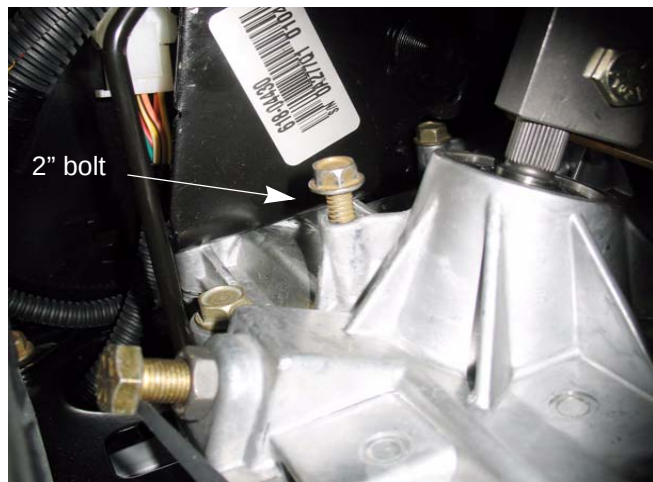


Figure 6.2

2. Jack the tractor up so that both rear wheels are off of the ground and place a pair of jack stands under the rear transmissions. See Figure 6.3.



Figure 6.3

3. Loosen the two screws that attach the linkage to the transmission(s). See Figure 6.4.

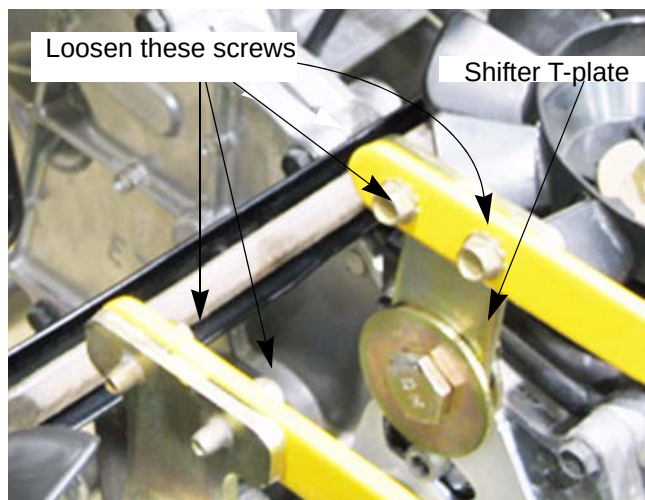


Figure 6.4

NOTE: Feel the shifter T-plate, it should be free of any input from the transmission links. If tension is felt there, disconnect the links completely.

4. While sitting in the seat, start the tractor and run it at full throttle. Release the brake.

5. Check the rear wheels.

NOTE: The rear wheel should not turn. If either wheel turns, adjust the transmission for neutral by:

- 5a. Loosen the socket headed cap screw in the slot of the shift selector plate. See Figure 6.5.

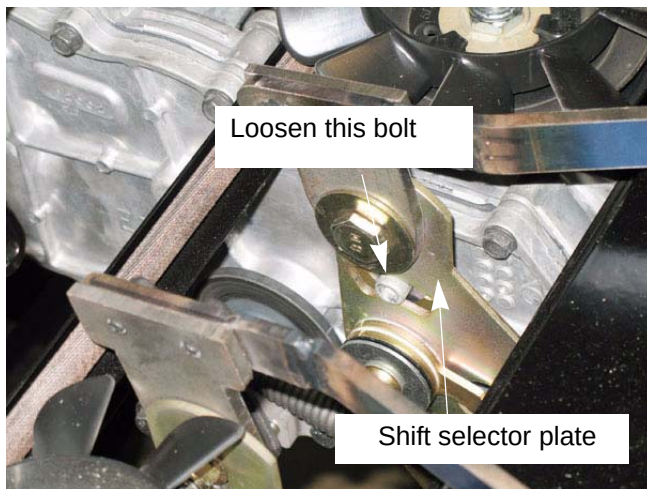


Figure 6.5

NOTE: It is not necessary to remove the fender for this step. The fender was removed in this photo for clarity.

NOTE: Only loosen the screws on the side that creeps.

- 5b. With the tractor still running, move the shift selector plate until the wheel stops moving.

- 5c. Tighten the socket headed cap screw.

NOTE: Leave the transmission links loose until the wheels are aligned.

Wheel alignment

NOTE: The transmission neutral adjustment must be done as the first step in adjusting the wheel alignment.

1. Remove the three screws holding each steering gear cover in place. See Figure 6.6.

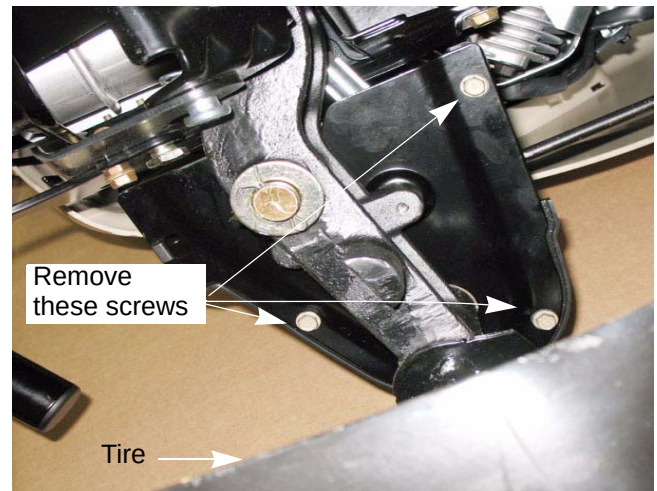


Figure 6.6

2. Align the marks on the axle gear and the steering gear for both wheels. See Figure 6.7.

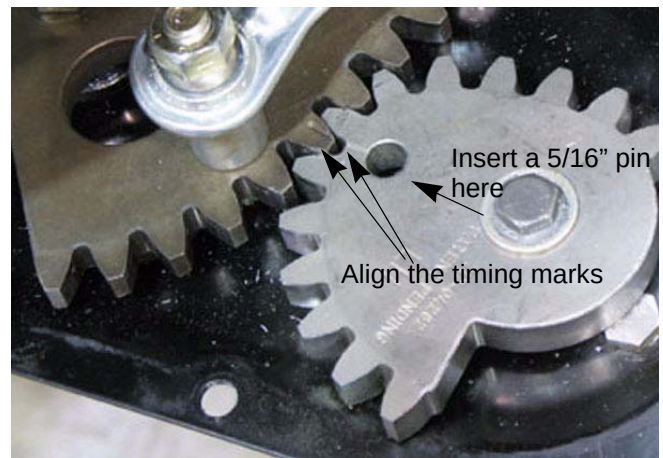


Figure 6.7

ELECTRICAL SYSTEM

3. Insert a 5/16" pin through the hole in the steering gear on each side. The pins should pass through the gears, through the lower cover plate and into the pivot bar. See Figure 6.8.



Figure 6.8

NOTE: If the alignment is off the holes may not line up. If this is the case, adjust the front end by:

- 3a. Loosen the jam nuts on both ends of the drag link. See Figure 6.9.



Figure 6.9

- 3b. Adjust the drag link until the holes line up. See Figure 6.10.

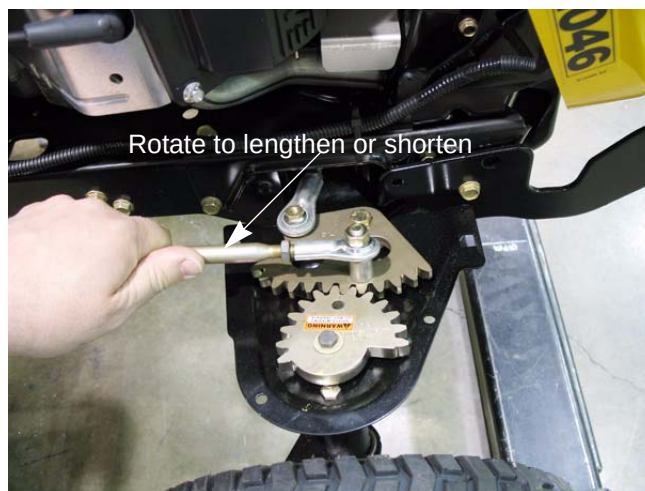


Figure 6.10

NOTE: The punch should slide in and out without drag. Also as the drag links are being adjusted, rock the tires back and forth to remove the load created from the tires twisting on the floor.

- 3c. Tighten the jam nuts.

4. Tighten the transmission links.
5. Remove the long 1/4"-20 screw from the steering gear box and place the short one back in it.
6. Install the steering gear covers.

CAUTION: Never allow an I-series tractor to be operated without the steering gear covers. Personal injury may result.

7. Test drive the tractor in a safe area before returning to service.

Cam Slot Angle Adjustment

The cam slot adjustment is the most critical adjustment on the I-series tractor. It should only be necessary in two cases.

- The cam slot angle adjustment must be set if the steering gear box is replaced.
- In the extremely rare case that the angle is simply out of adjustment. The indications are as follows:
 - A The tractor is running.
 - B Parking brake released.
 - C Feet off of the brake and drive peddles.
 - D Turn the steering wheel fully in both directions.
 - E If it creeps, cam angle needs adjusted.

CAUTION: The second would be a safety issue and must be addressed before returning to service. to adjust the cam slot angle:

NOTE: A special tool P/N 753-05437 is needed to make this adjustment. Do not attempt to make this tool, if needed it can be ordered from the Cub Cadet parts department.

1. Adjust the transmission for neutral and align the front wheels as described in the previous section of this chapter.

NOTE: Leave the transmission links loose and the long screw in the steering gear box.

2. Remove the dash and fender by following the steps described in chapter 4 BODY/CHASSIS.

3. Disconnect the transmission link from the right side of the gear box only by removing the nut and bolt. See Figure 6.11.

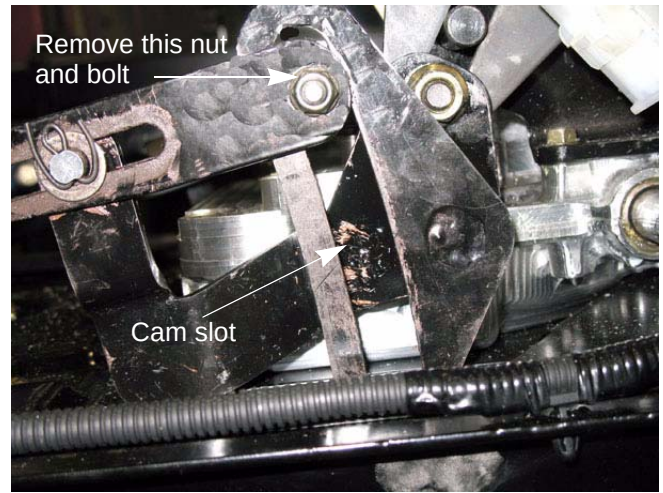


Figure 6.11

4. Remove the cotter pin and clevis pin. See Figure 6.12.

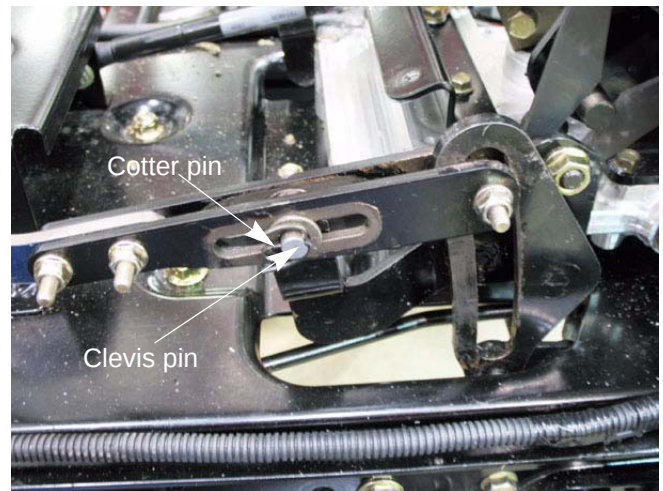


Figure 6.12

ELECTRICAL SYSTEM

5. Raise the transmission link away from the cam slot.

NOTE: Make sure to catch the double roller when lifting the transmission link away from the steering gear box. See Figure 6.13.

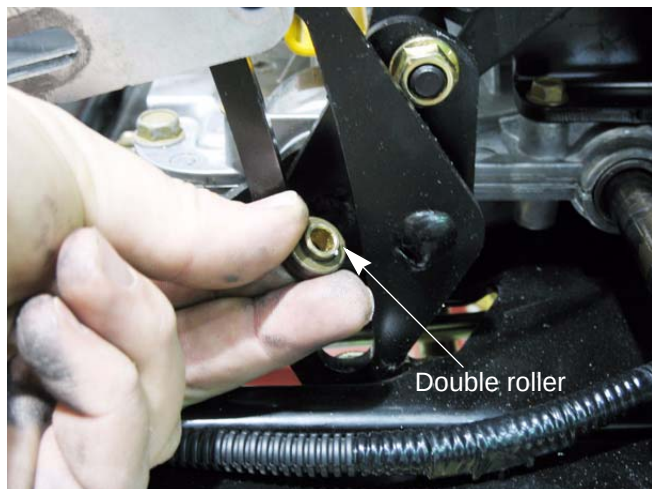


Figure 6.13

6. Loosen the return to neutral bolt using a 9/16" wrench and a 1/4" hex key. See Figure 6.14.



Figure 6.14

7. Insert the pins of the gauge block tool P/N 753-05437 into the cam slot. See Figure 6.15.

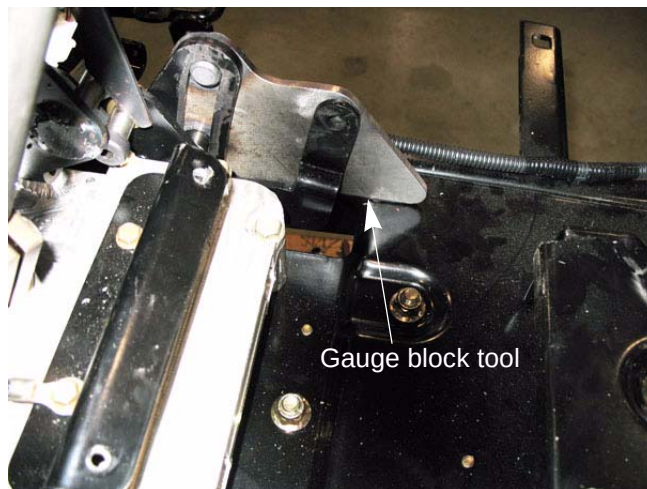


Figure 6.15

8. Rest the tool flat against the frame. See Figure 6.16.



Figure 6.16

9. Tighten the return to neutral bolt.
See Figure 6.17.



Figure 6.17

10. Remove the tool.
11. Reassemble the tractor by following the steps just described in reverse order.
12. Test drive the tractor in a safe area before returning it to service.

Steering gear box removal

For the first two years of production there will be no service parts for the steering gear box. The purpose of this is to have any failed gear box returned to the engineers for examination. For warranty, any gear box failure is to be repaired by replacing the gear box without opening it. To replace the gear box:

1. Remove the dash and fender by following the steps described in chapter 4 BODY/CHASSIS.
2. Disconnect the transmission linkage:
 - 2a. Remove the cotter pin, washer and clevis pin in the linkage. See Figure 3.18.



Figure 3.18

- 2b. Remove the nut and bolt attaching the transmission linkage to the levers on the steering gear box. See Figure 6.19.

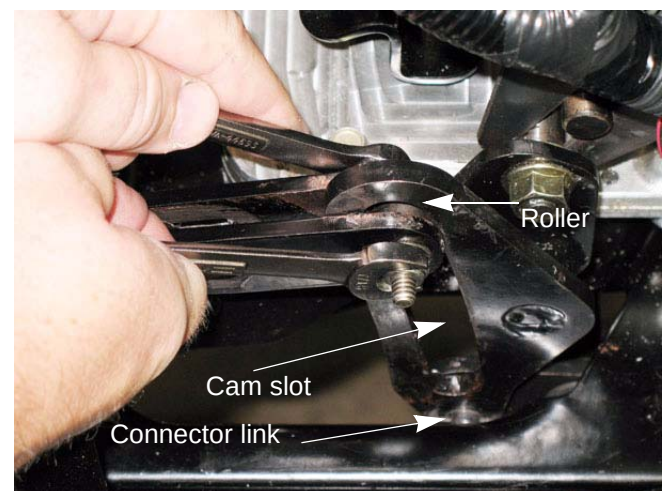


Figure 6.19

ELECTRICAL SYSTEM

2c. Lift the links away from the gear box.

NOTE: There are rollers in the slots. Take care not to lose them when removing the bolts.

3. At the bottom of the lever with the cam slot there is a connector link. Remove the hairpin clip and push it out of the lever. See Figure 6.20.

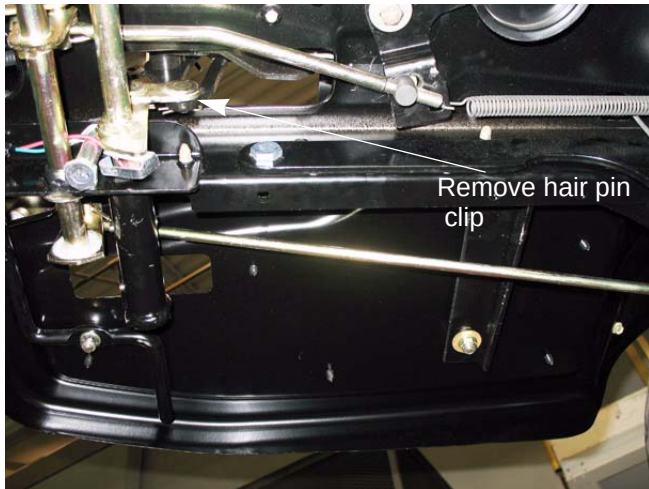


Figure 6.20

4. Disconnect the steering links on both sides:

4a. Gently pry the link retainer over the master link. See Figure 6.21.

NOTE: The steering link is a special master link. It is not an off the self link that can be found in the aftermarket. If the retainer is damaged during removal, the whole link must be replaced.

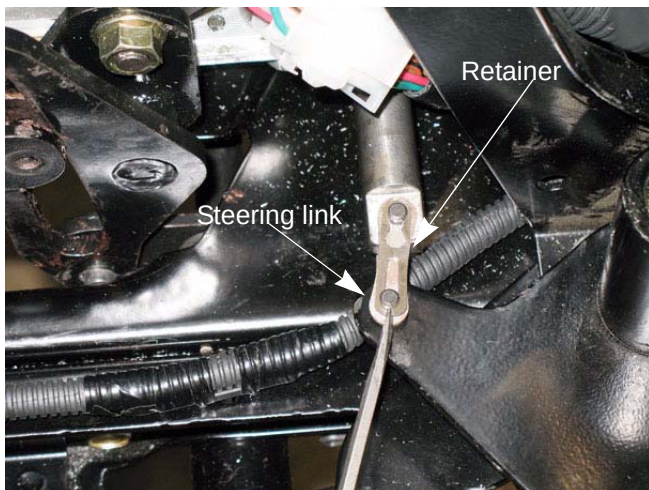


Figure 6.21

5. Remove the transmission dampener cylinder using two 1/2" wrenches. See Figure 6.22.

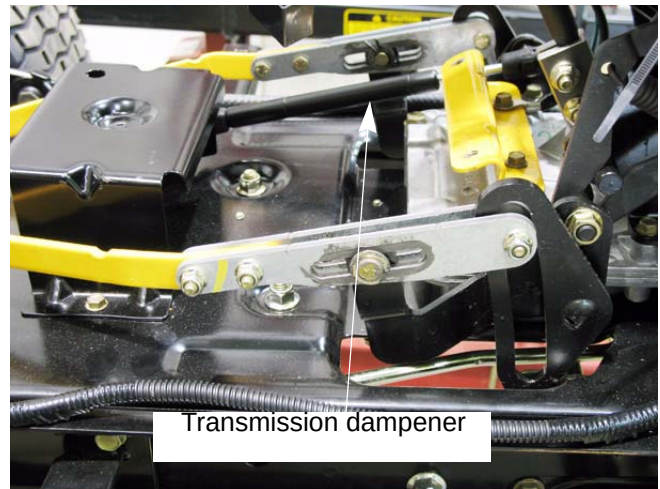


Figure 6.22

6. Remove the steering shaft by removing the two clamp bolts in the steering shaft receiver and lifting the shaft out. See Figure 6.23.

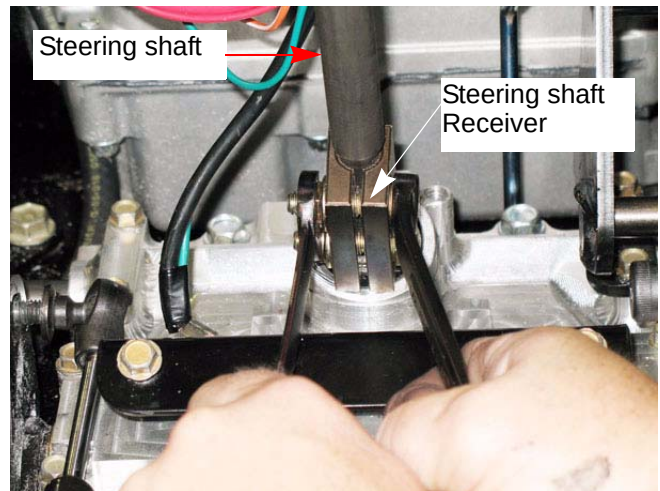


Figure 6.23

NOTE: Rotating the steering shaft bushing 90 degrees will allow the bushing to pop out relieving the pressure on the steering shaft. This will make it easier to remove or install the shaft. See Figure 6.24.

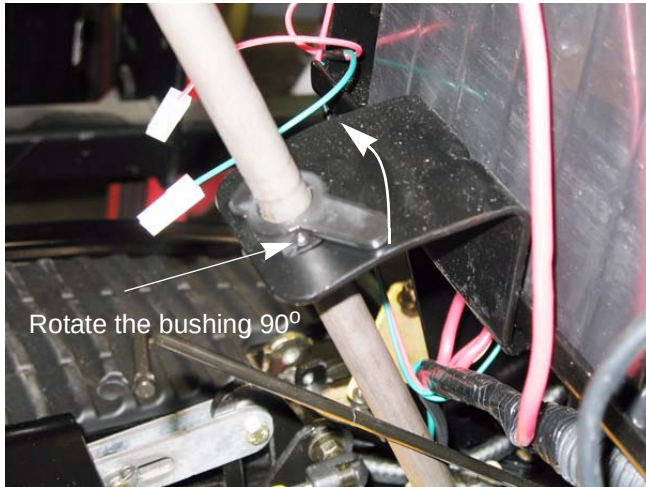


Figure 6.24

7. Remove the ground wire. See Figure 6.25.

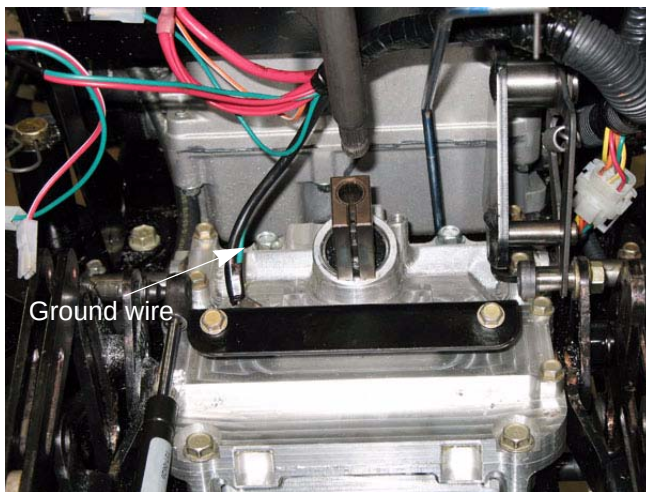


Figure 6.25

8. Remove the four screws holding the gear box to the frame with a 1/2" wrench. See Figure 6.26.

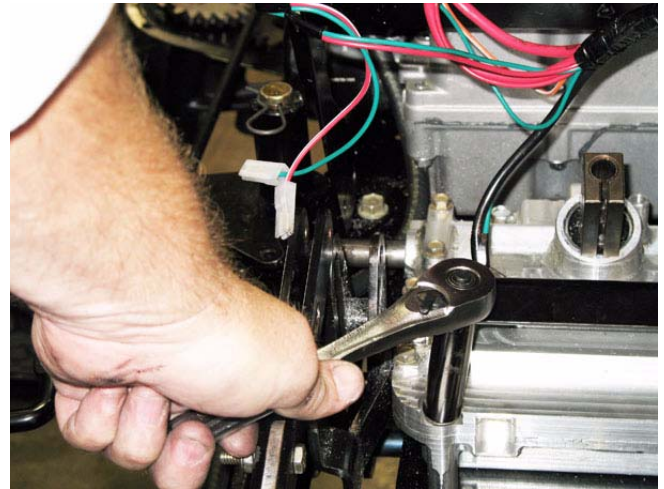


Figure 6.26

9. The new gear box should come with 1/4"-20 x 2" screw to lock it into the neutral/centered position.
10. Bolt the gear box to the frame with the four bolts removed in step 8.
11. Insert the steering shaft into the steering shaft receiver. Tighten the nuts to a torque of 130 - 160 in lbs (14.7 - 18.0 Nm).
12. Attach the steering links. Install the retainers.
NOTE: If the retainers are bent or twisted, the whole link must be replaced. The retainers are not available separately.
13. Attach the transmission dampener to the gear box.

ELECTRICAL SYSTEM

14. Place the link into the bottom of the lever with the cam slot. insert the hairpin clip to hold it in place. See Figure 6.27.

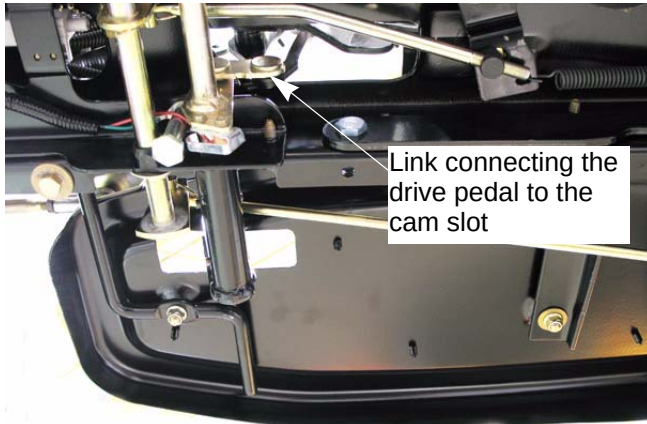


Figure 6.27

15. Apply anti-seize compound to the rollers and the cam slots on the gear box levers. See Figure 6.28.



Figure 6.28

16. Adjust the speed cam angle by following the step steps described in the previous section.
17. Connect the transmission links.
 - 17a. Place the rollers into the cam slots and slide the transmission links over the levers.
 - 17b. Insert the bolt through the transmission link and roller.
 - 17c. Install the nut on the bolt and tighten to a torque of 8 ft lbs (11 NM). See Figure 3.29.



Figure 3.29

18. Insert the clevis pin, washer and cotter pin.
19. Align the wheels and adjust the transmission links by following the steps described at the beginning of this chapter.
20. Install the fender and dash by following the steps described in chapter 4 BODY/CHASSIS.
21. Test drive the tractor in a safe area before returning to service.

Pivot bar, axles and steering gears

Because the axles and steering gears need to be removed in order to service the pivot bar, they will be covered as one section.

NOTE: This section is written so the technician can follow only steps needed to complete the repair required.

To remove the pivot bar:

1. Remove the drag links by:
 - 1a. Remove the steering gear covers.
 - 1b. Insert a 5/16" pin punch into one of the alignment holes to lock the steering gears in place. See Figure 6.30.

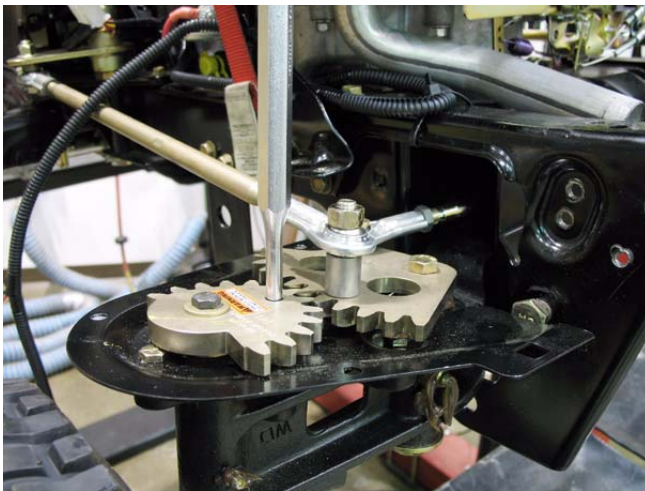


Figure 6.30

- 1c. Remove the nut holding the drag link to the inboard steering gear using two 9/16" wrenches. See Figure 6.31.



Figure 6.31

NOTE: The nuts used on the drag links and the tie rod are single use only. Do not try to reuse them by applying a thread locking compound. Use new nuts every time.

1d. Repeat the previous steps on the other side.

2. To remove the axles:

2a. Jack up the front end of the tractor and securely place on jack stands.

NOTE: If servicing the axle, remove the front wheel by popping the hub cap off with a flat head screw driver and removing the cotter pin. This will allow the wheel to slide off. If servicing the pivot bar, the wheels can remain on the axles while removing the axles.

2b. Loosen the bolt that holds the outboard steering gear to the axle. Back the bolt half way out.

NOTE: The axle had a tapered double-D shaft. Gear steering gear will be very tight on the shaft.

2c. Strike the bolt head, using a brass drift punch and a hammer. This will loosen the axle from the outboard steering gear. See Figure 6.32.

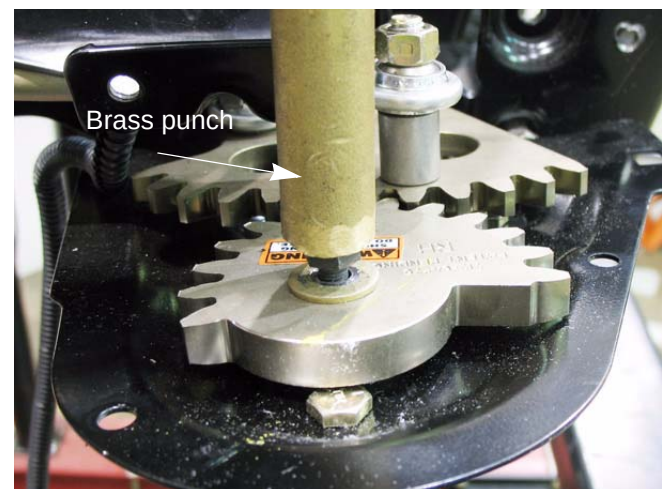


Figure 6.32

2d. Take the bolt all the way out.

NOTE: The axle should fall out at this point.

ELECTRICAL SYSTEM

- 2e. Set the outboard steering gear off to the side.
3. Remove the muffler by following the steps described in chapter 2 ENGINE RELATED PARTS.
4. Remove the four screws fastening the bumper mount bracket to the frame. See Figure 6.33.

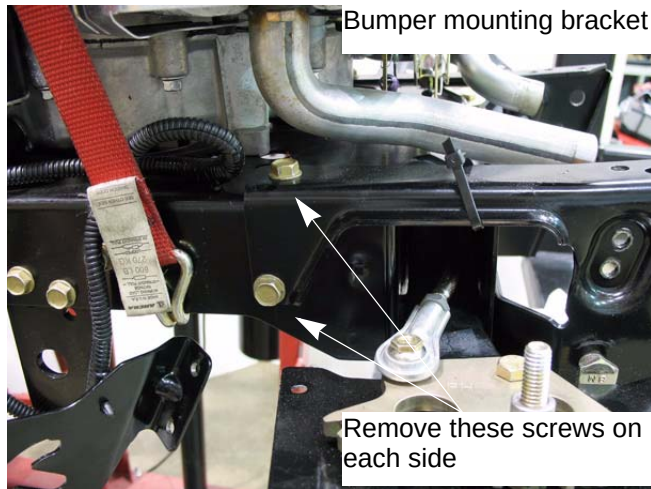


Figure 6.33

5. Remove the pivot bar shoulder bolts. See Figure 6.34.

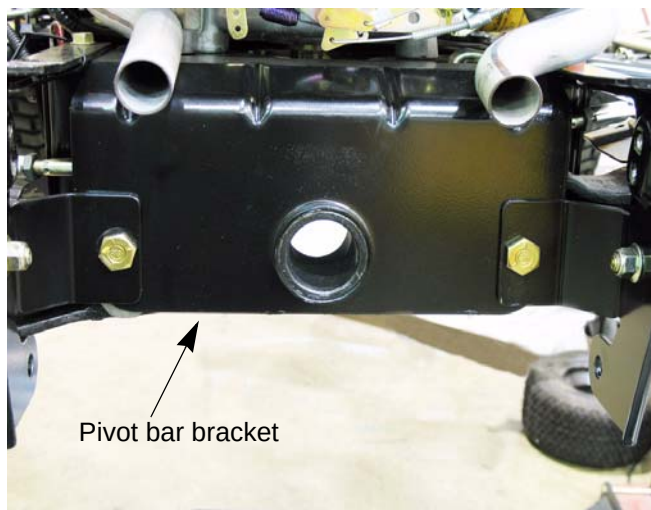


Figure 6.34

WARNING: At this point there is nothing holding the pivot bar in place. Take care to prevent the pivot bar from falling off of the tractor.

NOTE: When installing the pivot bar, use a clamp to line up the screw holes in the frame, pivot bar and bumper mounting brackets. See Figure 6.35.



Figure 6.35

6. Slide the bumper mounting bracket and the pivot bar bracket off of the tractor.
7. Remove the pivot bar.
8. Inspect the contact areas where the pivot bar meets the frame. If there is any material that has erupted, sand it down. Repeat inspection on the inside of the pivot bar bracket. See Figure 6.36.

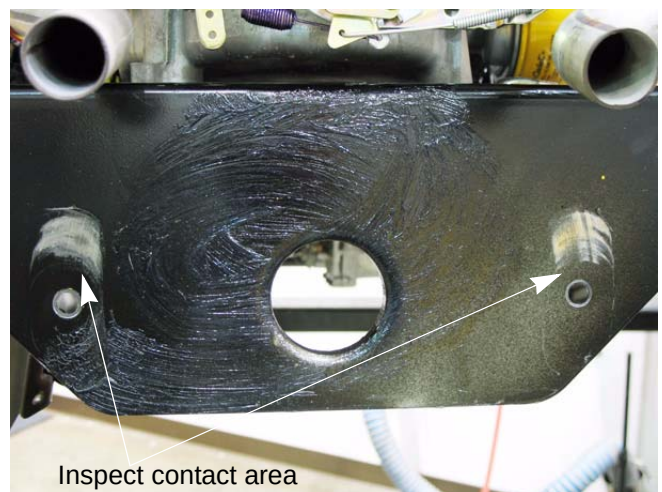


Figure 6.36

9. With the pivot bar on a bench, the inboard steering gear and the tie rod can be serviced.
10. Remove the tie rod by removing and discarding the nut holding the tie rod ends to the in board steering gear. See Figure 6.37.

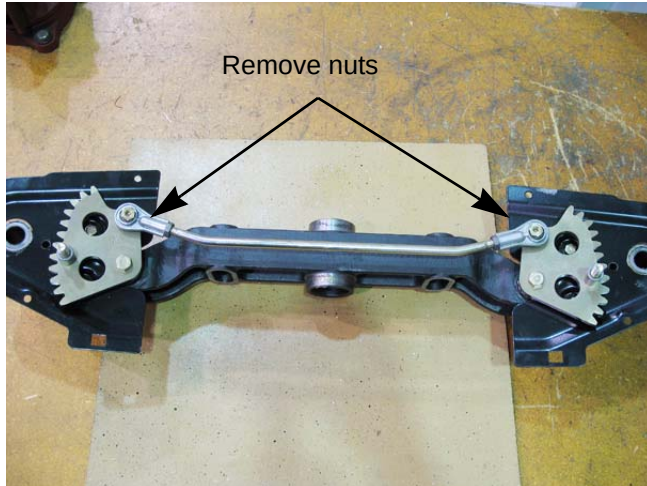


Figure 6.37

11. Remove the inboard steering gear by removing the bolt using a 9/16" wrench.
12. Remove the steering king pin by:
 - 12a. Removing the cotter pin in the bottom of the king pins.
 - 12b. Push the king pins out of the pivot bar. See Figure 6.38.

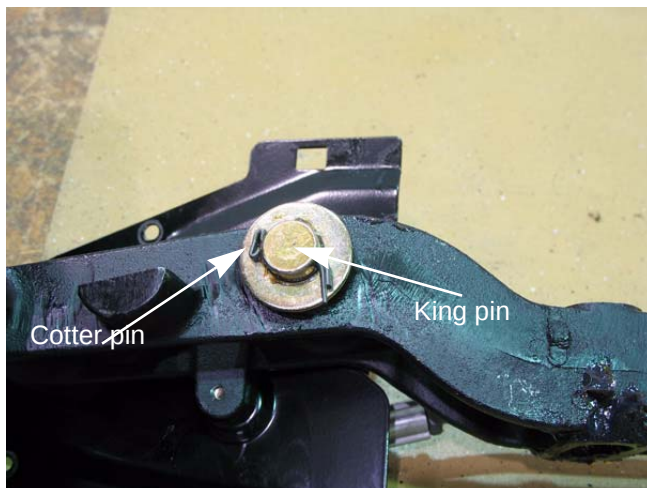


Figure 6.38

13. To re-assemble the pivot bar, start by inserting the steering king pins into the pivot bar. Securing them with new cotter pins. See Figure 6.38.
14. Install the axle assemblies.
15. Place the outboard steering gears on the axles and tighten to a torque of 100 - 150 in-lbs (11 - 17 Nm).

NOTE: The steering gears are marked LH and RH. Make sure the LH is facing up on the left hand side and that the RH is facing up on the right.

16. Apply a small amount of releasable thread locking compound such as Loctite® 242 (blue) on the bolt for the in board steering gears. Align the timing marks on the inboard and outboard steering gears and tighten the bolt that fastens the inboard steering gears to a torque of 380 - 450 in- lbs (43 - 51 Nm).

NOTE: Make sure the bolts for the drag link and tie rod are in the in place before installing the steering gears.

17. Insert a 5/16" pin punch in the alignment holes of the out board steering gears. Make sure they go all the way through into the pivot bar to lock the gears in position. See Figure 6.39.

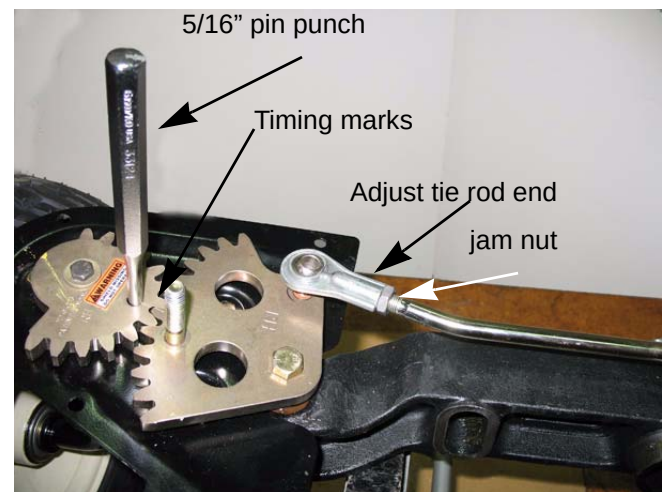


Figure 6.39

ELECTRICAL SYSTEM

18. Adjust the tie rod ends by loosening the jam nuts and rotating the tie rod ends until they slide on to the 1/4" bolts sticking up through the inboard steering gears. Tighten the jam nuts to lock the tie rod ends in place. See Figure 6.39.
19. Apply a small amount of releasable thread locking compound such as Loctite® 242 (blue) to the tie rod end bolt. Use a new shoulder nut to tighten the tie rod end in place.
20. Apply high quality grease to the frame and the inside of the pivot bar bracket, where the pivot bar rides. See Figure 6.40.

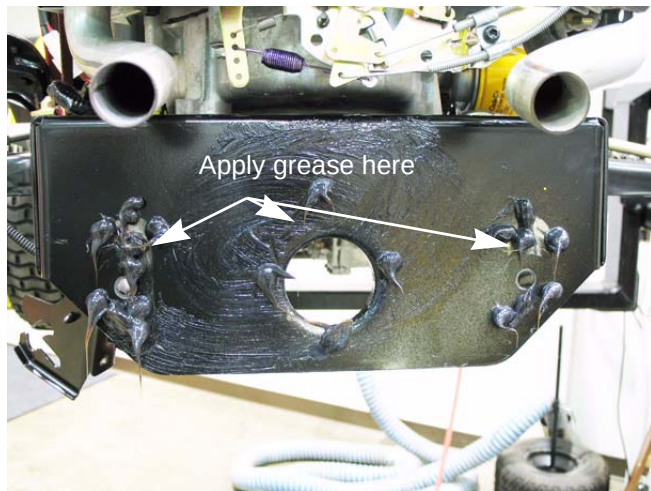


Figure 6.40

21. Install the pivot bar by following steps 3 - 7 in reverse order.
22. Slide the front wheels on. Secure in place with new cotter pins.
NOTE: Make sure the washer is installed between the wheel bearings and the cotter pin.
23. Push the hub caps on till they snap in place.
24. Take the tractor off of the jack stands.
25. Perform a neutral adjustment and wheel alignment as described in the beginning of this chapter.
26. Test drive the tractor in a safe area before returning to service.

CHAPTER 7: ELECTRICAL SYSTEM

Introduction

This chapter is divided into four sections:

- **Section 1:** About this chapter and Precautions
- **Section 2:** Components
This section will describe the location and operation of the electrical components on the tractor. Where appropriate, some disassembly or component removal instructions will be included.
- **Section 3:** Diagnostic Techniques
This section will cover basic tools, techniques, and methodology for diagnosing electrical issues on the tractor. A lot of the information in this section can be applied to other equipment.
- **Section 4:** Schematics

Precautions

CAUTION: Before disconnecting any electrical component, take precautions to prevent the component or the wires attached to it from shorting out. The most effective means of doing this is to disconnect the battery ground cable from the negative battery terminal.

CAUTION: Unless performing tests that require the electrical system to be in operation, disconnect the negative cable from the battery before doing any work to the electrical system of the tractor.

Components

The I-series tractor uses the same REV-TEC mow in reverse electrical system as the Cub Cadet 1000 series.

1. RMC Module

The **RMC module contains electronic logic circuits**. When diagnosing anything that is connected to the RMC module, a high impedance test light or a high impedance digital volt-ohm meter (DVOM) must be used. The amperage draw of a standard incandescent test light may over-burden some internal electronic circuits, burning-out the module.

NOTE: These tools are not outrageously expensive or exotic. High impedance test lights (Thexton model 125 is typical) can be purchased locally from stores like NAPA for under \$30.00. Appropriate multi meters can be purchased for under \$100.00, and are an invaluable tool for any competent technician.

- It is typical when industries **shift from electro-mechanical to electronic controls** that diagnosis shifts from tracing through a number of independent circuits to checking the in-puts to and out-puts from a central processor. This is similar to, but much less complex than the transition that the auto industry made with the conversion to fuel injection in the 1980s.

NOTE: The **starter safety circuit** has no connection to the RMC module.

- The **safety circuits that are capable of turning-off the engine** work through the RMC module.
- It is still important to be familiar with the workings of the individual components of the electrical system, but **some of them can now be checked from a central point on the tractor**. This makes life easier on the technician, frequently making it unnecessary to connect to difficult to reach switches in the preliminary stages of diagnosis.
- The function of individual safety switches can be seen as providing information “inputs” to the RMC module.
- The next part of this section gives a **detailed description of the electrical components** on this tractor, their function in the system, and their

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physical location on the tractor. Armed with this information and the proper tools, a technician should be able to efficiently diagnose most electrical problems.

2. Key switch

The **Key Switch** is similar to those used in a variety of MTD applications since 1999. The difference in this case is that it is incorporated in the same housing as the RMC module; the two items are not available separately. See Figure 7.1.

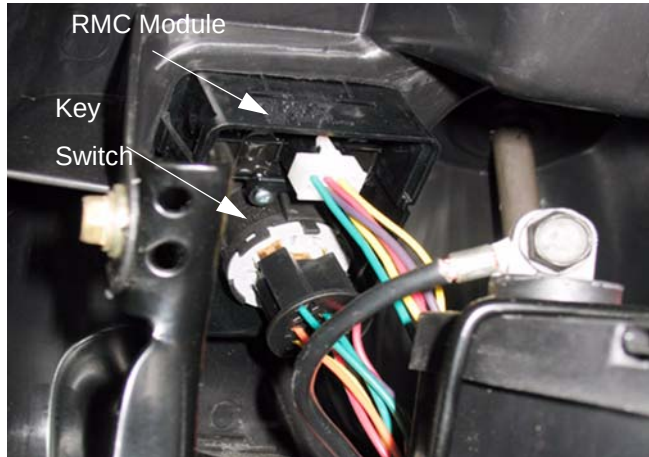


Figure 7.1

- 2a. In the **OFF** position, continuity can be found between the M, G, and A1 terminals. See Figure 7.2.

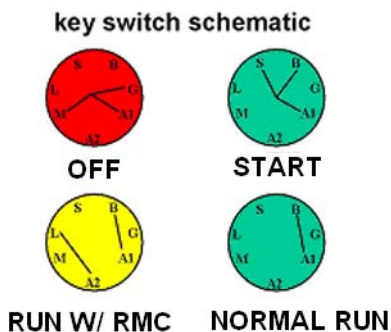


Figure 7.2

- M is connected to the magneto by a yellow wire, G is connected to ground by a green wire, and A1 is connected to the after fire solenoid.

NOTE: In the **OFF** position, the magneto primary windings are grounded, disabling the ignition system. The after fire solenoid loses its power from the B terminal. This turns-off the fuel supply.

- Symptom-engine runs with key in OFF position:** The key switch is not completing the path to ground either because of an internal fault or a bad ground connection elsewhere in the harness. Check continuity between M, G, and A1 terminals with key switch in OFF position. Check green wire for continuity to ground.
- Symptom-loud "BANG" when key is turned to the OFF position:** The after-fire solenoid is not closing, either because it is physically damaged or the power is not being turned off. Check for power at the solenoid. Check continuity between G and A1 terminals. Check for no continuity between A1 and the B terminals.

NOTE: If the engine is at an idle when the key is turned off, fuel is drawn into the engine through the idle ports of the carburetor by-passing the fuel shut off solenoid. The raw fuel will travel through the engine and ignite in the muffler causing an after fire.

- Symptom-Engine runs 3-5 seconds after key is turned to OFF position:** The after-fire solenoid is turning-off the fuel supply, but the ignition is continuing to operate. Check continuity between the M and G terminals in the OFF position. Check continuity from yellow wire connection all the way to the spade terminal on the magneto.

- 2b. In the **START** position, continuity can be found between B, S, and A1 terminals.

- Battery power from the B terminal is directed to the start circuit through the S terminal and to the after fire solenoid through A1.

- **Symptom-No crank and no starter solenoid click:** Power is not getting to the trigger spade on the starter solenoid. Test for a good battery then check for power where the fused red wire with white trace connects to the B terminal. Check for continuity between B and S terminals in START position. If power is getting to the S terminal in the START position, the problem lies down-stream in the starter circuit; Check continuity from the orange wire on the S terminal to the orange wire with white trace on the trigger spade on the starter solenoid. If it is broken, trace through the brake and PTO switches.
 - **Symptom-No crank, solenoid click:** The problem lies in the heavy-gauge side of the starter circuit; battery cables, starter cable, solenoid, or ground issue.
 - **Symptom-Crank, spark, but not fuel:** First test for power at the solenoid, if no power then check for continuity from B to A1 in the START position. If power is reaching the red wire that connects to the A1 terminal in the start position, the problem lies down-stream of the key switch. A handy quick-check is to apply power to the red wires where they connect to the S terminal (whole circuit) or directly to the after fire solenoid to listen for the audible “click” that it makes when functioning.
 - **Symptom-Crank, but no spark:** This is a highly unlikely scenario. If it occurs after a key switch has been changed independently of the RMC module, this would arouse suspicion that the wrong key switch was installed. Otherwise, the problem lies elsewhere in the safety circuits or engine. Do not over-look the possibility of a bad magneto or chafed ground lead within the engine harness.
- 2c. In the **NORMAL RUN** position (green zone), the B and A1 terminals should have continuity. Once the engine is running, the alternator produces current that tracks-back to charge the battery, via the red wire connected to the B terminal.
- **Symptom-Battery does not charge:** Follow the engine manufacturer’s recommendations for testing alternator output. If alternator output is getting to and through the key switch, but not reaching the battery, the fuse may have blown after start-up. A blown fuse will disable the starter circuit. A simple quick-test for the presence of alternator output at the battery is to check across the battery posts for DC voltage.
- **Symptom-After fire solenoid does not work: engine starts and dies:** The after fire solenoid is powered directly by the red wire from the B terminal of the key switch, and should operate independently of anything else on the tractor once the engine is running. If the alternator fails *and* battery power is not reaching the after fire solenoid through the key switch, it will not work. This is an unusual set of circumstances.
- 2d. In the **REVERSE CAUTION MODE** (yellow zone), the same characteristics are true as for the normal run position, but *in addition* the L terminal will have continuity with the A2 terminal. The A2 terminal is connected to the RMC module by a purple wire. The L terminal (formerly used for the lighting circuit) connects directly to the ground circuit of green wires. When the key is in the REVERSE CAUTION MODE position, the purple wire carries a ground signal to the RMC module. When the parking brake is not set, this ground signal arms (enables), *but does not turn-on* the RMC module.
- **Symptom-RMC module will not turn-on:** Check for continuity between A2 and L terminals on the key switch when it is in the REVERSE CAUTION MODE position. Confirm that the green wire has continuity to ground. If the switch is capable of establishing a ground signal to the RMC module, the problem is likely to lie elsewhere in the system.
 - **Symptom-RMC module will not turn-on:** confirm that the ground path (continuity to ground) to the purple wire is broken when the key switch is in any position other than REVERSE CAUTION MODE.
The RMC module is disarmed (disabled) when the parking brake is set. To re-arm the module, the key is moved to another position, breaking the ground signal, then returned to the REVERSE CAUTION MODE, re-establishing the ground signal. It works something like a latched relay. If it is not possible to break the ground-path, it is not possible to freshly establish it either, and the RMC module will not be armable.
Causes for such a condition might include a shorted or incorrect key switch, or a chafed purple wire shorting to ground between the key switch and the RMC module.
- 2e. The RMC Module is in the same housing as the key switch, and is not available sepa-

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rately. For the purpose of diagnosis it is treated separately. Diagnosis of the module with the key switch introduces too many over-lapping variables. See Figure 7.3.



Figure 7.3

- **Principle:** To diagnose the module, the simplest approach is to check all of the inputs (safety circuits) that are connected to it. If the inputs work properly, but the RMC module does not work properly (outputs), then the module can be determined to be faulty. A specific procedure is covered, following the description of the correct operation of the RMC module.
- **Working properly:** The module cannot be diagnosed if its function is not understood. It is designed to work as follows: See Figure 7.4.



Figure 7.4

- When the **RMC module is disarmed**, the tractor will operate as MTD tractors have historically operated:
If reverse is engaged when the electric PTO is ON, the PTO clutch will turn-off.
If the operator leaves the seat with the engine running, the engine will turn-off.
If the operator leaves the seat with the PTO in the OFF position, the engine will turn-off unless the brake is applied.
When the RMC module is armed, the tractor will operate identically to when the module is disarmed.
- When the **RMC module is armed and turned-on**: The tractor will operate identically to when the module is disarmed, except that the operator will be able to put the transmission in reverse with the PTO engaged and the cutting deck will continue to run. The operator may put the tractor into and out of reverse as many times as they wish without having to re-arm or turn-on the module again.
- **To arm the RMC module**: the operator must turn the key switch to the REVERSE CAUTION MODE (yellow zone), with the parking brake released.
- **To turn the RMC module ON**: The module must first be armed, then the orange triangular button is depressed, illuminating the red LED indicator to indicate that it is ON. It is important that the operator must take two actions to turn the RMC module ON so that they do not do so inadvertently.
- **The RMC module will turn-OFF and disarm if**: The operator moves the key to any position other than REVERSE CAUTION MODE. The operator sets the parking brake. If the operator leaves the seat without setting the parking brake, the engine will turn-off. The key movement necessary to re-start the engine will make it necessary to re-arm and turn-on the RMC module if the operator wishes to continue with the ability put the tractor in reverse while the PTO is running.
- **To re-arm and turn the module ON**: If the key is in REVERSE CAUTION MODE position, it must be turned to another position (Normal Run), then returned to REVERSE CAUTION MODE. Once re-armed, the module can be turned-on by pressing orange triangular but-

ton. It will be confirmed that the module is ON by the illumination of the red LED on the module.

2f. **To identify a faulty RMC module:** If the RMC module does not function as described, the **RMC plug test** should be the first step in diagnosis.

- If the RMC plug test confirms that the safety circuits (inputs) work as designed, yet the RMC module does not work properly, the RMC module is faulty.
- The RMC plug test will give an indication of what the problem is if it is not a faulty RMC module. If the problem is identified in a particular circuit, check the safety switch that is associated with that circuit. If the switch is good, then the problem lies within the wiring harness.

NOTE: Like the electronic components found on most cars, the RMC module requires a fully charged battery to work properly. If the system voltage falls below 12 V, an accurate diagnosis of the RMC module is impossible because the module will be temporarily disabled by low voltage.

A Disconnect the molded 8-pin plug from the RMC module. See Figure 7.5.

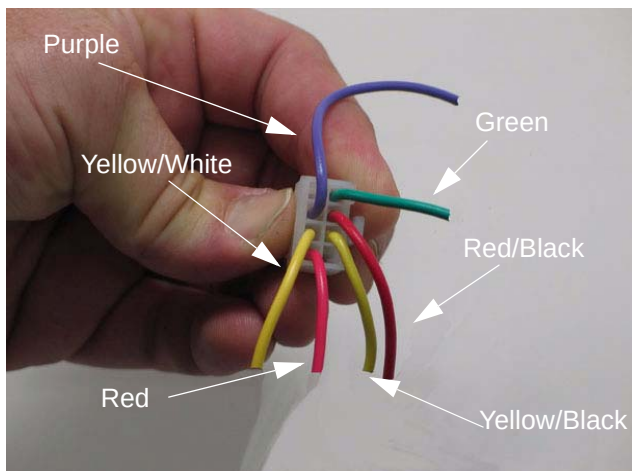


Figure 7.5

B Looking at the plug head-on, it will be configured as shown in the diagram: There will be 8 female pin terminals. When probed they should yield the results described in the following sections. See Figure 7.6.



Figure 7.6

C Top left middle q-shape: Yellow wire with Black trace:

- **Behavior:** Should show DC power with the key on.
- **Circuitry:** The yellow wire with black leads directly to the PTO switch.

D Check the PTO and seat safety circuits with the 8-pin pigtail connector unplugged, then reconnect it and continue with the RMC plug test.

- **Behavior:** When the female pin terminal leading into the main harness is probed (yellow wire), there should be continuity to ground *only* when the seat is empty.
- **Circuitry:** The yellow wire with white trace leads to the forward terminal on the seat safety switch, where it finds a path to ground when the seat is empty.
- **Interpretation:** If behavior is correct, the seat safety circuit is good. If there is continuity to ground when the seat is occupied, the switch may be inoperative, or there may be a short to ground in the wire leading to it. If there is not continuity to ground when the seat is empty, the switch may be inoperative or there may be an open condition in the wire leading to it.

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- **Circuitry:** The yellow wire with black trace leads to the PTO switch, where it finds a path to ground when the PTO is ON.

- **Interpretation:** If behavior is correct, the N.C. side of the PTO switch /circuit is functioning properly

If there is continuity to ground when the PTO is OFF, the switch may be inoperative or there may be a short to ground in the wire leading to it. If there is not continuity to ground when the PTO switch is ON, the PTO switch may be inoperative, or there may be an open condition in the wire that leads to it.

E There is a red wire with black trace between yellow wire with a black trace and the green wire. This wire provides the module with input from the **reverse switch**.

- **Behavior:** When the tractor is in reverse, this terminal should have continuity to ground.
- **Circuitry:** This wire runs directly to the reverse safety switch on the drive pedal shaft. This is a simple metal tang switch that grounds-out against a bolt.
- **Interpretation:** Continuity to ground when the tractor is not in reverse would indicate a short to ground. This could take the form of a chafed wire contacting ground, a bent reverse safety switch that is always in contact with another metal part, or a broken plastic insulator that separates the switch from the drive pedal shaft.

Lack of continuity to ground would indicate a broken or disconnected wire leading to the reverse safety switch, or a switch that is not closing because of physical damage or corrosion.

F At the opposite end of the top row from the yellow wire with black trace is a green wire.

- **Behavior:** The green wire should always have continuity to **ground**.
- **Circuitry:** The green wire leads to ground.
- **Interpretation:** If this ground path is not good, there will probably be other ground-related issues with the tractor: slow starter motor, slow battery charge, dim lights. All ground connections should be mechanically secure and corrosion free.

G The red wire on the OCR plug carries **battery voltage**.

- **Behavior:** D.C. battery voltage should show-up on a volt meter when the red probe is touched to

this terminal and the black probe is grounded, regardless of the key switch position.

- **Circuitry:** This wire draws power directly from the B terminal on the key switch.

- **Interpretation:** If there is not battery voltage at this terminal, the tractor is probably not function at all. Look for a blown fuse, disconnected battery, disconnected ammeter or some other major fault.

H The purple wire provides a **ground signal** to the RMC module when the key switch is placed in the **REVERSE CAUTION MODE**.

- **Behavior:** There should be continuity to ground at this terminal when the key switch is in the REVERSE CAUTION MODE position.
- **Circuitry:** When the key switch is in the REVERSE CAUTION MODE position, a ground path is established by connecting terminal A2 to terminal L within the key switch. The purple wire from the RMC module connects to A2, and a green ground wire connects to L.
- **Interpretation:** If the purple wire fails to reach a ground path when the key switch is in the REVERSE CAUTION MODE position, the RMC module will not arm or operate. Check the key switch for continuity between A2 and L in the REVERSE CAUTION MODE position, confirm that the green wire connecting to the L terminal does have good continuity to ground, and check for any loss of continuity in the purple wire that extends from the key switch to the RMC module, including the molded connector between the two components.

I If the RMC plug test indicates fault with any of the safety switches, the next step is to test the suspect switch. The operation of those switches is described in the following sections.

3. Understanding the PTO switch

3a. A-COM is in the starter inhibit circuit. It is a normally closed (NC) set of contacts. When the PTO is OFF, and the contacts are closed, power coming from the brake switch (key switch in START, brakes ON) through the orange wire with black trace is passed on to the trigger terminal on the starter solenoid through the orange wire with white trace.

- 3b. B-COM is in the safety shut-down circuit. It is a normally opened (NO) set of contacts. A circuit is completed from the M terminal on the key switch through the yellow wire to the Magneto terminal on the RMC module through the yellow wire with black trace when the contacts are closed. This gives the RMC module the ability to turn-off the engine when the PTO is ON.
- 3c. In C-Com, power is supplied to the PTO switch from the A1 terminal of the ignition switch through a red wire. when the PTO switch is turned on this completes the circuit to allow power to go to the PTO clutch. It is a normally opened (NO) set of contacts.

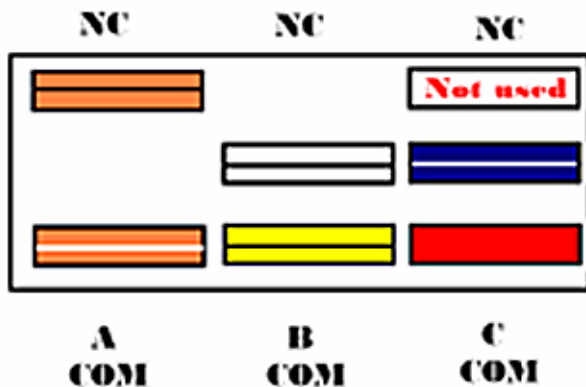


Figure 7.7

NOTE: The top terminals are showing normally closed at rest and the middle terminals are normally open at rest

NOTE: There are three contacts on the right side in the C-COM. For this application the normally opened (NO) contact is used.

4. The **Brake Switch** is mounted to the inside of the frame on the right side. See Figure 7.8.

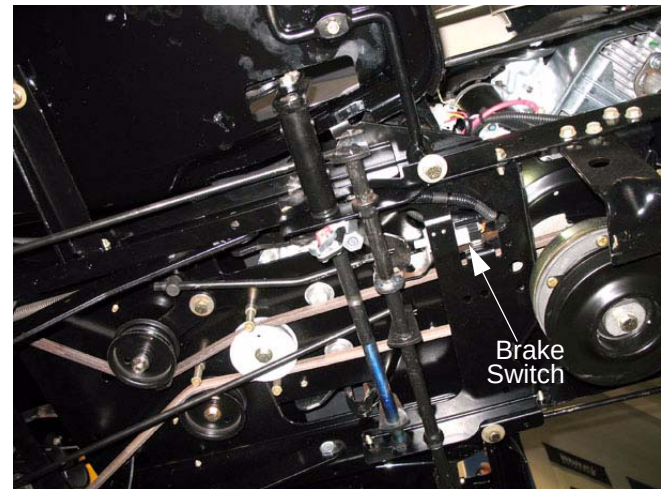


Figure 7.8

- The plunger on the switch is depressed when the clutch / brake pedal is pressed-down, de-clutching the drive belt and applying the brakes. The switch contains two sets of contacts.
- A normally open (NO) set of contacts is in the starter inhibit circuit. When the clutch / brake pedal is depressed, the contacts are closed, power coming from the key switch (key switch in START) through the orange wire is passed on to the PTO switch through the orange wire with black trace.
- A normally closed (NC) set of contacts is in the safety shut-down circuit. A circuit is completed from the M terminal on the key switch, and directly from the magneto primary windings through the pair of yellow wires to the clutch / brake switch through to the yellow wire with black trace when the contacts are closed.
- The yellow wire with black trace leads to one element of the seat switch. If the seat is vacant *and* the pedal is up, the engine will turn-off.

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5. The **Reverse Safety Switch** is a simple metal contact tang. When the drive pedal is pressed into reverse, the reverse switch is pushed into a bolt. This provides a path to ground. See Figure 7.9.

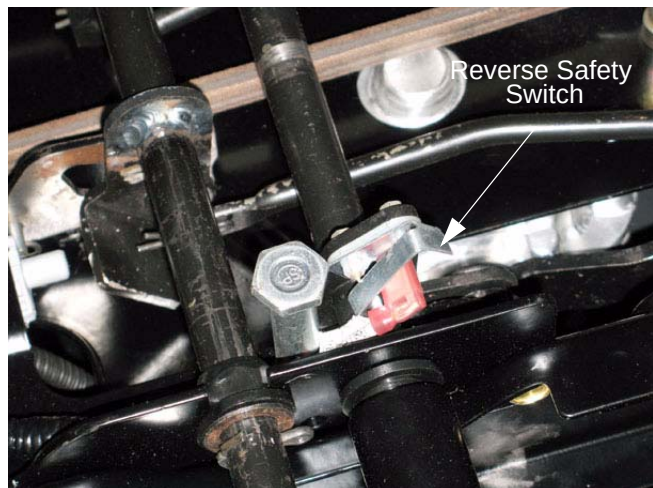


Figure 7.9

6. The **Seat Safety Switch** consists of a pair of simple metal contact tangs attached to the seat mounting bracket. See Figure 7.10.

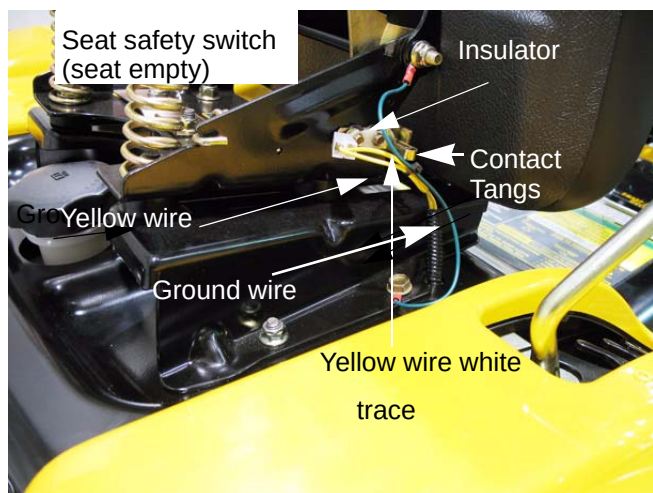


Figure 7.10

NOTE: The rubber mounts for the seat bracket insulates it from ground. There is a ground wire that provides a ground for the seat bracket. A failure in that wire will prevent the seat switch from working. See Figure 7.10.

- The yellow wire with white trace is connected to the front spade terminal on the seat safety switch. When the seat is vacant, the tab on the seat bracket closes a ground path in series with the PTO switch. If the PTO is ON and the seat is empty, the circuit is completed, shorting-out the primary windings of the magneto, turning-off the engine.
 - The yellow wire is connected to the rear spade terminal on the seat safety switch. When the seat is vacant, the tab on the seat bracket closes a ground path in series with the brake switch. If the brake is not applied, and the seat is empty, the circuit is completed, shorting-out the primary windings of the magneto, turning-off the engine.
 - The most common problems are likely to be caused by physical damage: a broken insulator between the switch and the seat bracket, an unplugged wire, or a bent tang.
7. The **starter solenoid** is mounted underneath the battery. The mounting bracket is visible from the left side of the engine. See Figure 7.11.



Figure 7.11

- When the proper safety conditions are met, (brake applied, PTO OFF) the orange wire with white trace energizes the windings that magnetize an iron core, pulling the contacts closed between the two heavy posts, connecting battery power to the starter motor.

8. The **lighting circuit** is hot whenever the engine is running. It does not draw from the battery, but runs directly off its own circuit on the alternator. See Figure 7.12.



Figure 7.12

- The blue wire carries alternator current, the green wire is a ground.
9. The 20A fuse is located near the RMC module / key switch assembly, under the dash panel. See Figure 7.13.

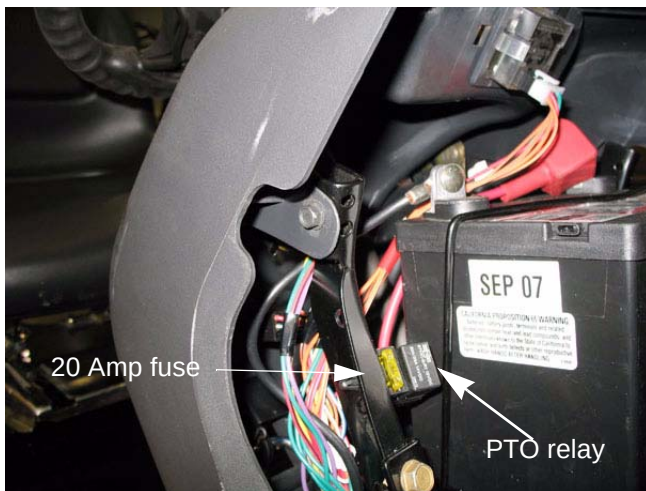


Figure 7.13

- The solid red wire feeds the fuse with power picked-up from the battery cable connection to the "hot" post of the starter solenoid.
- The red wire with white trace carries fused power to the B terminal on the key switch.

- There is a second red wire with white trace for the auxiliary power point that will supply a 5 amp service to the power point.

CAUTION: DO NOT PUT A CIGARETTE LIGHTER IN THIS POWER POINT. this will cause the fuse to blow and can seriously damage the harness.

NOTE: The fuse for the auxiliary power point is located above the starter solenoid. See Figure 7.14.

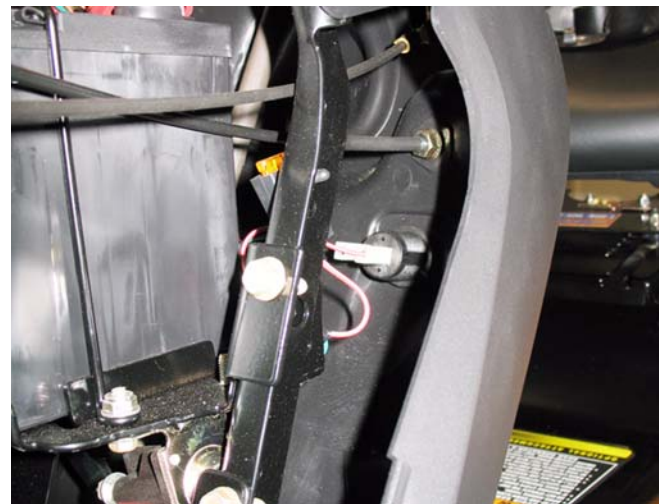


Figure 7.14

- A failed fuse will disable most of the tractor's electrical system.
- NOTE:** A fail fuse for the auxiliary power point will only affect the power point.
- Remember that a failed fuse has done it's job of protecting the rest of the circuit from an overload. If a fuse blows, figure-out why and correct the core problem before returning the tractor to service.
10. Refer to the engine manufacturer's specifications to test the engine and charging systems.
 11. **Ground issues:** It is relatively easy to track where power is on the positive side of the system. The negative side is frequently neglected, though it may account for just as many electrical problems as the positive side.

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ELECTRICAL DIAGNOSIS

NOTE: Electrical diagnostic procedures and tools are the same for all Cub Cadet and MTD tractors. This section is written in a way to provide basic trouble shooting skills that can be used on any tractor.

With a basic understanding of the behavior of electricity and the tools used to measure that behavior, a technician can be about 80% effective at finding electrical problems.

80% effective is not bad, but the remaining 20% of the diagnoses are the really difficult ones that can devour the same amount of time as the easy 80%. Experience plays a big part in successfully diagnosing the really difficult electrical problems. Experience leads to greater understanding.

Two German Physicists, working independently during the late 18th and early 19th centuries summarized what they had figured-out about electricity into some basic laws that can help a technician understand how a system works or why it does not work. Their names were Gustav Kirchhoff and Georg Ohm, and their laws are named for them.

There are basically three things that a technician is likely to test in trying to identify an electrical problem: Volts, Resistance, and Flow. To help technicians understand the behavior of electricity, this section begins with an explanation of:

- Basic electrical values.
- Ohm's law.
- Kirchhoff's current law.
- Kirchhoff's voltage law.
- How the system is wired together.

NOTE: A graphic explanation of Kirchhoff's laws can be found at the following web site: <http://online.cctt.org/physicslab/content/phyapb/lessonnotes/DCcircuits/lessonKirchoff.asp>

The section then continues by explaining handy tools and techniques for diagnosing electrical problems on outdoor power equipment.

Electronics:

The outdoor power equipment has historically had relatively simple electro-mechanical controls. Customer expectations and regulatory demands continue to drive change in the industry, while electronic controls have become relatively inexpensive.

In many cases, electronic controls can simplify a system that would otherwise be very complex. Instead of creating a huge mass of switches and relays that are tied together by spaghetti-like wiring harness, sensors (switches) in an electronic system send signals to a processor. These input signals are processed by a control module that produces outputs.

Outputs can include power to run an electric PTO clutch, a trigger signal to a starter solenoid, or the grounding of a magneto to turn-off an engine if an unsafe condition exists.

Most electronic devices are quite dependable, but they are vulnerable to things that simple electrical devices are not bothered by. Examples include:

- **EMI:** Electro-Magnetic Interference is created by electronic "noise". This noise is created by ignition systems in general with non-resistor spark plugs being especially "noisy". Alternators, and even power passing through wires can also generate EMI. Countermeasures against EMI include metal shielding (take a look at the ignition system on a fiberglass-bodied Corvette), and filtering devices built into vulnerable components. Something as simple as putting non-resistor spark plugs in a machine with electronic controls can disable the controls.
- **Voltage Spikes:** A dramatic increase in voltage will damage many electronic devices. Such spikes may be caused when jumper cables are disconnected or a voltage regulator fails. Some early automotive systems could even be damaged by personal discharge of static electricity. Most are better protected now.
- **Low Voltage:** Many electronic devices simply stop working if system voltage falls below a given threshold. If a 12 volt system is run at 11 volts with a failing alternator, electronic controls may stop working.
- **Bad Grounds:** Bad grounds can reduce the effective system voltage, create resistance and heat, and send false signals. This is the single most common breeding ground of electronic gremlins.

- **Heat and Vibration:** Heat and vibration are hard on most mechanical devices. The same is true of electronics.
- **Moisture:** Moisture causes a nasty combination of corrosion and shorts. Corroded connections and wires create resistance that results in low voltage and ground issue. Many electronic components are “potted” or encased in a sealant that protects them from moisture. They are still vulnerable to bad inputs caused by corroded external connections and damaged switches.
- **Improper Tools:** Some test lights can overload electronic circuits.

Electrical environment: AC Vs. DC

Most modern outdoor power equipment that has an electrical system complex enough to require diagnosis will be equipped with an alternator that produces alternating current (AC). In most systems, this current is immediately rectified to direct current (DC), and regulated to a nominal 12 Volts. The presence of AC is very limited. The primary concern of this section is 12 Volt DC systems, though much of the theory and techniques apply equally well to other DC systems.

1. **Voltage:** Pressure

- Voltage is the “pressure” that electricity has. It is the amount of force pushing electrons through a circuit.
- The unit of measurement for this pressure is volts.
- The capital letter “V” is used to represent volts.
- Most (not all) outdoor power equipment operates on a nominal 12 volts. In practice, system voltage may run as high as 13.5V or 14V.

2. **Amperes:** Flow

- Current is the “flow” of electricity. It is the amount of electrons flowing in circuit.
- The flow of current is measured in Amperes or Amps for short.
- The capital letter “I” is used to represent Amps.

3. **Ohms:** Resistance

- Resistance is the opposition to current flow. It is a restriction that slows down the flow of current.
- Resistance is measured in Ohm’s.
- The greek letter omega “ Ω ”, or the letter “R” for Resistance is used to represent Ohm’s.
- Resistance creates heat. A circuit with too much electrical load, or too much resistance for the load placed on it will get hot.

ELECTRICAL SYSTEM

4. **Ohm's Law:** relates voltage, amperage, and resistance
- Ohm's law states that voltage is the product of resistance times current.
 - It is written as $V = I \times R$.
 - In simplest terms, it goes like this: It takes 1 volt to push 1 amp through a resistance of 1 ohm ($1 = 1 \times 1$).
 - This equation can be rearranged using algebra to solve for any one variable.
 - Those who were traumatized by algebra can represent Ohm's law as a triangle. When using the triangle, cover the value to be found, and the two values left exposed signify how to obtain that value. See Figure 7.15.

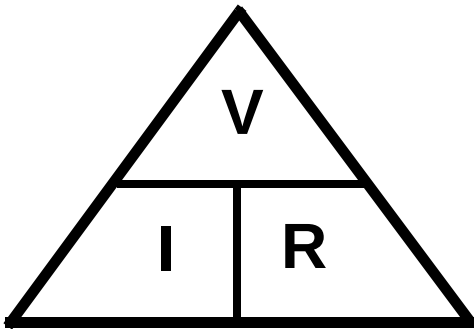


Figure 7.15

- As an example if the "R" is covered, the "V" is over the "I" which means "V" divided by "I" will solve for the covered letter "R" ($V/I = R$). If the "V" is covered, "I" and "R" are exposed on the same line, meaning that the product of "I" times "R" will solve for the unknown "V" ($I \times R = V$).

5. **Kirchhoff's current law:**

- Kirchhoff's current law deals with nodes. Nodes are the junction of two or more wires or the junction of a wire to a component.
- Kirchhoff's current law states that what ever current goes into a node must come out.
- As an example: Three wires are connected with a wire nut. One wire has 5 amps going into the connection. The sum of the currents coming out of the other two wires must equal 5 amps. That could be 3 amps in one wire and 2 amps in the other or it could be 2.5 amps in each wire, but the total coming out must be the same as the current going in. See Figure 7.16.

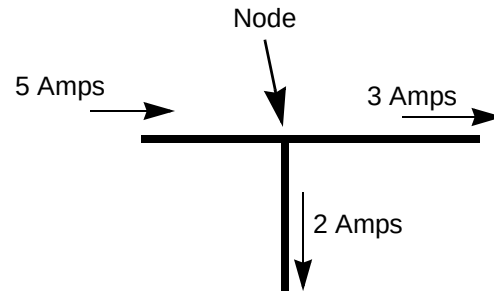
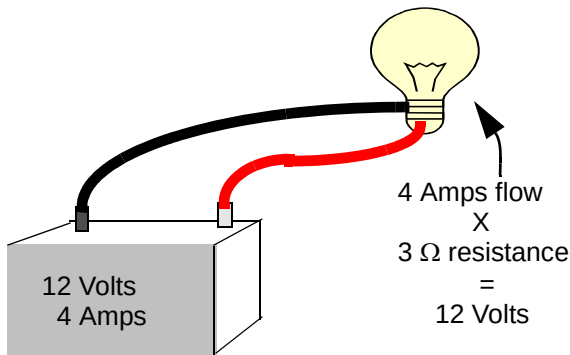


Figure 7.16

6. Kirchhoff's voltage law:

- Kirchhoff's voltage law deals with voltage drops. A voltage drop is the amount of voltage used up or "dropped" by resistance in a circuit. Ohm's law states that $V = I \times R$, every component in a circuit has resistance, even the wires. To push current through resistance, it takes voltage. Kirchhoff's voltage law states that the sum of all the voltage drops equals the source voltage.
- As an example, imagine a circuit that has a 12V battery that produces 4 amps of current powering a light bulb that creates 3 Ω of resistance. The wires are assumed to have 0 Ω resistance*. The light bulb uses 12 volts (4 amps x 3 ohms = 12 volts). The battery produces 12 volts that equals the 12 volts used by the light bulb. See Figure 7.17.

**Figure 7.17**

NOTE: * If the proper size wire is used and there is no corrosion in the wire, the resistance will be too small to worry about.

7. How the system is wired together

The Rules: All circuits have some basic rules that must be followed:

- 7a. All circuits must have at least one voltage source. It could be a battery, an alternator or both.
- 7b. All circuits must have a load. A circuit without a load is the same as shorting out the power source. Typical loads could be:
 - _ lights
 - _ a motor
 - _ a solenoid
- 7c. All circuits must have a complete path back to the voltage source. This is also known as having continuity.

NOTE: On outdoor power equipment, the frame of the machine is frequently used as the return path to the battery. This is referred to as grounding the machine. Any point on the frame should be the same as the negative post of the battery (Electrically) unless there is a bad connection between the battery and the frame or between the frame and the component or cable that is assumed to be grounded to it.

- 7d. Most circuits have additional components like switches and fuses.

ELECTRICAL SYSTEM

Types of circuits

There are three ways a circuit can be wired:

- Series
- Parallel
- Series/parallel

Series

- Series circuits are wired so that the current has only one path to follow. If one component in the system fails, the circuit will be broken and whole system will not work. See Figure 7.18.

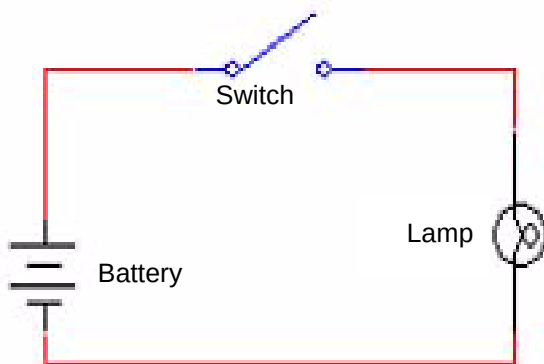


Figure 7.18

Parallel

- Parallel circuits are wired so that current has multiple paths to follow. If a component in one of the parallel paths fails, the rest of the circuit will keep working. See Figure 7.19.

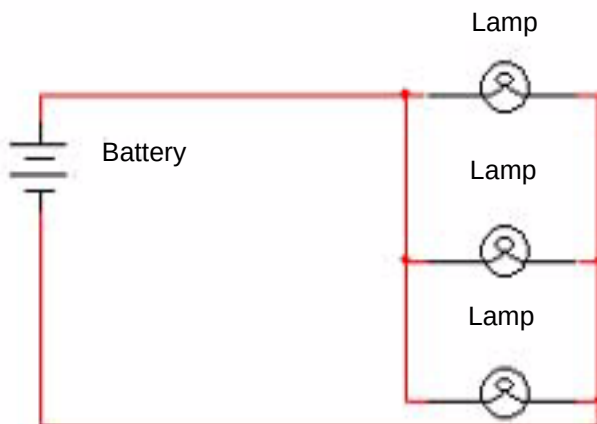


Figure 7.19

Series/parallel

- Series/parallel circuits have some sections wired in series and some in parallel. See Figure 7.20.

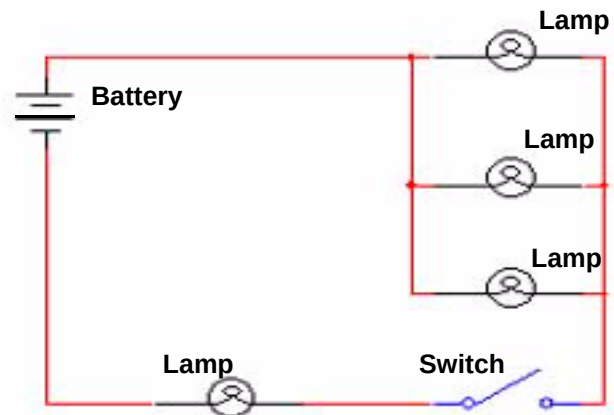


Figure 7.20

What can go wrong?

There are three types of failures that can occur in an electrical circuit:

1. Shorts
2. Opens
3. Increased resistance

Shorts

- A short is when electricity takes a path that it was not designed to take by-passing a component in the circuit.
- An common example of a short is a wire with insulation that chafed through, exposing the copper conductor. The bare copper will short the circuit when it touches a ground source.

Opens

- An open is when current can not complete its path back to the power source.
- A common example of this is a burned-out lamp (light bulb) in a series circuit.

Increased resistance

- Increased resistance is, as the name implies, an increase in resistance.
- Causes: This can be caused by loose or corroded connections, or connections that are insulated by grease, paint, or coatings. Fasteners finished in oil/phosphate or black oxide are bad conductors. Use bright fasteners (zinc coated).
- Resistance can be problem on the ground side as well as the hot side of a system: remember that electricity must complete a loop (circuit) back the battery post. Any resistance in that loop will interfere with the flow.
- Arguably the most common electrical failure, and the hardest to find, increased resistance can have more subtle symptoms than outright open circuits. Many times effected circuits will still partially function. It is not an open because there is some current that can get through, but the increase in resistance is enough to affect the circuit.

The Tools

Equipment needed to diagnose an electrical system:

- DVOM (Digital Volt-Ohm Meter)
- Wiring schematic or diagram

Equipment that may be useful:

- Fused jumper wires.
- Test light
- Self-powered continuity light
- Ammeter
- Battery charger
- Battery tester
- Battery jumper cables
- Hand tools to gain access to components.
- Flash light.

Digital Volt Ohm Meter

- A DVOM is the most useful tool to trouble-shoot any electrical system. There is an amazing variety of DVOMs on the market. Some are very basic, others are tailored to specific industries, and some high-end graphing meters function like oscilloscopes. Even the most basic ones are quite versatile. See Figure 7.21.



Figure 7.21

Uses:

Voltage: Set meter to read “Volts DC (_ _ _)” if using an auto-ranging meter or to an appropriate scale (typically 20 Volts DC) if using a more basic model.

- Connect the **meter in parallel** to the circuit being measured, between the test point and a known-good ground. Turn-on the circuit to be tested, and read the meter. For most tests the engine need not be running, but the key will be turned-on.
- If there is question about which end of the circuit the electricity is coming from, the circuit may be disconnected near the test point.
- If the meter is connected with the **polarity** reversed, a “-” will appear in front of the voltage reading. It has no ill effects on the meter nor on accuracy.
- If the meter is set to Volts AC (~) it may not register any DC voltage, but no physical harm will be done to the meter nor the equipment being diagnosed. It may waste some time though.

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Amperage: Most DVOMs have a very limited capacity to test amperage (2-3 Amperes). When measuring current flow, the meter must be connected in series with the component to be measured. That means opening the circuit and having the circuit go through the meter.

- Some meters have an inductive “Amp clamp” accessory that can be used without breaking the circuit.
- Testing amperage beyond the capacity of the meter can burn-out an internal fuse in some meters. The fuses can be expensive.

Resistance: Set the meter for the “ Ω ” scale.

- Isolate the part of the circuit to be tested (disconnect it from the source of power).
- Ohms are read on a **scale of 0 to 1**, with “0” indicating no resistance and “1” indicating infinite resistance.
- Most auto-ranging meters will provide readings on several scales. For outdoor power equipment, the straight Ohm scale is most appropriate. If a letter appears next to the W on the screen of the DVOM, it indicates different scales of sensitivity.
- “m” is micro-Ohms, a less sensitive scale that effectively moves the decimal point three places to the left of its location for plain Ω
“M” is Meg-Ohms, a more sensitive scale that effectively moves the decimal point three places to the right of its location for plain Ω
“K” is Kilo-Ohms, a more sensitive scale that effectively moves the decimal point six places to the right of its location for plain Ω
- A reading of “0” may be called “**Continuity**”. A reading of “OL” may be referred to as “**No Continuity**”.
- Mistaken Ohm readings most frequently come from bad technique. Poor connections between the probes and the point to be read can throw-off readings. False readings can be generated if the technician touches both probes with their fingers while taking the reading.
- The meter has its own power source to measure resistance. connecting the meter to a component that has current going through it will damage the meter (usually beyond repair).

Wiring diagram or schematic

- A wiring or a schematic diagram, and the ability to read it are very important in troubleshooting a circuit. The diagram shows how the circuit was designed and what paths the electricity is supposed to flow.

Fused jumper wires

- Fused jumper wires are handy to help find bad grounds or to jump across switches for testing purposes.

CAUTION: Only use fused jumper wires. If there is a short in the circuit, using an unfused jump could damage components in the circuit.

Test lights

- Test lights are used as a quick way to verify voltage at a point in a circuit. Like DVOMs, they come in a wide variety from many manufacturers.
- The most basic test lights simply use the current being checked to light an incandescent lamp. These should not be used on any equipment that has or may have solid-state circuitry. The power necessary to light the bulb is more than many solid-state circuits were designed to handle. Components will be destroyed in the process of testing them. See Figure 7.22.

NOTE: Do not use a test light on an I-series tractor. It can damage the RMC module.

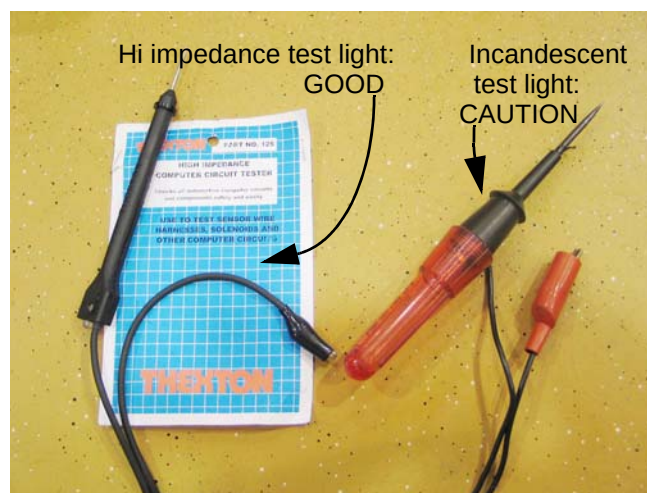


Figure 7.22

- If a test light is used at all, it should have “**high-impedance**”, indicating that it only takes a sample of the electricity being tested, and illuminates an LED to indicate the presence of power.

- Some high impedance test lights are capable of indicating whether the current being sampled is AC or DC.

Self-powered continuity lights

- Continuity lights can indicate whether a circuit is complete or not, but they give no indication of resistance. They are handy for finding point-break when static-timing some older engines, but have largely been replaced by DVOMs.
- There are some powered high-impedance test lights on the market that have a continuity feature, and some technicians like the fact that they can be less bulky than a DVOM.

Battery Jumper Cables

- The obvious use: jumper cables can be used to jump-start equipment to get it into the shop. This is not recommended for any fuel injected Kohler-powered equipment.
- The clever use: If the technician suspects that there is resistance on the ground side of the system, a quick-and-dirty test can be made using jumper cables. See Figure 7.23.

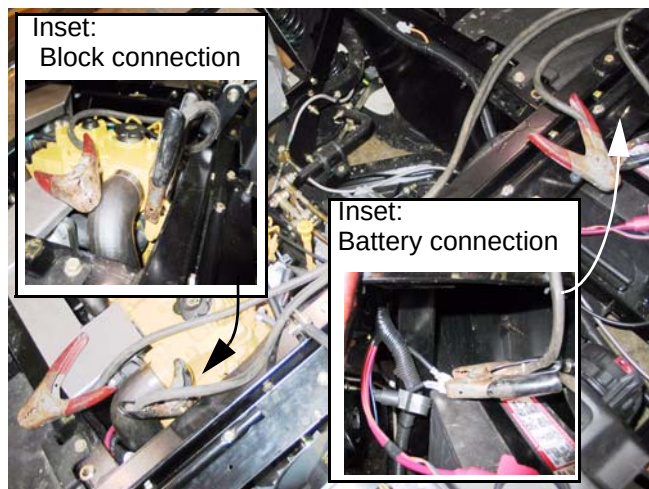


Figure 7.23

- Connect one cable clamp to the negative post of the battery, and connect the clamp at the other end of the same cable to the engine block.
- If there is an immediate difference in starter motor performance, use the voltage drop technique discussed later in this section to identify the source of the resistance.

Ammeters and specialized charging system testers

- Inductive ammeters are available in many forms. Some are as simple as a gauge to be held against the circuit in question when it is energized. See Figure 7.24.



Figure 7.24

- There are two primary reasons to measure amperage:
To check the out-put of a charging system or battery and to check the performance of a component that draws a substantial flow of power, typically a motor or clutch.
- Briggs and Stratton sells a DC Shunt that converts amperage into a reading on the millivolt scale of a DVOM. Briggs and Stratton part # 19359 covers low amperage systems, while part # 19468 tests higher amperage systems. See Figure 7.25.

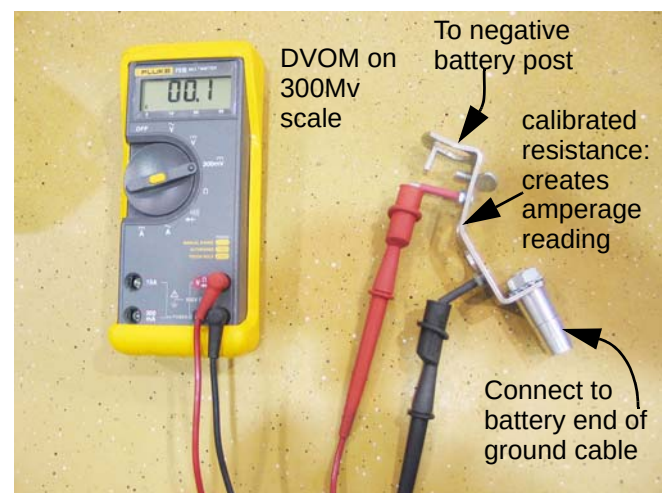


Figure 7.25

ELECTRICAL SYSTEM

- Usage of the DC Shunt tool is detailed in the 1995 and 1999 editions of their Update Seminar materials.

NOTE: The operating principle is based on Ohm's Law, as described earlier in this section.

- Kohler makes a proprietary Rectifier/Regulator tester (Kohler Part Number 25 761 20 and the up-dated version: 25 761 20-S). This tester works on Kohler regulator / rectifiers and the company claims it works on similar systems from other companies. See Figure 7.26.



Figure 7.26

- Instructions are included with the Kohler tool (TT480-A)

Testing the charging system:

- Quick and dirty test: check voltage across the battery posts using a DVOM set to read D.C. voltage with the engine turned-off. It will read battery voltage, typically around 12 V. Start the engine and repeat the voltage measurement. The system voltage should rise, reflecting the out-put of the charging system, typically in the range of 12.5 - 14.5 V. If the voltage does not rise, or rises significantly above this threshold, there is a problem with the charging system that needs to be identified using more in-depth techniques.

NOTE: If system voltage is beyond roughly 15.7 volts, it is over-charging and there is a problem with the voltage regulator / rectifier.

- To identify a specific charging system problem, isolate the components of the system and check their performance individually.

1. First check the raw A.C. Voltage out-put from the stator. It will be necessary to compare it to the engine manufacturer's specified out-put. This varies from model to model. See Figure 7.27.

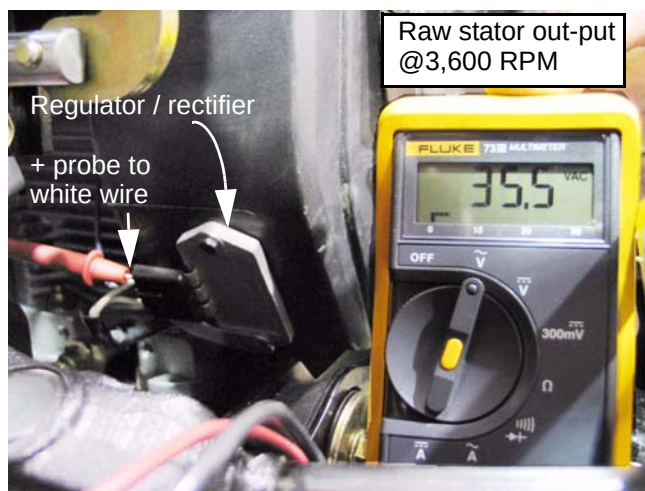


Figure 7.27

- 1a. With a DVOM set to read A.C. Voltage, connect the probes between ground and one of the white wires from the stator.
 - 1b. Leave the regulator-rectifier connected to the harness.
 - 1c. Start the engine and run it at 3,600 RPM.
 - 1d. Read the voltage on the meter.
 - 1e. If the voltage is substantially low, try the other white wire.
2. If raw out-put of the running alternator is less than the manufacturer's specifications, check the stator.
 - 2a. With the engine stopped, unplug the stator lead from the voltage regulator / rectifier.

- 2b. Check the stator for resistance across the leads. It should be in the range of 0.1 - 0.2Ω. See Figure 7.28.

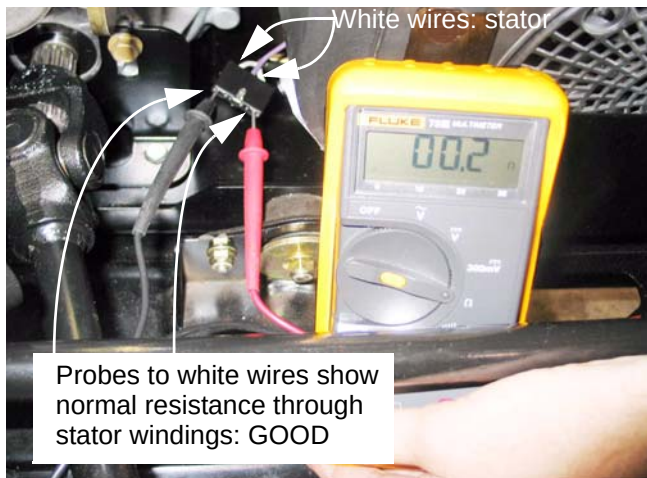


Figure 7.28

- 2c. With the engine stopped and the stator lead unplugged from the voltage regulator / rectifier, check the resistance from each purple stator lead to ground (engine block).
- 2d. The meter should indicate 1.0 Ω or O.L., indicating no continuity. See Figure 7.29.



Figure 7.29

- 2e. Interpretation: If the ohm meter indicates **no continuity** between the two the purple stator leads, there is a **fault** in the stator windings. If the ohm meter indicates continuity between either purple stator lead and **ground**, the stator windings are **shorted** to ground.

NOTE: If there is an intermittent charging system problem, perform these tests when the engine is cold, and again when the engine is hot.

NOTE: Low voltage readings may also result from poor test connections or low engine RPM.

3. If the stator is good, test the amperage out-put from the regulator / rectifier.
- 3a. Attach a DC shunt with DVOM or an ammeter capable of reading up to 25 amperes of DC current. The most accurate point to take a reading will be at the battery ground cable.
- 3b. The alternator should produce the rated current at 3,600 RPM under an electrical load.
- 3c. Connect a load tester between the battery terminals.
- 3d. With the engine running at 3,600 RPM, energize the load tester to draw amperage from the system.
- 3e. Read the amperage on the meter. See Figure 7.30.



Figure 7.30

NOTE: Output varies with load. A fixed-load battery tester can be used to apply enough load to test the charging system out-put.

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- 3f. With the engine off, connect Kohler tool #25 7651-20 to the regulator/rectifier: The two black leads go to the terminals normally connected to purple stator leads. The red lead goes to the center terminal (B+). The ground clip goes to ground.
- 3g. Plug the tester into a 110V AC outlet, turn it ON and push the test button until it clicks. Repeat the test to confirm.
- 3h. Read the illuminated jewel for the verdict. See Figure 7.31.



Figure 7.31

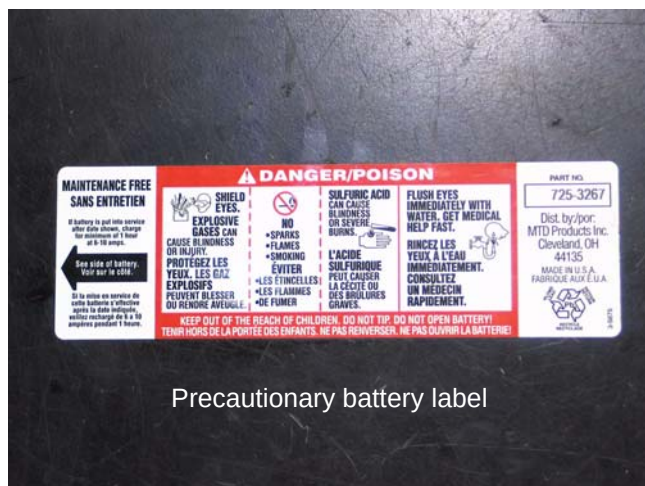
NOTE: A flashing “LOW” jewel may result from a poor ground connection.

NOTE: If the regulator rectifier is being tested on the engine, check the ground quality using the voltage drop test described elsewhere in this section.

Batteries

1. Precautions: See Figure 7.32.

CAUTION: Batteries produce flammable and explosive gases, particularly during charging:



Precautionary battery label

Figure 7.32

- Do not smoke or allow an open flame or heat source near the battery.
- Charge batteries in an open area
- Wear eye protection and acid resistant gloves when handling batteries.
- Do not allow direct metal contact across the posts. This will produce extreme heat that may cause direct burns or ignite flammable gas.

CAUTION: California Proposition 65 warning: Battery posts, terminals, and related accessories contain lead and lead compounds. These chemicals are known in the State of California to cause cancer and reproductive harm. Wash hands after handling.

NOTE: The batteries used in Current Cub Cadet equipment are sealed. It is not possible to check, test or add fluid.

CAUTION: Batteries contain electrolyte, which is highly corrosive. If a battery is ruptured, neutralize the electrolyte with baking soda, then carefully rinse the effected area with water.

2. Importance of battery charge level and condition: A fully charged battery that is in good condition is an important factor when trying to diagnose other parts of an electrical system:

- Some charging systems do not work if the system voltage falls below 6V. It takes a certain amount of voltage to excite the fields in the alternator.
- Some solid-state components will not work if the system voltage falls below a given threshold.
- Some solid-state components can be damaged by the jump-starting that accompanies operation with a dead battery.
- Many electric PTO clutches will fail to work dependably if battery needs to be replaced. Even though the charging system produces enough out-put to drive the clutch, it is over-taxed driving the clutch and forcing a charge into a damaged battery.
- Continued operation with a weak battery over-taxes the charging system.

3. Charging the battery:

NOTE: It is best to remove batteries from equipment for charging to minimize corrosion from out-gassing during charging.

CAUTION: When disconnecting or removing the battery, disconnect the ground cable first. When reconnecting or installing a battery, connect the ground cable last. These steps will minimize the chance of shorting-out the battery posts with a tool.

3a. Batteries on most modern outdoor power equipment are 12 volts so set the charger to 12 volts.

3b. Set the charge rate to 2 amps.

CAUTION: Never charge an outdoor power equipment battery at a rate higher than 2 amps. Damage to the battery will result.

CAUTION: Never attempt to charge or jump a frozen battery.

3c. Charge the battery until it is fully charged. Most battery chargers have an amp gauge to show the charging rate. When the gauge is at zero, stop charging the battery.

4. Checking battery condition: There are three things to do when testing a battery:

- Visual inspection
 - Electrolyte test
 - Operational test
- #### 4a. Visual inspection

- Inspect the battery and battery connections for corrosion. Clean if necessary. Neutralize acid with baking soda, and protect the terminals once they are cleaned.

NOTE: Battery cable corrosion is the most common type of increased resistance circuit failures.

- Inspect the battery case for signs of damage and missing vent caps. Battery cases that bow out in the middle indicate that the battery froze or over heated and should be replaced.

5. Check the electrolyte level if the caps can be removed. Fill as needed with distilled water. After initial charging, do not add electrolyte to the battery.

6. Hydrometer test (non-sealed batteries only) See Figure 7.33.

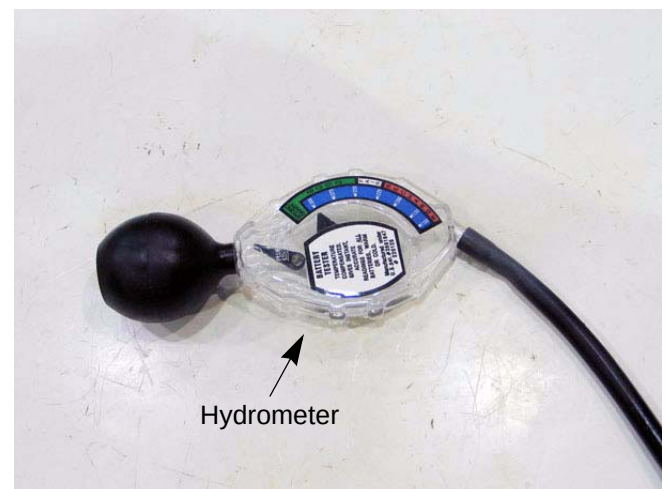


Figure 7.33

CAUTION: Always wear eye protection and acid resistant gloves when working with electrolyte. Use baking soda to neutralize any spilled acid.

- 6a. Give the battery at least ten minutes for the electrolyte to stabilize after charging the battery or adding water to the cells.
- 6b. Measure the temperature of the electrolyte in the middle cells of the battery.

ELECTRICAL SYSTEM

6c. Squeeze the bulb on the hydrometer, then insert the hose into the cell.

6d. Release the bulb, drawing electrolyte into the hydrometer to the fill line.

IMPORTANT: Hold the hydrometer straight up and down when drawing up the electrolyte. The float needs to float free, not rubbing against the sides of the hydrometer.

6e. Write down the specific gravity of each cell.

6f. The readings must be corrected for the temperature of the electrolyte. The hydrometer manufacture should list the temperature the float is calibrated to. Most are calibrated to 80°. To correct the reading, add .004 to the reading for every 10° Above the calibrated temperature or subtract .004 for every 10° below the calibrated temperature.

6g. Compare the reading to the chart.

Specific Gravity	Charge Condition
1.265	Fully Charged
1.225	75% Charged
1.190	50% Charged
1.155	25% Charged
1.12	Fully Discharged

IMPORTANT: To prevent damage to the charging system disconnect the battery to charge it.

NOTE: If battery needs to be charged, let battery sit for ten minutes to stabilize after charging. Apply a load to the battery for 15 seconds to remove the surface charge. Then re-check the battery.

Battery Testers:

There are four major ways to check a battery:

- Electrolyte test using a **Specific Gravity** tester to compare the density of the electrolyte in a fully charged battery to the density of water (water = 1.0 s.g.).
- Electrolyte test using a **Refractometer** to check the density of the electrolyte by measuring the degree to which light waves bend when passing through the electrolyte.
- **Load test** that checks the out-put of the battery after the fully charged battery has done a certain amount of work. Fixed load testers are commonly available. Variable load testers are not generally found in outdoor power equipment repair shops.
- **Capacitance** test that checks the condition of the battery plate core, regardless of the level of charge.

Testing the battery:

1. Adjustable load testing

Adjustable load testing is used if an adjustable load tester is available. Follow the procedures specified by the manufacturer of the tester to connect to the battery.

1a. Disconnect the battery cables.

IMPORTANT: Disconnect the negative cable first to help prevent a shorting hazard.

1b. Measure the temperature of the electrolyte.

1c. Connect a voltmeter and the load tester to the appropriate terminals.

1d. Hook an amp probe onto the ground lead of the load tester.

NOTE: A shunt can be used in place of the amp probe, but a second voltmeter will be needed to get a measurement from the shunt.

1e. Apply a load equal to 50% of the battery's rated CCA for 15 seconds.

NOTE: CCA stands for cold cranking amps. The rating should be on the battery for aftermarket batteries. For OEM batteries, contact the manufacturer for the CCA rating. Most riding mower batteries are 200-275 CCA. See Figure 7.34.



Figure 7.34

- 1f. Record the voltage while the load was applied. Compare the voltage to the following chart:

Electrolyte Temperature	Minimum Required Voltage
≥ 70 deg. f. (21deg. c.)	9.6 V
60 deg. f. (16 deg. c.)	9.5 V
50 deg. f. (10 deg. c.)	9.4 V
40 deg. f. (4 deg. c.)	9.3 V
30 deg. f. (-1 deg. c.)	9.1 V
20 deg. f. (-7 deg. c.)	8.9 V
10 deg. f. (-12 deg. c.)	8.7 V
0 deg. f. (-18 deg. c.)	8.5 V

- 1g. If the battery voltage is above what is listed in the chart, the battery is good. If the battery voltage is below what is listed in the chart, replace the battery.

2. Fixed load testing

Fixed load testers (sometimes called toasters) are inexpensive load testers found at any auto parts store. See Figure 7.35.



Figure 7.35

CAUTION: It is not recommended to use any fixed load tester on a battery under 200 CCA. To do so can boil the water out of the battery and damage the plates in the battery.

NOTE: Because they have a fixed load value, they do not give most batteries a reliable and safe load test. Most fixed load testers have a load that is more than 50% of the rated CCA of riding mower batteries. This makes them inappropriate to use on smaller pieces of outdoor power equipment.

- 2a. Disconnect the battery cables, ground first.
- 2b. Measure the temperature of the electrolyte in the middle cells.
- 2c. Connect a voltmeter and the load tester to the appropriate terminals.
- 2d. Apply the test load for 15 seconds. Monitor the meter on the load tester for the battery's performance.
- 2e. Refer to the manufacturer of the test on how to read the test meter.
- 2f. The results of this test are not accurate and should only be relied on if the battery fails badly.

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3. Capacitance testing

There are several brands of capacitance battery tester presently on the market. Capacitance battery testers use the battery being tested as their power source. These testers send a small AC signal through the battery to measure the capacity of the plate to hold a charge.

Capacitance testers are very easy to use and are far less damaging to the battery being tested. For these reasons, capacitance battery testing is the preferred method of battery testing.

NOTE: Contact the manufacturer of the tester being used for specific test procedures.

- 3a. Connect the tester to the battery.
- 3b. Set the tester to the CCA rating of the battery.
- 3c. Initiate the test.
- 3d. Read the display of the tester. The tester's display will indicate if the battery passed or not. See Figure 7.36.

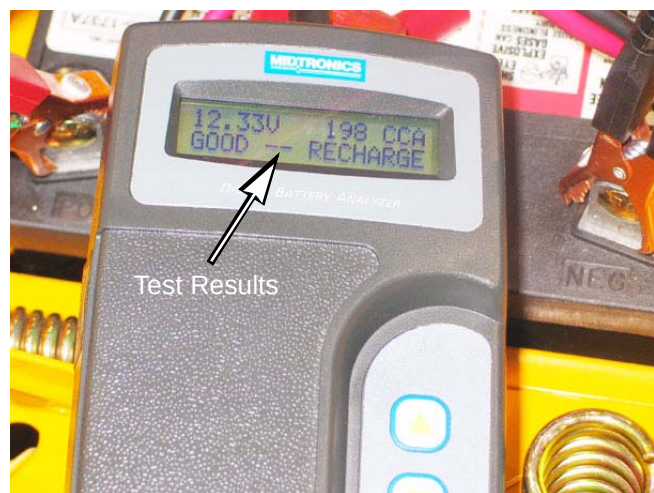


Figure 7.36

4. Battery discharge test

Occasionally a battery will discharge while sitting unused. To test for a battery that is “leaking” voltage:

- 4a. Confirm that operator technique is not creating a situation that causes a draw. As an example, if a homeowner habitually turns their equipment off using a safety switch (perhaps vacating the seat with the key switch still ON), that may leave a relay or fuel shut-off solenoid energized.
- 4b. Disconnect and charge the battery fully.
- 4c. Use the ammeter function of a DVOM to check for a power draw between the negative post on the battery and the end of the ground cable that normally connects to it. There should be no significant D.C. Amperage flow. See Figure 7.37.



Figure 7.37

NOTE: A spark jumping from the post to the cable end is an indication that there is a substantial current draw, but should not be used repeatedly as a diagnostic tool. This is an extremely unkind thing to do to any electronic components of the tractor.

- 4d. Once the presence of a draw is confirmed, disconnect components of the system one at a time while monitoring an ammeter to see which makes the draw stop.

- 4e. If the battery is being checked independently of the equipment it powers, measure and note the battery voltage while it is disconnected, over a three-day period.
 - 4f. There should be less than a .2 volt drop in the readings. If there is more than a .2 volt drop, the battery is bad.
5. Storage of batteries
- 5a. Always store a battery with a full charge (unless the battery is a dry battery and the electrolyte has not been added yet). This may require periodic re-charging.
 - 5b. Take measures to prevent the battery from freezing in cold weather. The electrolyte in a fully charged battery has a lower freezing point than the electrolyte in a battery with a lower state of charge.
 - 5c. Store the battery in a cool, dry place.
 - 5d. If storing multiple batteries (primarily store stock), rotate the stock so that the oldest battery goes out first. This will increase the life of the batteries.
6. Troubleshooting
- 6a. The first step in troubleshooting is to always verify the complaint. Defining and verifying the problem reduces the possibility of misunderstanding and helps clarify the diagnostic approach.
 - 6b. The next step is to check the simple stuff first:
 - Check the **fuse** or fuses. Some models have ground side fuse. Failure of any fuse is an indication that there is a problem of some sort in the circuit that the fuse protects.
 - Look for obvious physical damage.
 - Use the hour meter and indicator lamps as a guide to direct the search. As an example, when diagnosing a “no-crank” condition on a lawn tractor with a PTO safety switch: if the PTO light is lit on the hour meter but the technician has visually verified that the PTO clutch is not engaged, the PTO circuit would be a reasonable place to check for problems.
 - Check the battery. A valid diagnosis of many systems cannot be made without full system voltage applied.
 - 6c. Take a methodical approach to finding the problem.
As a rule of thumb, start at one end of the circuit and work to the other.
 - 6d. The next step is to decide what method to use to troubleshoot the circuit.
 - If checking a safety circuit that grounds the magneto, use an Ohms meter to test for continuity.
 - If checking a safety circuit that enables a starter motor or accessory, use a volt meter to confirm the presence of power at each junction in the system.
 - If a circuit does not work at all, look for a short or an open.
 - If the circuit works slowly or intermittently, look for resistance by doing a voltage drop test.

NOTE: In all diagnosis, it is very important to understand the circuit that is being checked. The use of a schematic is recommended, even if a technician is thoroughly familiar with the system.
7. Testing for opens/shorts
- NOTE:** When checking circuits for **continuity**, disconnect the circuit at the nearest plugs and use the metal terminals of the plug as a connection point for the test probes. **DO NOT STAB THE WIRES.**
- NOTE:** When checking circuits for **voltage**, back-probe the terminals nearest the point to be checked. **DO NOT STAB THE WIRES.** See Figure 7.38.



Figure 7.38

ELECTRICAL SYSTEM

- 7a. Starting with a fully charged battery and battery cable connections that are clean and tight, measure the battery voltage. See Figure 7.39.



Figure 7.39

- 7b. With the circuit energized, start at either end of the circuit and check for voltage.

- If starting at the battery-end of a powered circuit, trace it through until power vanishes.
- If starting at the far end of a powered circuit, trace it through to the point that power appears.
- If there is low voltage at the far end of the circuit, do a voltage drop test (as described later in this section) on the circuit to find the source of resistance.

NOTE: When working toward the battery, check each junction with the connector disconnected, then re-check with the junction reconnected. If there is voltage with the connector unplugged but not when it is connected there is a short between that point and the last connector tested.

NOTE: When working toward the battery, if one junction has lost power, but the next connector has voltage with its junction still connected, there is an open between the two junctions.

8. Continue checking each connector until the other end of the circuit is reached or the fault is found.

Voltage Drop Test

To review:

- Ohm's law states that it takes voltage to push current through a resistance.
- Kirchhoff's voltage law states that the sum of all the voltage drops equals the source voltage.
- Combining those two laws, we see that any restriction in a circuit (e.g.: loose connector damaged wire, or corroded terminal) will use up some voltage as the current is pushed through.
- A voltage drop test is a way of looking for that voltage.
- Because electricity needs to complete a full circle (circuit), voltage drop tests are useful on both the positive or the negative side of the system.
- This text will address the negative side to begin with. Bad grounds are responsible for as many electrical failures as the positive side of the system, yet the ground side is frequently neglected by technicians. See Figure 7.40.



Figure 7.40

IMPORTANT: Ultimately, all current will find its way back to the negative post of the battery.

9. To check ground-side voltage drop: set-up a multimeter to measure 12V DC.
- 9a. Make a good electrical connection between the black (-) probe and the negative post on the battery.
- 9b. Make a good electrical connection between the red (+) probe and the suspect point of ground.
- 9c. Power-up the circuit in question.

- 9d. The voltage that shows-up on the meter is the voltage that is being used to pass current through a resistance in the circuit.
- 9e. Voltage drop on a good circuit should be less than 0.1 volts. A voltage drop reading on the meter of greater than 0.2 volts indicates a fairly substantial problem that demands attention.
- As an example, if the starter solenoid does not engage properly, check for voltage drop between the ground point for the starter solenoid and the negative post on the battery. See Figure 7.41.



Figure 7.41

- With the starter engaged, this machine exhibited a voltage-drop reading of 0.308 volts, indicating a poor ground connection.

- 9f. A similar ground-side test on a tractor with a slow-cranking starter motor can be conducted between the engine block and the negative battery post. See Figure 7.42.



Figure 7.42

- 9g. With the starter engaged, this machine exhibited a voltage-drop reading of 0.312 volts, indicating a poor ground connection.
- 9h. Individually, these readings should lead a technician to inspect the connection between the solenoid and the ground path on the first tractor (e.g. mounting hardware, green wire with eyelet beneath head of solenoid mounting bolt), or the engine and the frame on the second tractor (e.g. loose or rusty engine mounting bolts).
- 9i. If both of these readings were found on the same tractor, a common point in the system would be the primary suspect (e.g. poor connection between negative battery cable and frame).

ELECTRICAL SYSTEM

10. Applying this principle to the positive side of the system: See Figure 7.43.



Figure 7.43

IMPORTANT: Ultimately, all positive current will find its way from the positive post of the battery to the negative post.

- 10a. To check hot-side voltage drop: set-up a multi meter to measure 12V DC.
- 10b. Make a good electrical connection between the red (+) probe and the positive post on the battery.
- 10c. Make a good electrical connection between the black (-) probe and the suspect point of the circuit.
- 10d. Power-up the circuit in question.
- 10e. The voltage that shows-up on the meter is the power that is not following the intended path back to the negative battery post.
- 10f. Voltage drop on a good circuit should be less than 0.1 volts. A voltage drop reading on the meter of greater than 0.2 volts indicates a fairly substantial problem that demands attention.

- As an example, if the tractor had a slow-turning starter, the ground-side voltage drop measured below 0.1 volts, and there was not a parasitic load on the engine (e.g. PTO clutch that is not fully disengaged), it would be logical for the technician to check voltage drop to the starter. See Figure 7.44.



Figure 7.44

- With the starter motor engaged, the voltage drop reading here is nearly 0.6 volts, indicating a serious problem in the heavy-gauge circuit between the starter and the battery.
- 10g. Checking voltage-drop at various points along the circuit can help pin-point the problem.
- Check voltage-drop at the output lug on the starter solenoid:
- If there is a significant difference, the problem lies between the lug on the solenoid and the lug on the starter.
- If there is little change, the problem lies further up-stream.
- Check voltage drop at the input lug on the solenoid. If there is significant difference between the reading here and the reading at the output lug (greater than 0.10 volt), then the contacts inside the solenoid may be burned. If there is little change, the problem lies further up-stream, between the battery and the solenoid.
- Results may be cross-checked by testing voltage drop across the two posts of the starter solenoid while cranking the starter motor.

11. Testing switches:

- Refer to the "COMPONENTS" section of this chapter that describes the function of the individual switches to be tested.
- Switches can be tested "hot" by looking for voltage at the appropriate posts. This is not definitive, since the source of the voltage is not always confirmed. Checking for voltage does not work on switches that work by providing a ground path to the magneto primary windings or a solid state control device.
- The most valid way to test switches is a **continuity test**.
 - Understand the internal functions of the switch. Key switches and PTO switches can be fairly complex.
 - Isolate the switch from the rest of the circuit.
 - Test each pair of terminals for continuity in all modes of switch operation: at-rest, and actuated.
 - Many switches on Cub Cadet equipment are typed by their at-rest state: Normally Open, Normally Closed, Common.
- Normally Open (N.O.) contacts do not complete a circuit when the switch is at-rest (plunger extended). They close to complete a path through the switch when the plunger is depressed.
- Normally Closed (N.C.) contacts complete a circuit when the switch is at-rest (plunger extended). They open to break the path through the switch when the plunger is depressed.
- Some Cub cadet switches contain more than one pair of contacts. The same switch housing can contain normally open and normally closed switch elements.
- When testing a switch that contains more than one set of contacts (elements), the male spade terminals associated with Normally Closed contacts will be stamped "N.C."

- The male spade terminals that are associated with each-other face each-other broad-surface to broad surface. See Figure 7.45.

Normally Closed
switch element:

Spades marked: "NC"

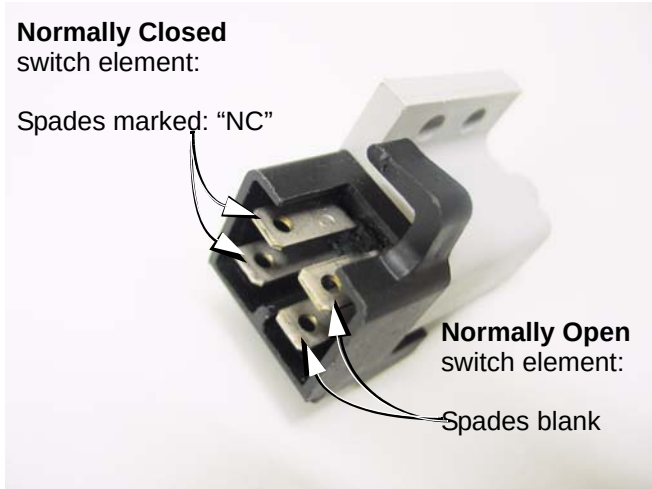


Figure 7.45

12. Diodes

- What is a diode?: A diode acts like a one way valve, allowing current to flow in only one direction. See Figure 7.46.

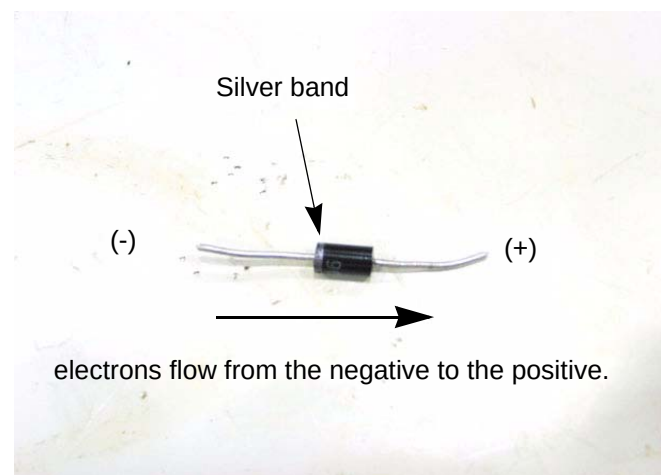


Figure 7.46

- Which way does this electrical check-valve work?: There will be a band on one end of the diode. The band indicates the negative side of the diode
- Most DVOMs have the ability to test a diode.

ELECTRICAL SYSTEM

- 13. Testing a diode:
 - 13a. Isolate the diode in the circuit.
 - 13b. Set the DVOM to the diode or Ω scale. See Figure 7.47.

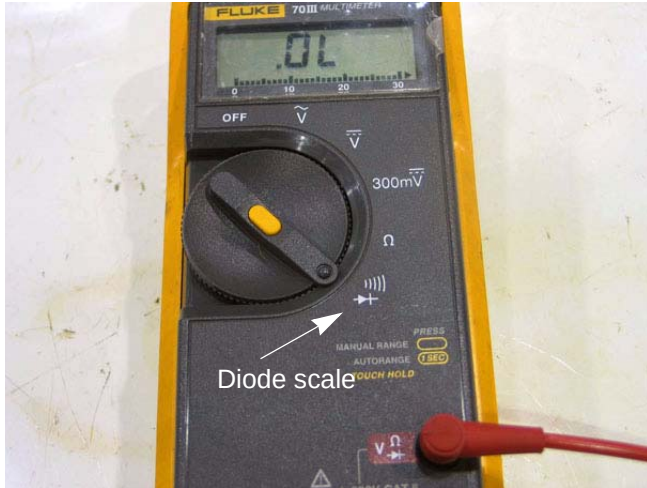


Figure 7.47

- 13c. Attach the negative lead of the DVOM to the side of the diode with a band on it.
 - 13d. Place the positive lead on the other side of the diode.
 - 13e. There should be continuity. See Figure 7.48.

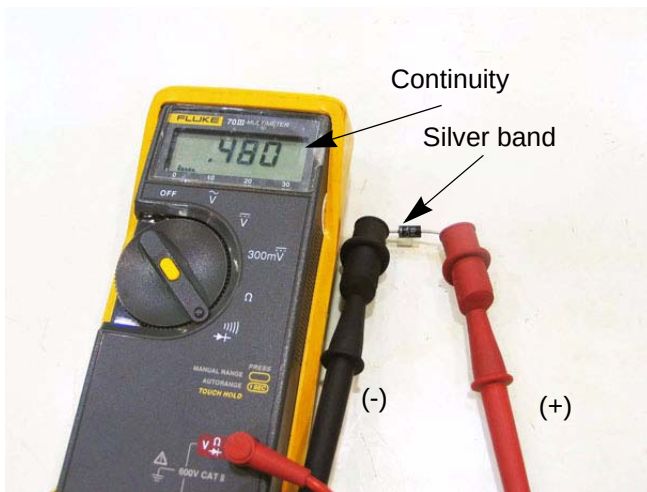


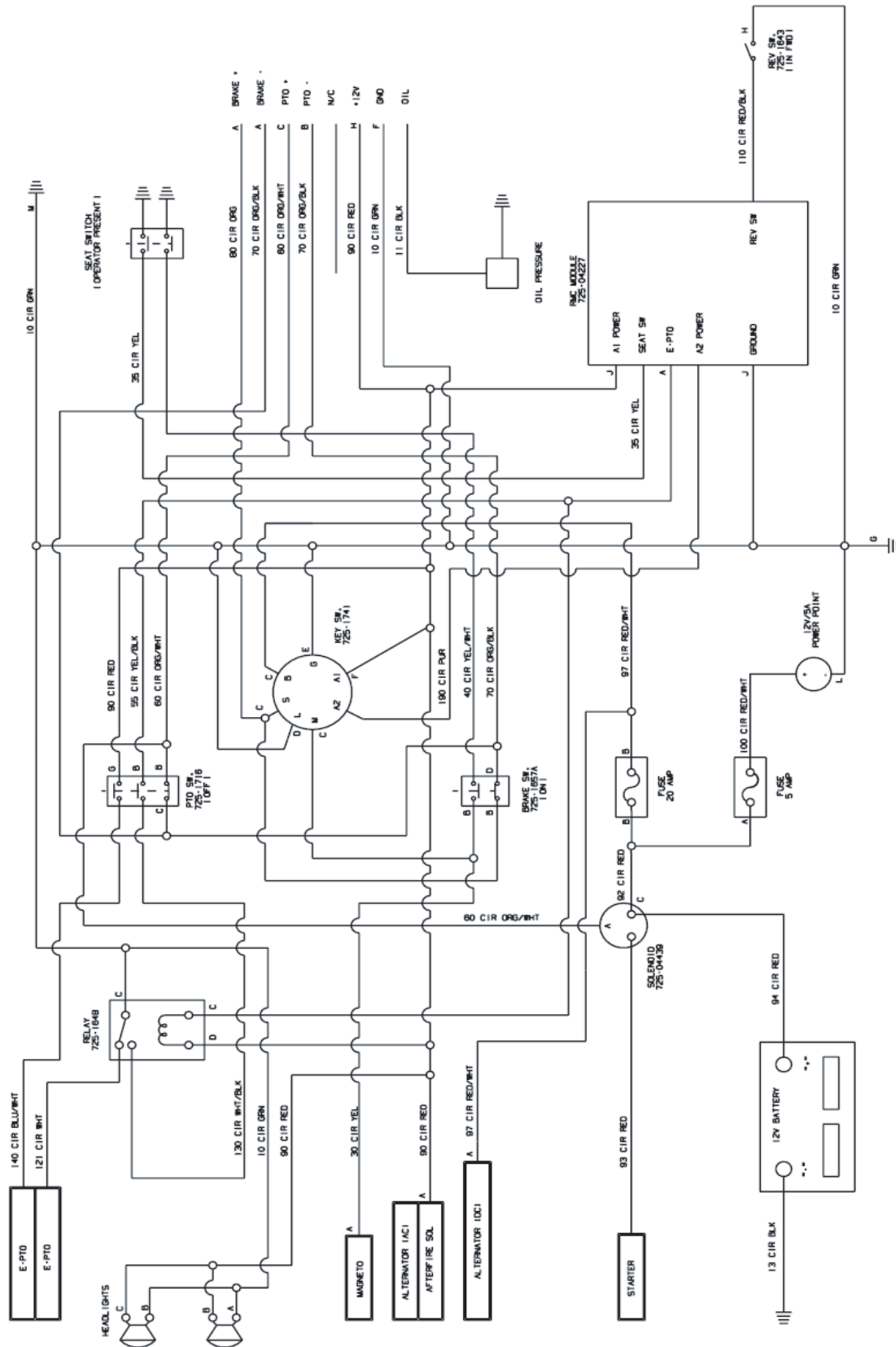
Figure 7.48

- 13f. Switch the leads.
 - 13g. The meter should indicate no continuity. See Figure 7.49.



Figure 7.49

- 13h. If the results do not match the above, replace the diode.



CHAPTER 8: CUTTING DECKS AND LIFT SHAFT

Cutting decks

The I-series comes with two deck options; a 46" and a 50" deck. The procedure to remove the deck is the same for both.

To remove the deck:

1. Place the tractor on firm level ground and set the parking brake.
2. Lower the deck to the lowest cutting height.
3. Pull the deck pins on both sides and rotate them to keep them out. See Figure 8.1.



Figure 8.1

4. Raise the deck lift lever to the highest setting.

5. Slide the deck forward to unhook the front hanger. See Figure 8.2.

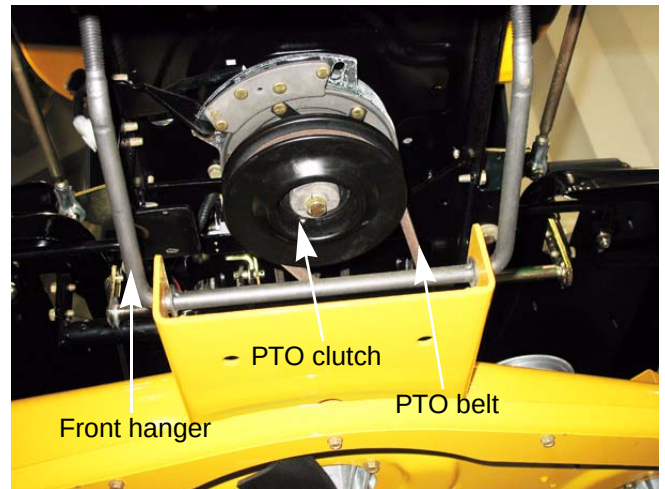


Figure 8.2

6. Slide the PTO belt off of the PTO clutch. See Figure 8.2.
7. Slide the deck out to the right, from underneath the tractor.
8. Install the deck by following the above steps in reverse order except the belt. The belt goes on the PTO clutch last.

NOTE: The deck is easier to install if the front edge is supported by a length of 2"x4" lumber. This brings the front hanger closer to the horizontal position. The closer the front hanger is to horizontal, the further back the deck can move to connect to the "J" pins in the rear of the deck to the lift links.

CUTTING DECKS AND LIFT SHAFT

Cleaning the deck

Cleaning debris off of the deck should be done every time the deck is removed. It is routine maintenance that will make the deck easier to work on and prolong the life of the deck and spindles.

DANGER: Debris build up on the mower deck is an unsafe condition. The debris traps heat in the spindles causing damage to the spindle bearings. Debris around the belt can over-heat.

To clean the deck while it is removed:

1. Blow all the debris off of the top of the deck using compressed air.
2. Scrape off the debris build up from the under side of the deck using a plastic scraper.

NOTE: Applying a light coating of oil to the underside of the deck after scraping it clean will help prevent rusting of the deck and help keep the debris from building up on the underside of the deck.

Blades

The condition of the blades will greatly effect the quality of the cut.

The blades should be sharpened and balanced after every five acres, depending on local conditions. A dull blade tears the grass instead of cutting it. Torn grass blades leaves a rough look and makes the grass vulnerable to diseases.

Blades need to be examined for damage before sharpening. Blades must be balanced after sharpening to reduce the vibrations felt from the deck.

Bent blades are a sign of a blade impact. The blades must be replaced and the spindles inspected for bent shafts and cracked housings if a bent blade is found.

Blades come in a variety of styles; side discharge, mulching, bagging, combination, there are even de-thatching blades on the market. The I-series comes with what Cub Cadet calls a 3 in 1 blade. This means it can side discharge, bag and mulch.

The cutting deck on the I-series tractor is mounted with a slight rake, meaning that the front of the deck is a 1/4" - 3/8" lower than the rear of the deck. This is very important to get the proper air flow in the deck so that the blades can make the grass blades stand up to get cut.

The air flow in the cutting deck is generated by the spinning blades. If the blades are mounted upside down, the air flow will be reversed pushing the grass down instead of standing up.

NOTE: Blades that are mounted upside down, increase the risk of impacting an object.

To remove the blades:

1. Remove the deck as described in the previous section of this chapter or lift the tractor using a professional grade lift.
2. Remove the blade nuts using an impact wrench and a 15/16" socket. See Figure 8.3.

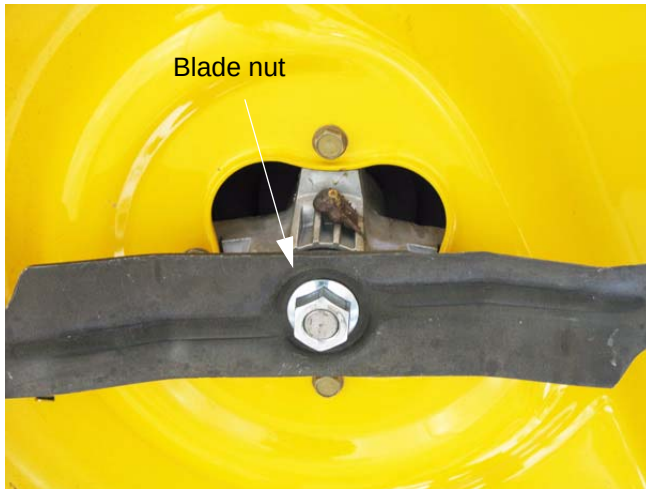


Figure 8.3

CAUTION: Use care around the blade while removing or tightening the nut. The blade can spin and cause an injury to the technician.

3. Remove the blade.
4. When sharpening the blades:
 - To properly sharpen the cutting blades, remove equal amounts of metal from both ends of the blades along the cutting edges, parallel to the trailing edge, at a 25° to 30° angle.

IMPORTANT: If the cutting edge of the blade has already been sharpened to within 1 5/8" from the edge, or if any metal separation is present, replace the blades with new ones.

- It is important that each cutting blade edge be ground equally to maintain proper blade balance.

CAUTION: A poorly balanced blade will cause excessive vibration and may cause damage to the tractor and result in personal injury.

- The blade can be tested by using a blade balancer. Grind metal from the heavy side until it balances evenly.

5. Install the blade by following the above steps in reverse order. Tighten the blade nut to a torque of 70 - 90 ft-lbs (95 - 122 Nm).

NOTE: The I-series blades have a star center. The star must seat on the raised star on the bottom of the spindle shaft with the fins of the blade pointing to the deck. If there is damage to the raised star of the spindle shaft, the spindle must be replaced. See Figure 8.4.

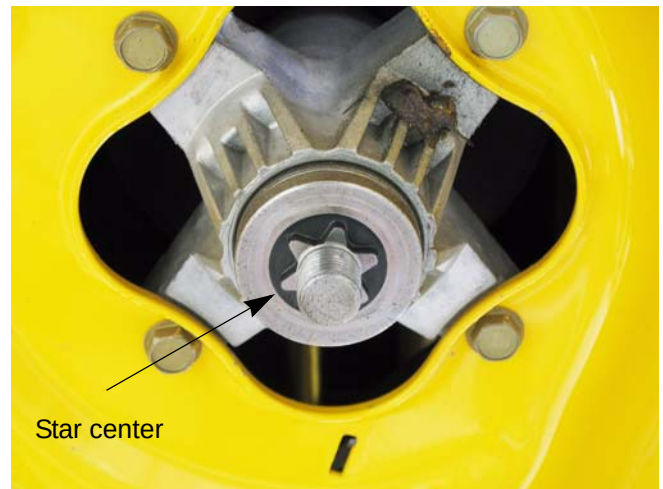


Figure 8.4

CUTTING DECKS AND LIFT SHAFT

Spindles

The spindles are a complete unit. The only replaceable part is the pulley. The spindles are equipped with a grease fitting that should get one squirt of grease after every use of the deck wash system or every 10 hours of use.

NOTE: Never put more than one squirt of grease in a spindle. Putting more grease in the spindle will push the bearing out of the spindle housing, ruining the spindle.

To replace a pulley:

1. Remove the deck as described at the beginning of this chapter.
2. Remove the blade following the steps described in the previous section of this chapter.
3. The center spindle pulley can be removed at this point using an impact wrench with a 15/16" socket to remove the pulley nut. See Figure 8.5.

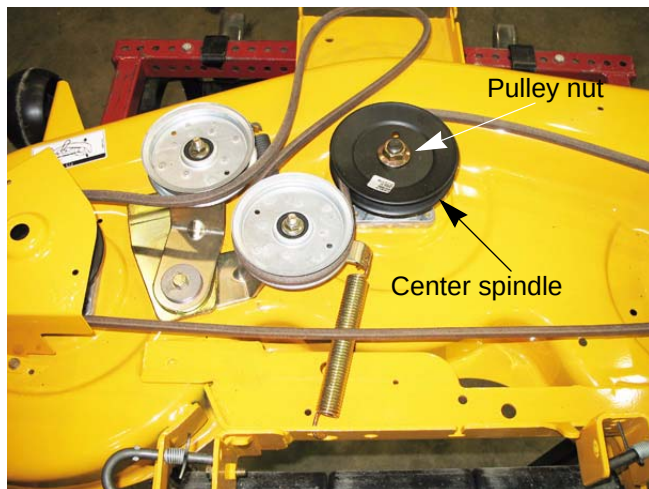


Figure 8.5

NOTE: The spindle bearings are sealed. The grease injected into the spindle housing will break down and seep through the seals to lubricate the bearings. It will also keep condensating moisture within the spindle from reaching the bearings.

4. To access the outer spindles, remove the spindle covers. See Figure 8.6.



Figure 8.6

5. Remove the pulley nut using an impact wrench with a 15/16" socket.
6. Install the spindle pulleys by following the above steps in reverse order.
7. Test run the tractor before returning to service.

To replace a spindle:

1. Remove the deck as described at the beginning of this chapter.
2. Remove the blade following the steps described in the previous section of this chapter.
3. Remove the spindle covers. See Figure 8.6.
4. Remove the four bolts fastening the spindle to the deck. See Figure 8.7.

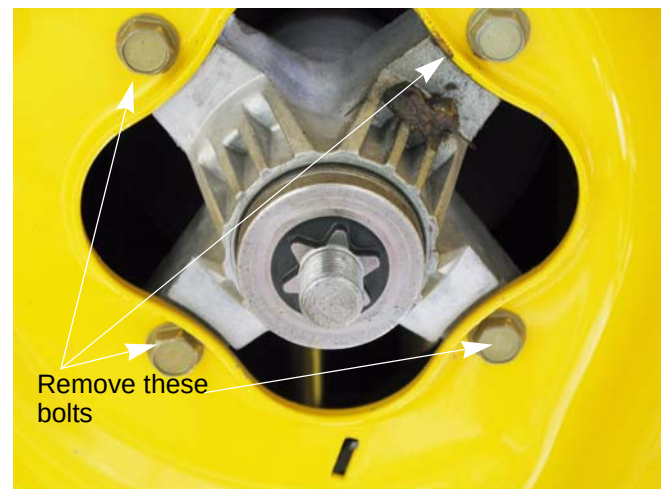


Figure 8.7

5. Lift the spindle out of the deck shell.
6. Install the spindle by following the above steps in reverse order.

NOTE: The four spindle bolts are self tapping bolts. The new spindle housing will not have threads in it.

NOTE: Tighten the spindle bolts to a torque of 200 - 300 in-lbs (23 - 34 Nm).

PTO belt

The function of the PTO belt is to transfer the mechanical force from the engine to the blades. The belt faces a lot of different forces.

- The friction of the belt grabbing the different pulleys creates heat. This heat softens the belt which weakens it.
- Every time the electric PTO is engaged, the PTO belt is subjected to an impact load. When the electric PTO is engaged, it goes from 0 to 3,600 RPM instantly. This can actually remove sections of the belt.

NOTE: Engaging the Electric PTO before the mowing deck is placed into the grass will reduce the impact load on the belt.

- When a blade impacts an object like a rock or a tree root, the belt is subjected to an impact load similar to the impact load of engaging the electric PTO.
- The belt has rubber in it. As the rubber ages, it becomes brittle making it weaker.

NOTE: A damaged belt can cause the deck to vibrate when the deck is engaged. The vibration can be bad enough to simulate an engine issue.

NOTE: Not all belt damage is visible. Broken cords inside the belt are not visible to the naked eye, but can cause vibration issues and greatly reduce the life of the belt.

CAUTION: Cub Cadet belts are designed to fit our equipment and are not standard lengths. Use of a non-OEM belt may prevent the mowing deck from working properly.

To replace the PTO belt:

1. Remove the deck as described at the beginning of this chapter.

NOTE: Removal of the deck is not necessary, but make it easier to route the belt around the spindles.

2. Slide the belt off of the pulleys.

NOTE: Generally it is not necessary to remove the spindle covers, however if there is debris build up under the spindle covers it is recommended to remove them and clean out the debris. To remove the spindle covers follow the steps described in the spindle section of this chapter.

CUTTING DECKS AND LIFT SHAFT

3. Route the new belt around the pulleys.
- For a 46" deck, See Figure 8.8.

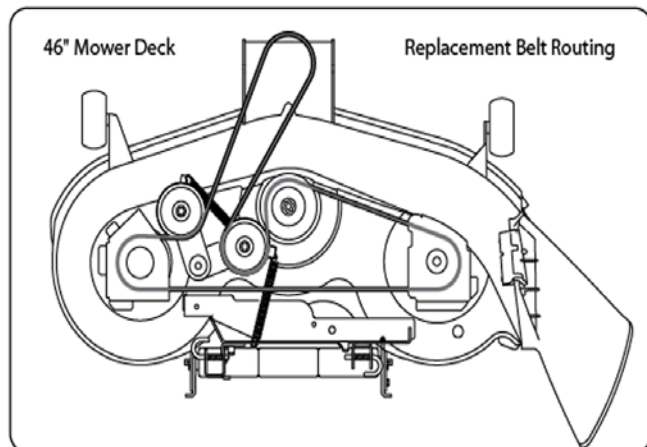


Figure 8.8

- For a 50" deck, See Figure 8.9.

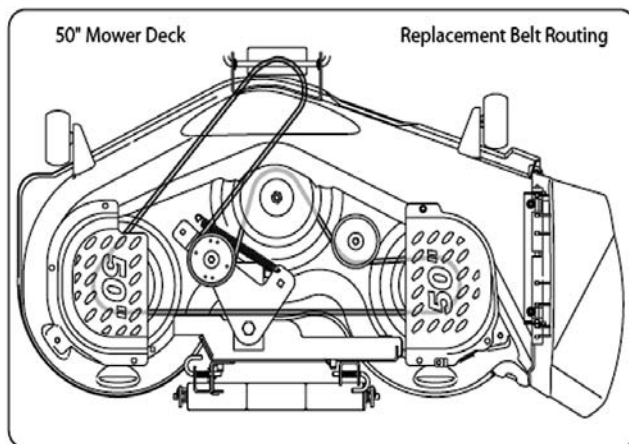


Figure 8.9

4. Install the deck as describe at the beginning of this chapter.
5. Test drive the tractor before returning to service.

Leaving the deck

For the best quality cut, the deck must be level side to side and the front of the deck should be 1/4" - 3/8" lower than the rear of the deck.

To level the deck:

NOTE: Check the tractor's tire pressure before performing any deck leveling adjustments. The recommended operating tire pressure is:

- Approximately 10 psi for the rear tires
- Approximately 14 psi for the front tires

Side to Side Leveling

1. With the tractor parked on a firm, level surface, move the deck to the mid height position (third or fourth notch) using the deck lift lever. Rotate both blades so that they are perpendicular with the tractor frame.
2. Measure the distance from the outside of the left blade tip to the ground and the distance from the outside of the right blade tip to the ground. Both measurements taken should be equal. If they are not, note whether the left side of the deck is lower or higher and proceed to the next step.

NOTE: Use of Cub Cadet deck leveling gauge, part number 490-900-0041, will make measuring the blade tip height easier. See Figure 8.10.



Figure 8.10

3. Working from the left side of the tractor, loosen, but do not remove, the bolt on the left deck hanger bracket. See Figure 8.11.



Figure 8.11

4. To even the deck turn the adjustment gear, located immediately behind the bolt, clockwise (rearward) to raise the left side of the deck. Turn the gear counter-clockwise (toward front) to lower the left side of the deck. See Figure 8.11.
5. The deck is properly leveled when both blade tip measurements, as described earlier, are equal.
6. Retighten the bolt on the left deck hanger bracket when proper adjustment is achieved.

Front To Rear Leveling

The front of the cutting deck is supported by an adjustable front deck hanger rod. This rod can be adjusted to set the front to rear pitch of the deck. The front of the deck should be between 1/4-inch and 3/8-inch lower than the rear of the deck. Adjust if necessary as follows:

1. With the tractor parked on a firm, level surface, move the deck to the mid height position (third or fourth notch) using the deck lift lever. Rotate the blade nearest the discharge chute so that it is parallel with the tractor frame.

2. Measure the distance from the front of the blade tip to the ground and the rear of the blade tip to the ground.

NOTE: The front measurement taken should be between 1/4" - 3/8" less than the rear measurement. Determine the approximate distance necessary for proper adjustment and proceed, if necessary, to the next step.

3. Working at the front of the tractor, loosen the two hex lock nuts at the front of the deck hanger rod. Thread the lock nuts away from the hex nuts behind them. See Figure 8.12.

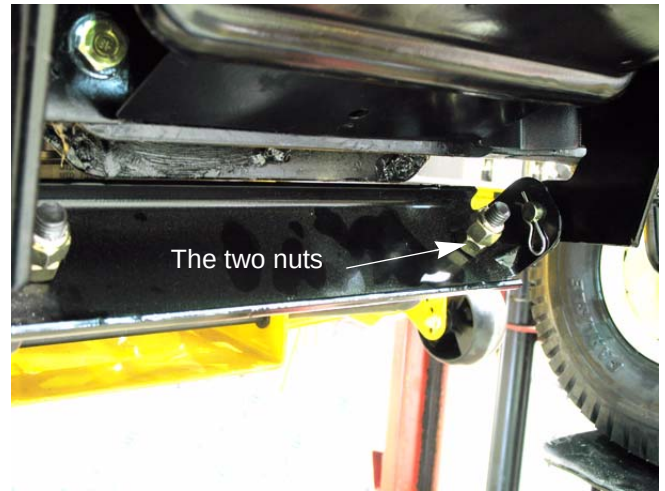


Figure 8.12

NOTE: Both nuts are on the top side of the bracket to float and rise if the deck impacts something. This helps to minimize the damage to the deck

4. Using a wrench, turn the inner hex nuts clockwise to raise the front of the deck, or counter-clockwise to lower the front of the deck. Adjust the hex nuts evenly so that the deck hanger rod is at the front of both slots in the hanger bracket on the front of the deck.
5. Retighten the two hex lock nuts when properly adjusted.

CUTTING DECKS AND LIFT SHAFT

Deck Gauge Wheel Adjustment

The cutting decks are of a "floating" design. This means that they are suspended above the ground. The gauge wheels occasionally touch the ground. They are designed to bump the deck up and over irregularities. This prevents scalping damage to the turf and to the deck.

Adjust the gauge wheels as follows:

1. Place the tractor on a smooth, flat surface and move the deck to the desired mowing height using the deck lift lever.
2. Check gauge wheels distance from the flat surface below. If the gauge wheels contact the ground, they must be raised. If the gauge wheels are higher than 1/2" above the ground, they should be lowered.
3. Remove the shoulder bolt securing one of the front ball wheels to the front index bracket.
4. Reposition the ball wheel to align with the one of four index holes that places the wheel 1/4" to 1/2" above the ground. See Figure 8.13.

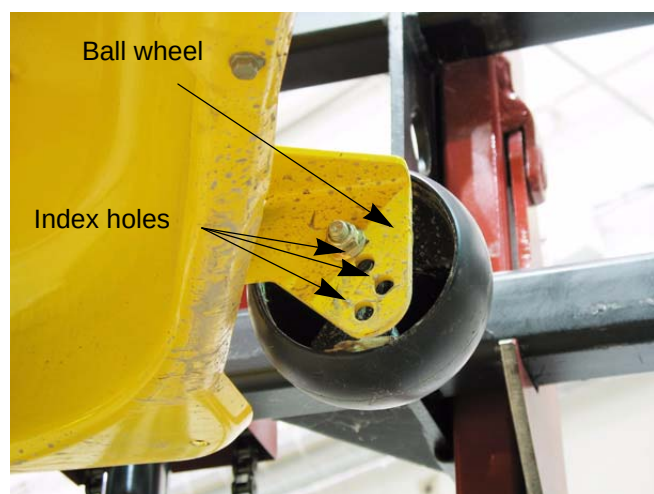


Figure 8.13

5. Secure the ball wheel to the index bracket with the shoulder bolt. Note the index hole used and secure the other ball wheel in the same position.

Deck Rear Roller Adjustment

The rear rollers on the mower deck are not designed to carry the weight of the deck. The rear rollers should be adjusted to approximately 1/4" to 1/2" above the ground when the deck is moved to the desired cutting height.

To adjust the rear roller:

1. Place the tractor on a smooth, flat surface, move the deck to the desired cutting height.
2. Check the height of the rear rollers.

46" Deck ONLY

NOTE: The 46" deck roller assembly index bracket has three adjustment positions using either the bottom two holes, middle two holes, or top two holes.

- A Support the roller assembly and remove the two self tapping screws from both the left and right roller index brackets. See Figure 8.14.

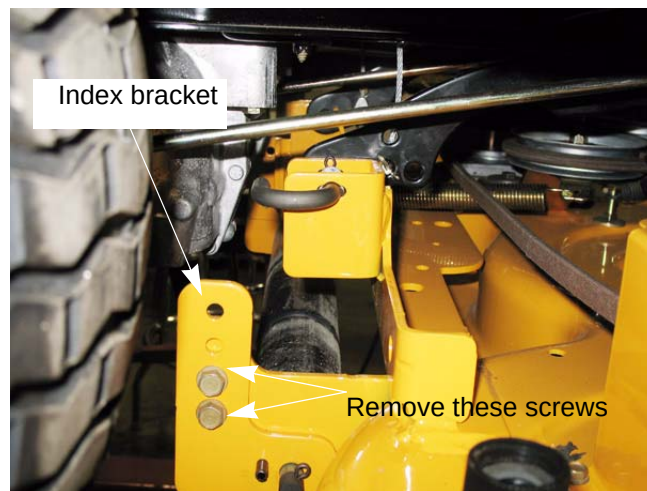


Figure 8.14

- B Position the roller assembly so that the rollers are approximately 1/4" to 1/2" above the flat surface below. Align the nearest two index bracket holes with holes in the deck mounting brackets.
- C Secure the roller assembly with the four self tapping screws.

NOTE: The self tapping screws should be in the corresponding holes of both the left and right roller index brackets.

50" Deck ONLY

NOTE: The 50" deck roller assembly index bracket has five adjustment holes.

- D While supporting the roller assembly, remove clevis pin and withdraw the clevis pins from both of the roller index brackets. See Figure 8.15.

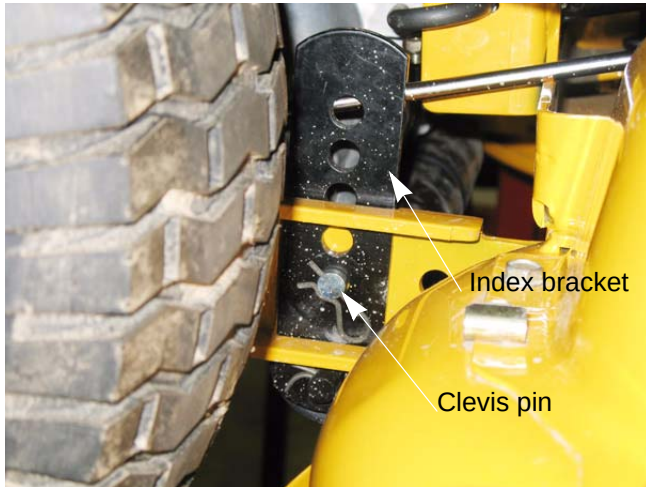


Figure 8.15

- E Position the roller assembly so that the rollers are approximately 1/4" to 1/2" above the flat surface below.
- F Align the nearest index bracket holes with the holes in the deck mounting brackets. Insert the clevis pins through the deck brackets and the index brackets and secure with the click pins.

NOTE: The clevis pins should be in the corresponding holes of both the left and right roller index brackets.

Deck lift shaft assembly bushings

The deck lift shaft assembly bushings for the I-series tractor can be replaced without removing the deck lift shaft assembly. To replace the bushings:

1. Remove the deck by following the steps described at the beginning of this chapter.
2. Remove the E-ring that retains the lift shaft bushing. See Figure 8.16.

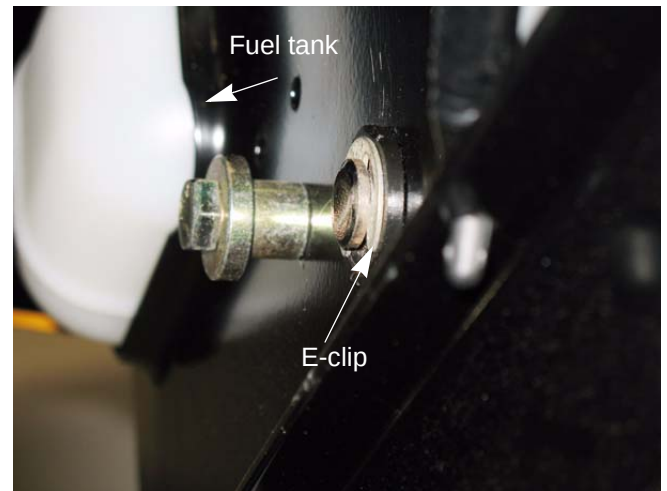


Figure 8.16

3. Slide the old bushing out.
4. Slide the new bushing in.
5. Install the E-ring that retains the bushing.
6. Repeat steps 2 - 6 on the opposite side.
7. Install the deck.
8. Test drive the tractor in a safe area before returning to service.

CUTTING DECKS AND LIFT SHAFT

Deck lift shaft assembly removal/replacement

1. Remove the deck by following the steps described at the beginning of this chapter.
2. Remove the fender by following the steps described in chapter 4 BODY/CHASSIS.
3. Remove the hairpin clips that hold the top of the deck lift cables and slide the cables out of the deck lift shaft assembly. See Figure 8.17.



Figure 8.17

4. Unhook the lift assist spring. See Figure 8.18.



Figure 8.18

5. Remove the E-clips that retain the bushings. See Figure 8.19.

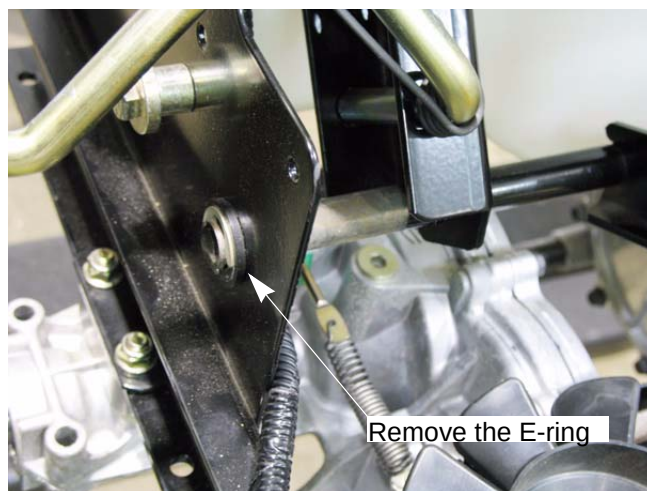


Figure 8.19

6. Slide the bushings out of the seat box assembly. See Figure 8.20.



Figure 8.20

7. Work shaft out of the seat box assembly.
8. Work the lift shaft handle and spring off of the deck lift shaft.
9. Install the deck lift shaft by following the above steps in reverse order.

Deck lift links and cables

The deck lift links have two functions. The first function is to support the rear of the deck. The second function is to raise or lower the deck in response to movement of the deck lift lever.

To accomplish the second function, the deck lift cables run from the deck lift shaft assembly, over a pulley to the lift links.

As with most tractors made by Cab Cadet there are two holes in the lift link that the lift cable can go into. The top hole is for garden tractors and the bottom hole is for lawn tractor. See Figure 8.21.

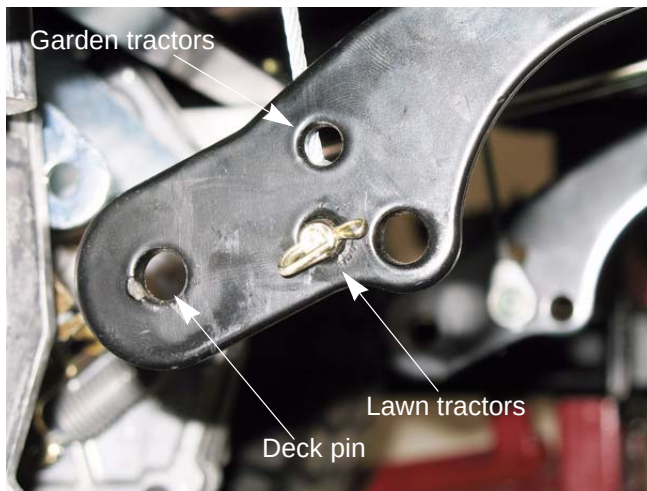


Figure 8.21

NOTE: If the cable is installed in the wrong hole, the belt angle between the electric PTO clutch and the deck will be off. This will result in the PTO belt being throwing off.

CHAPTER 9: MAINTENANCE INTERVALS

Lubrication

To help keep the I-series in proper running order it is recommended the following lubrication intervals be used (adjustable to local conditions). Use a high quality petroleum grease to lubricate the tractor.

Table 1:

Lube Point	Number of fittings	Interval
Pivot bar	4	25 hours
Steering arms	2	25 hours
Wheel bearings	2	25 hours
Spindles	3	10 hours

NOTE: Lubricate all of the pivot points with a light coating of oil once a season.

Engine maintenance

The recommended maintenance intervals listed in this manual are a guideline. They are adjustable for local conditions.

Table 2:

Maintenance items	Interval
Oil Change	100 hrs
Air filter pre cleaner	25 hrs
Air filter	50 hrs
Spark plugs	100 hrs
Fuel filter	100 hrs

The spark plugs

The spark plugs should be checked, cleaned and re-gapped on a monthly basis or every 100 hours of use. The plugs should be replaced every six months or 300 hours of use.

When checking the spark plugs, a dry, light colored residue on the plugs is a sign of running lean. Check the fuel mixture and adjust the carburetor.

If there is a thick, wet, black residue on the plug the engine is running rich. Check the fuel mixture and adjust the carburetor.

There should be a dry tan coating on the plugs. this would indicate the proper mixture.

1. To remove/replace the spark plugs:
 - 1a. Remove the spark plug wires on each side. See Figure 9.1.

NOTE: Do not use metal pliers on spark plug wires. Damage to the wire can result.

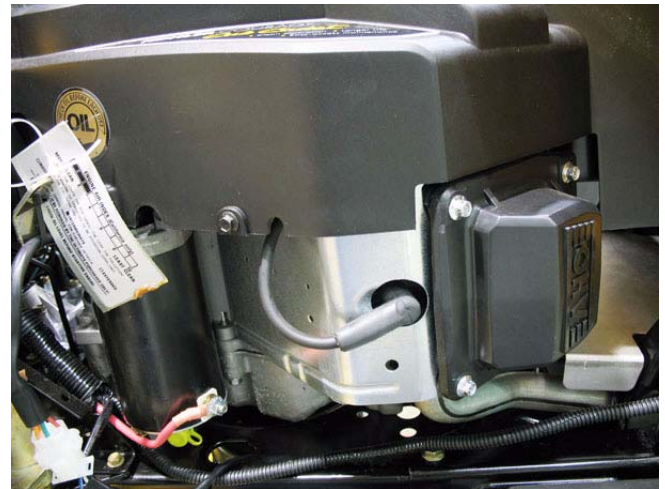


Figure 9.1

MAINTENANCE INTERVALS

- 1b. Remove the spark plugs with a 5/8" spark plug socket. See Figure 9.2.



Figure 9.2

- 1a. Clean the Spark plugs with carburetor cleaner or replace them with two Champion RC12YC spark plugs.

NOTE: Do not clean the spark plugs mechanically (sand blasting or scraping). This will damage the insulator.

- 1b. Gap the electrodes to .030" (.76mm).
- 1c. Thread the spark plugs into the spark plug holes.
- 1d. Tighten the spark plugs to a torque of 18-22 ft - lbs (24.4 - 29.8Nm).

NOTE: Refer to Kohler manual TP-2574 for more detailed instructions.

- 1e. Push the spark plug wires onto the spark plugs until they snap into place.

Air filter and foam pre cleaner

A dirty air filter and/or foam pre cleaner can reduce engine power, increase fuel consumption and make starting more difficult.

The foam pre cleaner should be checked before each use and cleaned every 25 hours.

The air filter should be cleaned before each use and replaced every two months or 50 hours of use.

To check the air filter and pre cleaner:

1. Swing open the air filter door located at the front of the engine. See Figure 9.3.



Figure 9.3

2. Lift up the wire retainer. See Figure 9.4.



Figure 9.4

3. Remove the air filter and pre cleaner.
4. Slide the pre cleaner off of the air filter.
See Figure 9.5.



Figure 9.5

5. Install by following the above steps in reverse order.

To clean a pre cleaner:

1. Remove the pre cleaner following the steps described above.
2. The foam pre clean should be cleaned by:
 - 2a. Wash the filter in warm soapy water.
 - 2b. Rinse it and let it air dry.

IMPORTANT: Always replace a damaged filter.

NOTE: Do not oil the pre cleaner before placing it on the air filter. The oil can wick into the air filter, reducing the air flow through the air filter.

Oil change

The oil change interval is every 100 hrs.

NOTE: The first oil change should be preformed at 5 hours.

To change the oil:

1. Remove the cap from the oil drain.
See Figure 9.6.



Figure 9.6

2. Slide a piece of 1/2" rubber hose onto the drain.
3. Push in on the oil drain and rotate 90 degrees to open the drain.
4. After all of the oil has been drained, close the oil drain.
5. Remove the drain hose.
6. Place the cap back on the oil drain.
7. Fill engine with new oil. Use a good quality 10w30 motor oil that meets the specifications recommended by Kohler.
8. Check the dip stick to verify that the oil is at the proper level before returning to service.

MAINTENANCE INTERVALS

Oil filter

To replace the oil filter:

1. Drain the oil by following the previously described steps.
2. Remove the oil filter using an oil filter wrench.

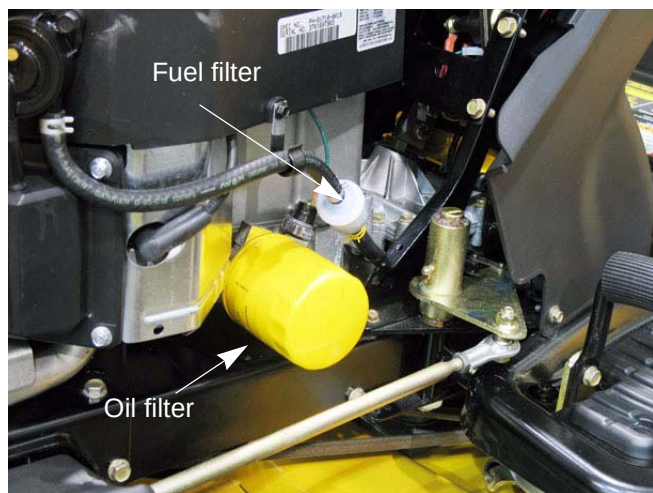


Figure 9.7

3. Place a light coating of oil on the O-ring of the new filter.
4. Pre-fill the new filter with fresh, clean oil.
5. Thread the new filter on to the engine. Hand tighten only.
6. Fill the engine with oil.
7. Test run the engine and check for leaks before returning to service.

Fuel system

What you should know about fuel.

Most of the fuel presently available in North America is oxygenated to some extent. This is commonly done through the addition of ethanol. Most engines offered for sale on outdoor power equipment in the North American markets are designed to tolerate no more than 10% ethanol by volume

Ethanol is hygroscopic, meaning it absorbs water. If left exposed to air, it will draw water out of the air.

Ethanol is an oxygenator, which means that it will oxidize (corrode) metal that it comes into contact with. Exposure to air causes fuel to go bad quickly, leaving gum and varnish deposits.

Fuel used in Cub Cadet outdoor power equipment should be no more than 30 days old. Because it may already have been stored at the refinery or gas station for a week or more, fuel should be purchased in small quantities and stored in safety approved gas cans with the caps closed.

For storage, all fuel should be run out of the tank and engine. Anti-oxidation additives such as Sta-bil will help keep the fuel fresher.

Servicing the fuel system

Inspect the fuel system every time the tractor is operated. If dirty or fuel that does not smell "right" is found in the fuel tank, drain the fuel tank and replace the fuel filter

Drain the fuel tank by removing the fuel line from the fuel filter and drain the fuel into an empty safety approved gas can. dispose of the bad fuel in a safe manner that follows local laws.

Fuel filter

A dirty fuel filter can result in a lean run condition. The fuel filter should be replaced every 100 hours.

To replace the fuel filter:

1. Clamp off the fuel lines to prevent fuel from leaking when the lines are disconnected. See Figure 9.7.

IMPORTANT: Take care that the fuel lines are not damaged when clamping them off. Never insert a screw or anything else into the fuel line to prevent fuel from coming out. This will damage the inside of the fuel line.

NOTE: There are commercially available fuel line clamping tools that will not damage the fuel lines.

2. Squeeze the tabs on the fuel line clamps and slide them away from the filter.
3. Carefully slide the fuel lines off of the filter. If there are pieces of rubber on the barbs of the fuel filter, replace the affected fuel line.

IMPORTANT: The I-series tractor uses low permeation fuel line to meet EPA guidelines. When replacing the fuel lines, they must be replaced with the same type of low permeation fuel line.

4. Install the new filter by following the above steps in reverse order.
5. Test run the engine and check for leaks before returning to service.

Clean the engine

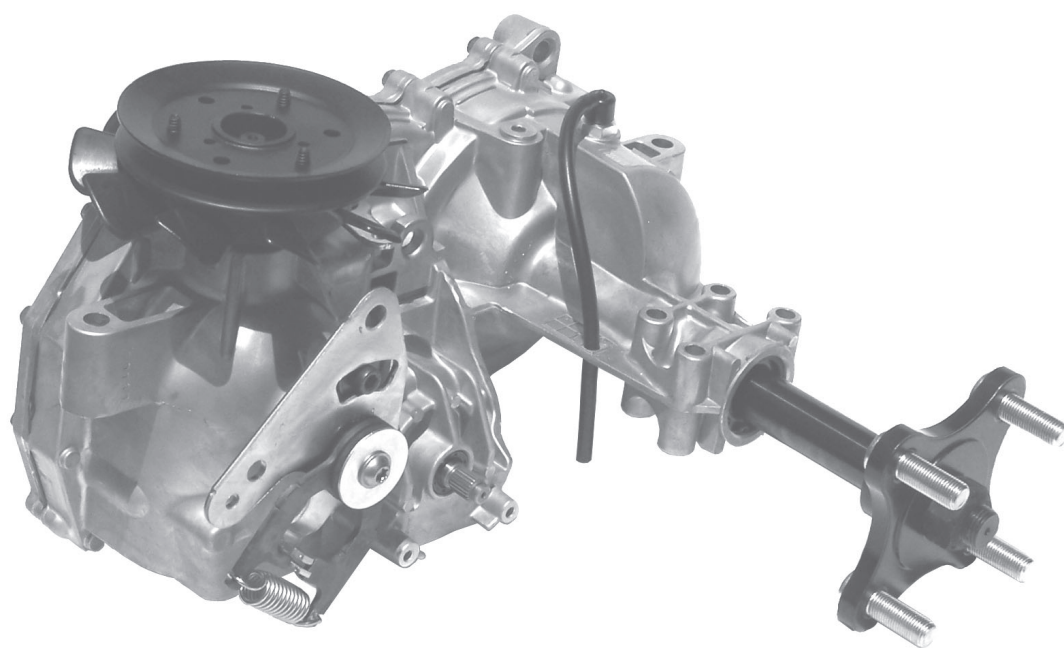
Air cooled engines cool better if they are clean. Check for nesting or signs of nesting especially after dormant season storage.

HYDRO-GEAR APPENDIX

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We set the wheels in motion.®



EZT®
Integrated Zero-Turn Transaxle
Service and Repair Manual
(ZC & ZD Models)

BLN-52622
May 2007

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FOREWORD

Headquartered in Sullivan, Illinois, Hydro-Gear® is a world leader in the design, manufacture, and service of quality hydrostatic transaxles for the lawn and garden industry. The mission of our company is to be recognized by our customers and the industry as a world-class supplier and the quality leader in everything we do.

This Service and Repair Manual is designed to provide information useful in servicing and troubleshooting the Hydro-Gear EZT® Integrated Zero-Turn Transaxle.

Also included is a glossary of terms that are frequently used throughout the industry and in Hydro-Gear service publications. Understanding terminology is very important!

It is necessary, and a good shop practice, that your service area be equipped with the proper tools and the mechanics be supplied the latest information available. All repair procedures illustrated in this guide are suggested, but preferred methods of repair.

Repair procedures require that the transaxle unit be removed from the vehicle.

This is not a certification, test or study guide for a certification test. If a technician is interested in certification, they should contact an agent representing OPEESA (Outdoor Power Equipment and Engine Service Association) at (860) 767-1770 or their Hydro-Gear Central Service Distributor. Many distributors will be hosting certification testing. These study guides will cover most of the products and manufacturers in our industry.

For more information about Hydro-Gear or our products, please contact your Central Service Distributor, or call our Customer Service Department at (217) 728-2581.

SECTION 1. DESCRIPTION AND OPERATION

INTRODUCTION

The purpose of this manual is to provide information useful in servicing the Hydro-Gear® Integrated Zero-Turn Transaxle (EZT®). This manual includes the EZT's general descriptions, hydraulic schematics, technical specifications, servicing and troubleshooting procedures.

The transaxle normally will not require servicing during the life of the vehicle in which it is installed. Should other servicing be required, the exterior of the transaxle will need to be thoroughly cleaned before beginning most procedures. Do not wash the transaxle while it is hot. Do not use a pressure washer to clean the unit.

GENERAL DESCRIPTION

The EZT is a self contained unit designed for the transfer and control of power. It provides an infinitely variable speed range between zero and maximum in both forward and reverse modes of operation.

This transaxle uses a variable displacement pump with a maximum displacement of 10cc per revolution, and motor with a fixed displacement of 10cc per revolution. The variable displacement pump features a trunnion mounted swashplate with a direct-proportional displacement control. Reversing the direction of the swashplate reverses the flow of oil from the

pump and thus reverses the direction of the motor output rotation. The pump and motor are of the axial piston design and utilize spherical nosed pistons which are held against a thrust race by internal compression springs.

The EZT has a self contained fluid supply and an internal filter. The fluid is forced through the filter by a positive "head" on the fluid in the housing/ expansion tank with an assist by the negative pressure created in the pump pistons as they operate.

The check valves in the center section are used to control the make-up flow of the fluid to the low pressure side of the loop.

A cam style, block lifting bypass is utilized in the EZT to permit moving the vehicle for a short distance at a maximum of 2 m.p.h. (3.2 Km/h) without starting the engine.



WARNING

Actuating the bypass will result in the loss of hydrostatic braking capacity. The machine must be stationary on a level surface and in neutral when actuating the bypass.

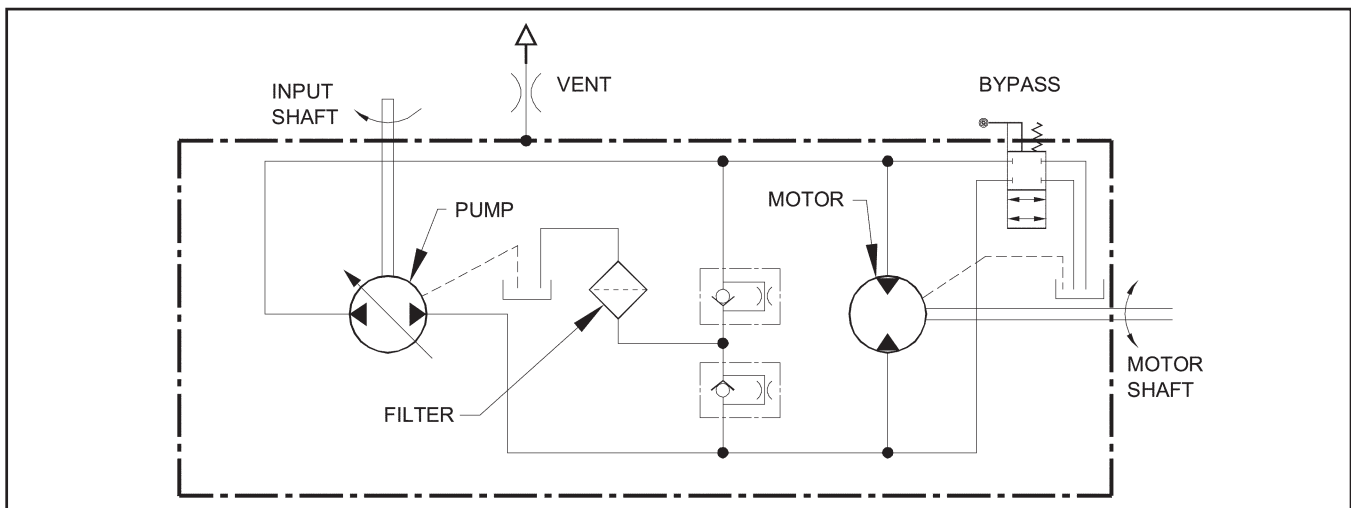


Figure 1. Hydraulic Schematic

EZT® HYDRAULIC FLOW SCHEMATIC

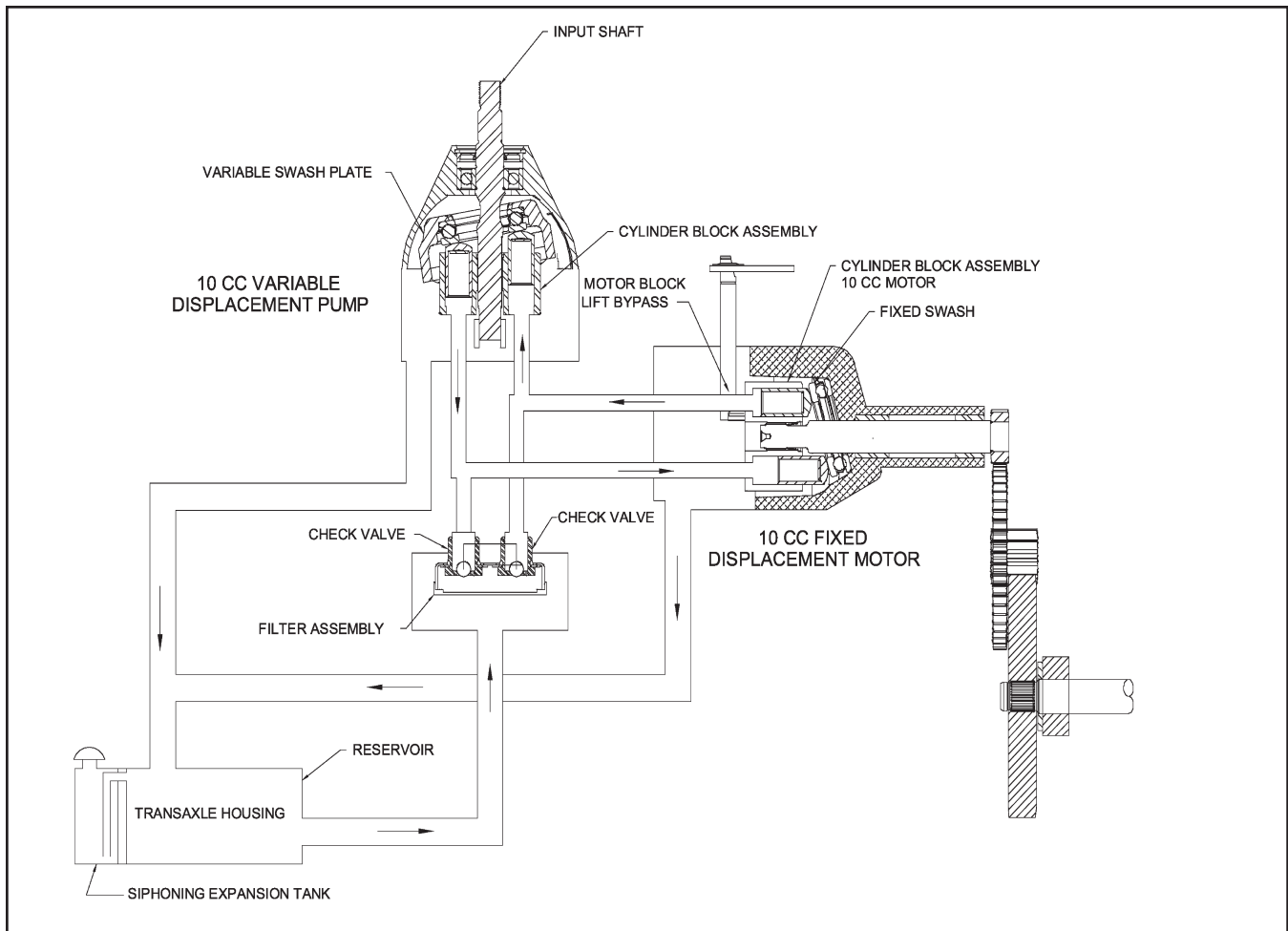


Figure 2. Hydraulic Flow Illustration

HYDRAULIC SCHEMATIC

Figure 2 provides an illustration of the hydraulic oil circuit. The oil supply for the hydraulic system of the EZT® is also utilized for lubricating the components of the final drive assembly.

The input shaft and pump cylinder block are turned in one direction only by the engine/drive belt/pulley combination. Output of the oil flow is controlled by the direction and amount that the variable swashplate is angled. As the pump pistons compress they force the oil to flow through one of two passageways (forward or reverse) in the center section to the motor cylinder block and motor shaft. Since the motor has a fixed displacement angle it is forced to turn with the flow of oil. As the angle of the pump swashplate is increased the amount of oil being pumped will increase and cause a higher speed output of the motor. Re-

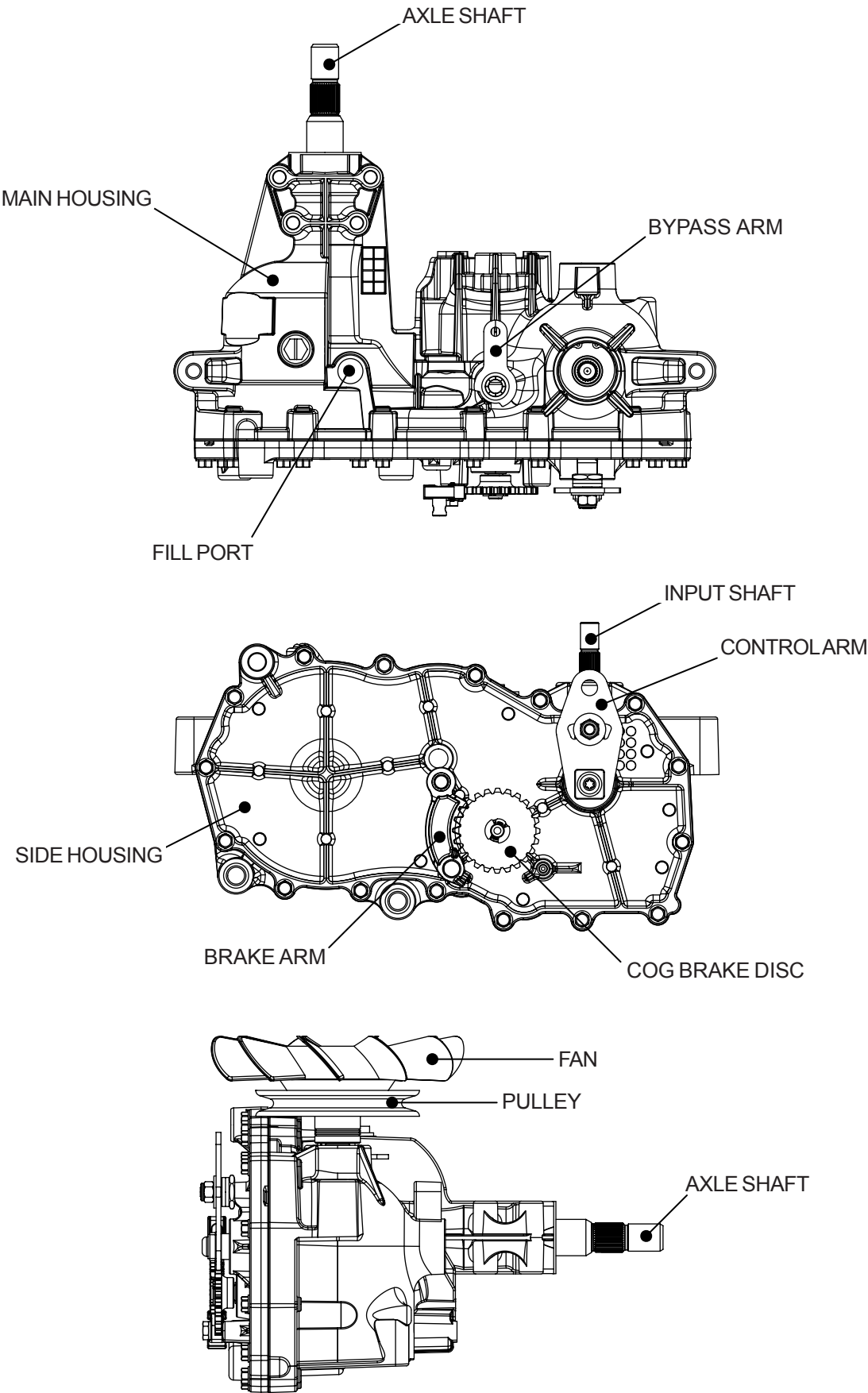
versing the angle of the pump swashplate will reverse the direction of oil flow.

During the operation of the transaxle, fluid is “lost” from the hydraulic loop through leak paths designed into the product for lubrication purposes (around pistons, under the rotating cylinder blocks, etc.). This “lost” fluid returns to the transaxle housing, then is pulled back into one of the check valves depending upon the direction of vehicle operation. All of this oil must pass through an internal filter.

The motor cylinder block mounts onto a splined motor shaft which drives the gear train.

The bypass feature in the EZT has a mechanical lever which lifts the motor block off of the center section running surface. This allows oil flow from the cylinder blocks to be discharged.

EXTERNAL FEATURES EZT®



TECHNICAL SPECIFICATIONS

Technical specifications for the EZT® are listed in Table 1.

Table 1. Technical Specifications

Input Speeds	Weight of Unit
Maximum: 3000 RPM	29 lbs. (13 Kg)
Minimum: 1800 RPM	

Table 2. EZT Component Options

Component	Component Options	
Axle Shaft Diameter and End Options:	1" Flange	1" DD
Brake Location:	Inboard	Outboard
Brake Type:	Cog	Friction Disc
Control Arm Location:	Inboard	Outboard
Control Arrangements:	Standard Control Arm	RTN (scissor style)
Overall Transaxle Reduction:	19.2:1	

PRODUCT IDENTIFICATION

The model and configuration of the EZT can be determined from the label shown in Figure 3.

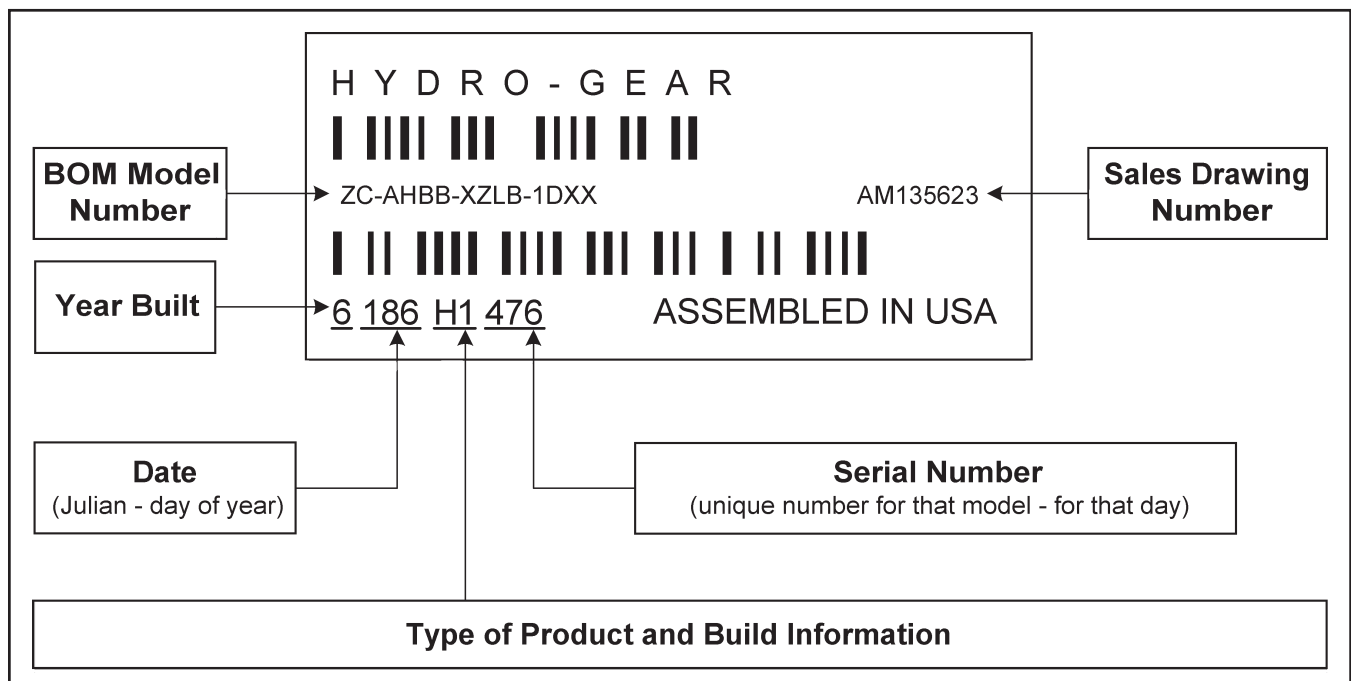


Figure 3. Configuration Label

SECTION 2. SAFETY



This symbol points out important safety instructions which, if not followed, could endanger the personal safety and/or property of yourself and others. Read and follow all instructions in this manual before attempting maintenance on your transaxle. When you see this symbol - **HEED ITS WARNING.**



WARNING

POTENTIAL FOR SERIOUS INJURY

Inattention to proper safety, operation, or maintenance procedures could result in personal injury, or damage to the equipment. Before servicing or repairing the EZT®, fully read and understand the safety precautions described in this section.

PERSONAL SAFETY

Certain safety precautions must be observed while servicing or repairing the EZT. This section addresses some of these precautions but must not be considered an all-inclusive source on safety information. This section is to be used in conjunction with all other safety material which may apply, such as:

- 1) Other manuals pertaining to this machine,
- 2) Local and shop safety rules and codes,
- 3) Governmental safety laws and regulations.

Be sure that you know and understand the equipment and the hazards associated with it. Do not place speed above safety.

Notify your supervisor whenever you feel there is any hazard involving the equipment or the performance of your job.

Never allow untrained or unauthorized personnel to service or repair the equipment.

Wear appropriate clothing. Loose or hanging clothing or jewelry can be hazardous. Use the appropriate safety equipment, such as eye and hearing protection, and safety-toe and slip-proof shoes.

Never use compressed air to clean debris from yourself or your clothing.

TOOL SAFETY

Use the proper tools and equipment for the task.

Inspect each tool before use and replace any tool that may be damaged or defective.

WORK AREA SAFETY

Keep the work area neat and orderly. Be sure it is well lit, that extra tools are put away, trash and refuse are in the proper containers, and dirt or debris have been removed from the working areas of the machine.

The floor should be clean and dry, and all extension cords or similar trip hazards should be removed.

SERVICING SAFETY

Certain procedures may require the vehicle to be disabled in order to prevent possible injury to the servicing technician and/or bystanders.

The loss of hydrostatic drive line power may result in the loss of hydrostatic braking capability.

Some cleaning solvents are flammable. Use only approved cleaning materials: Do not use explosive or flammable liquids to clean the equipment.

To avoid possible fire, do not use cleaning solvents in an area where a source of ignition may be present.

Discard used cleaning material in the appropriate containers.

SECTION 3. TROUBLESHOOTING



WARNING

Do not attempt any servicing or adjustments with the engine running. Use extreme caution while inspecting the drive belt assembly and all vehicle linkage!

Follow all safety procedures outlined in the vehicle owner's manual.

In many cases, problems with the EZT® are not related to a defective transaxle, but are caused by slipping drive belts, partially engaged bypass valves, and loose or damaged control linkages. Be sure to perform all operational checks and adjustments outlined in Section 4, Service and Maintenance, before assuming the pump is malfunctioning. Table 3 below provides a troubleshooting checklist to help determine the cause of operational problems.

Table 3. EZT Troubleshooting Checklist

Possible Cause	Corrective Action
UNIT OPERATES IN ONE DIRECTION ONLY	
Control linkage bent or out of adjustment Drive belt slipping or pulley damaged	Repair or replace linkage, Page 8 Repair or replace drive belt or pulley, Page 8
VEHICLE DOES NOT DRIVE/TRACK STRAIGHT	
Vehicle tires improperly inflated Control linkage bent or out of adjustment Bypass assembly sticking	Refer to vehicle manufacturer suggested pressure Repair or replace linkage, Pages 8 and 11 Repair or replace bypass, Page 20
UNIT IS NOISY	
Oil level low or contaminated oil Excessive loading Loose parts Bypass assembly sticking Air trapped in hydraulic system	Fill to proper level or change oil, Page 9 Reduce vehicle loading, Page 8 Repair or replace loose parts Repair or replace linkage Purge hydraulic system, Page 10
UNIT HAS NO/LOW POWER	
Engine speed low Control linkage bent or out of adjustment Drive belt slipping or pulley damaged Oil level low or contaminated oil Excessive loading Bypass assembly sticking Air trapped in hydraulic system	Adjust to correct setting Repair or replace linkage, Page 8 Repair or replace drive belt or pulley, Page 8 Fill to proper level or change oil, Page 9 Reduce vehicle loading, Page 8 Repair or replace linkage Purge hydraulic system, Page 10
UNIT IS OPERATING HOT	
Debris buildup around transaxle Cooling fan damaged Oil level low or contaminated oil Excessive loading Air trapped in hydraulic system	Clean off debris, Page 8 Repair or replace cooling fan Fill to proper level or change oil, Page 9 Reduce vehicle loading, Page 8 Purge hydraulic system, Page 10
TRANSAXLE LEAKS OIL	
Damaged seals, housing, or gaskets Air trapped in hydraulic system	Replace damaged component Purge hydraulic system, Page 10

SECTION 4. SERVICE AND MAINTENANCE

NOTE: Any servicing dealer attempting a warranty repair must have prior approval before conducting maintenance of a Hydro-Gear® product unless the servicing dealer is a current Authorized Hydro-Gear Service Center.

EXTERNAL MAINTENANCE

Regular external maintenance of the EZT® should include the following:

1. **Check the vehicle operator's manual for the recommended load ratings. Insure that the current application does not exceed load rating.**
2. Check oil level in accordance with Figure 4 Page 9.
3. Inspect the vehicle drive belt, idler pulley(s), and idler spring(s). Insure that no belt slippage can occur. Slippage can cause low input speed to the transmission.
4. Inspect the vehicle control linkage to the directional control arm on the transaxle. Also insure that the control arm is securely fastened to the trunnion arm of the transaxle.
5. Inspect the bypass mechanism on the transaxle and the vehicle linkage to insure that both actuate and release fully.

SERVICE AND MAINTENANCE PROCEDURES

Some of the service procedures presented on the following pages can be performed while the EZT is mounted on the vehicle. Any repair procedures as mentioned in the repair section of this manual must be performed after the unit has been removed from the vehicle.

FLUIDS

The fluids used in Hydro-Gear products have been carefully selected, and only equivalent, or better products should be substituted.

Typically, an engine oil with a minimum rating of 55 SUS (9.0 cSt) at 212° F (100° C) and an API classification of SL is recommended. A 20W50 engine oil has been selected for use by the factory and is recommended for normal operating procedures.

FLUID VOLUME AND LEVEL

Fluid volume information is provided in Table 4.

Certain situations may require additional fluid to be added or even replaced. Refer to Page 4 and Figure 4 for the proper fill port location.

Fill the EZT so the oil level is .75"-1.50" (19-38 mm) below the oil fill port.

Recheck the fluid level once the unit has been operated for approximately 1 minute.

Purging will be required. Refer to the purging procedures on Page 10.

FLUID CHANGE

FLUID CHANGE PROCEDURE

This transaxle is factory filled, sealed and does not require oil maintenance. However, in the event of oil contamination or degradation, oil addition or change may alleviate certain performance problems.

1. Remove the transaxle from the vehicle.
2. Clean the oil fill port area of any debris.
3. Remove the oil fill port fitting.
4. Position the transaxle so the oil will drain completely out of the housing.
5. Fill the transaxle at the oil fill port according to Figure 4.
6. Install the oil fill port fitting.
7. Purging will be required. Refer to the purging procedures on Page 10.
8. Recheck the fluid level once the unit has been operated for approximately 1 minute.

Table 4. Fluid Volumes for the EZT®

Fluid Description	Volume
20W50 engine oil	52.4 fl. oz. (1550 ml) to 55.8 fl. oz. (1650 ml)

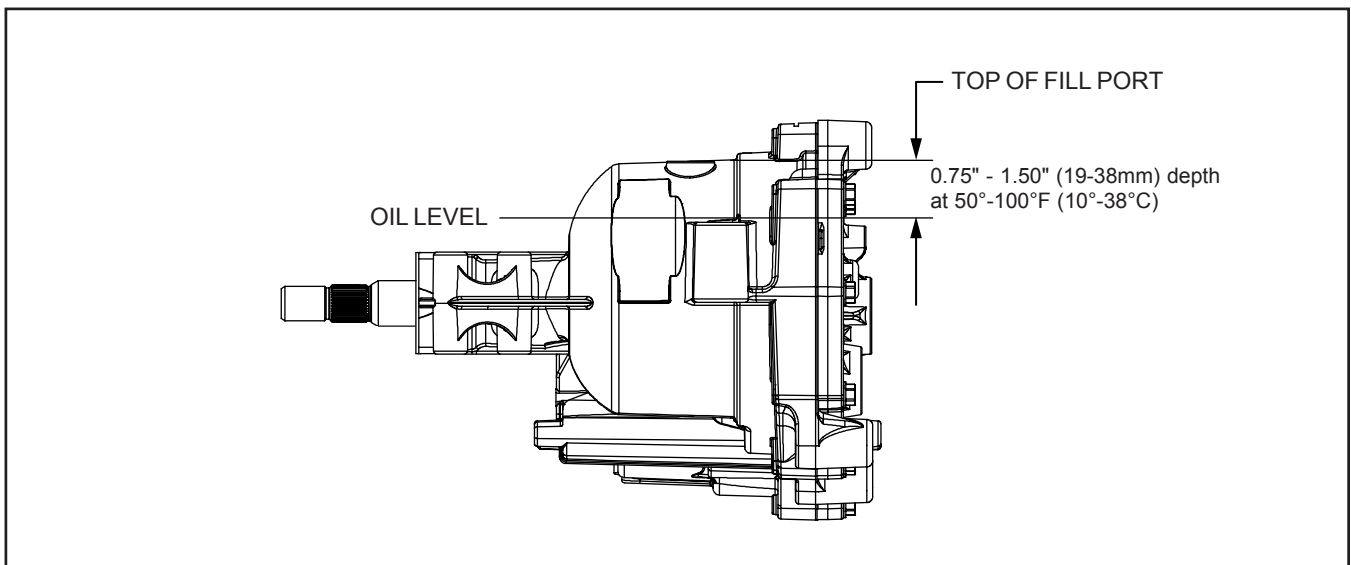


Figure 4. Fluid Level and Fill Port

PURGING PROCEDURES

Due to the effects air has on efficiency in hydrostatic drive applications, it is critical that it is purged from the system.

These purge procedures should be implemented any time a hydrostatic system has been opened to facilitate maintenance or any additional oil has been added to the system.

Air creates inefficiency because its compression and expansion rate is higher than that of the oil approved for use in hydrostatic drive systems.

The resulting symptoms in hydrostatic systems may be:

1. Noisy operation.
2. Lack of power or drive after short term operation.
3. High operation temperature and excessive expansion of oil.

Before starting, make sure the transaxle/transmission is at the proper oil level. If it is not, fill to the specifications outlined on Page 9, Figure 4.

The following procedures should be performed with the vehicle drive wheels off the ground, then repeated under normal operating conditions.

1. With the bypass valve open and the engine running, slowly move the directional control in both forward and reverse directions (5 or 6 times), as air is purged from the unit, the oil level will drop.
2. With the bypass valve closed and the engine running, slowly move the directional control in both forward and reverse directions (5 to 6 times). Check the oil level, and add oil as required after stopping the engine.
3. It may be necessary to repeat Steps 1 and 2 until all the air is completely purged from the system. When the transaxle moves forward and reverse at normal speed purging is complete.

RETURN TO NEUTRAL SETTING



WARNING

POTENTIAL FOR SERIOUS INJURY

Inattention to proper safety, operation, or maintenance procedures could result in personal injury, or damage to the equipment. Before servicing or repairing the EZT®, fully read and understand the safety precautions described in this section.



WARNING

Do not attempt any servicing or adjustments with the engine running. Use extreme caution while inspecting the drive belt assembly and all vehicle linkage!

Follow all safety procedures outlined in the vehicle owner's manual.

The return to neutral mechanism on the transmission is designed to set the directional control into a neutral position when the operator releases the vehicle hand control. Follow the procedures below to properly adjust the return to neutral mechanism on the transaxle:

1. Confirm the transaxle is in the operating mode (bypass disengaged). Raise the vehicle's drive tires off the ground to allow free rotation.

NOTE: It may be necessary to remove the drive tire from the axle hub to access the linkage control and the transaxle return arm.

2. Remove the Original Equipment Manufacturer's (OEM's) control linkage at the control arm. Refer to Figure 5.

3. Start the engine and increase the throttle to full engine speed.

4. Check for axle rotation. If the axle does not rotate, go to Step 5. If the axle rotates, go to Step 6.

5. Stop the vehicle's engine. Reattach and adjust the OEM linkage according to Step 3 and Step 4. Stop the vehicle engine. Refer to Figure 5.

6. Note the axle directional movement. Stop the vehicle engine. Loosen the RTN adjustment screw until the control arm can be rotated. Rotate the control arm in the opposite direction of the wheel rotation in 5 degree increments. Tighten the RTN adjustment screw. Refer to table 6. Required Torque values, page 14. Recheck according to steps 3 and 4. Stop the vehicle engine. Reattach and adjust the OEM linkage according to the OEM manual. Recheck according to steps 3 and 4. Refer to Figure 5.

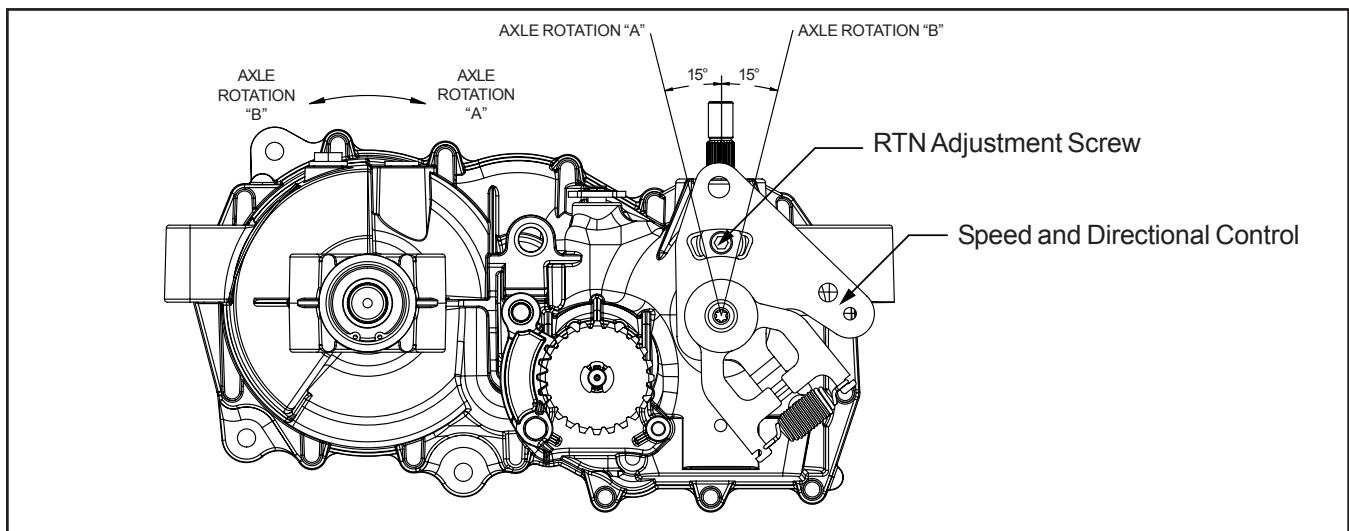


Figure 5. Return to Neutral Setting

NOTES

SECTION 5. REPAIR

HOW TO USE THIS MANUAL

Each subassembly illustrated in this section is illustrated with an exploded view showing the parts involved. The **item reference numbers in each illustration are for assembly instructions only**. See page 29 for part names and descriptions. A complete exploded view and item list of the transaxle is provided at the end of the repair section.

GENERAL INSTRUCTIONS

Cleanliness is a primary means of assuring satisfactory life on repaired units. Thoroughly clean all exposed surfaces prior to any type of maintenance. Cleaning of all parts by using a solvent wash and air drying is usually adequate. As with any precision equipment, all parts must be kept free of foreign material and chemicals.

Protect all exposed sealing surfaces and open cavities from damage and foreign material. The external surfaces should be cleaned before beginning any repairs.

Upon removal, it is recommended that all seals, O-rings, and gaskets be replaced. During installation lightly lubricate all seals, O-rings and gaskets with a clean petroleum jelly prior to assembly. Also protect the inner diameter of seals by covering the shaft with a cellophane (plastic wrap, etc.) material.

Parts requiring replacement must be replaced from the appropriate kits identified in the Items Listing, found at the end of this manual. Use only original Hydro-Gear® replacement parts found in BLN-51427 (CD).

IMPORTANT: When internal repair is performed on the EZT®, the filter assembly must be replaced.

TRANSAXLE REMOVAL

It is necessary to remove the EZT from the vehicle before performing the repair procedures presented in this section.

LIMITED DISASSEMBLY

The following procedures are presented in the order in which they must be performed to completely disassemble the unit. Do not disassemble the unit any farther than is necessary to accomplish the required repairs. Each disassembly procedure is followed by a corresponding assembly procedure.

Reassembly is accomplished by performing the "Assembly" portions of the procedures. If the unit has been completely disassembled, a summary of the assembly procedures, in the order in which they should occur, is given on page 24.

TOOLS AND TORQUES

Table 5. Required Tools

Miscellaneous	Sockets
EZT® Service & Repair Manual	1/2"-3/8" Adapter
Flat Blade Screw Driver (2)	3/8" Deep
Torque Wrench	1/2" Deep
Air Impact Wrench	7/16" Deep
Rubber Mallet	9/16" Deep
Breaker Bar	3/4" Deep
Side Cutters/Snips	13/16" Deep
Pliers	7/8"
Needle Nose	T-25 Torx Head
Large External Snap Ring	T-40 Torx Head
Small Internal Snap Ring	Apex AN-08

Table 6. Required Torque Values

Operation	Torque	Item	Description
Side Housing Screws	105-155 lb-in [12-17 Nm]	9	Screw 1/4-20 x 1.25
Control Arm Screw	230-310 lb-in [26-35 Nm]	25	Screw 5/16-24 x 1
Control Arm Stop Stud	50-120 lb-in [6-18 Nm]	21	Stud 5/16-24
Center Section Bolts	525-700 lb-in [60-80 Nm]	12	Screw 3/8-24 x 2.5
Check Plugs	280-400 lb-in [32-45 Nm]	56	Check Plug Assembly
Expansion Plate Screws	25-50 lb-in [3-6 Nm]	53	Screw 10-32 x 0.50
Fan/Pulley Lock Nut	360-520 lb-in [41-59 Nm]	122	Lock Nut 1/2 x 20
Cog Brake Bolt	80-120 lb-in [9-14 Nm]	55	Bolt 1/4-20 x 1
RTN Adjustment Screw	200-240 lb-in [23-27 Nm]	131	Screw 5/16-24 x 1.00
Hub Nut	180-200 lb-ft [244-271 Nm]	99	Nut, Hex 3/4-16 Lock
Stop Stud Nut	85-120 lb-in [10-14 Nm]	26	Nut, Lock 5/16-24 UNF

CONTROL ARM AND BYPASS ARM

Refer to Figure 6.

Disassembly

1. Loosen and remove the lock nut (26) and flat washer (24). Discard the lock nut (26) and flat washer (24).
2. Remove the torx head screw (25) from the directional control.
3. Remove control arm (23) and pucks (22). Discard the pucks.
4. Remove the bypass arm retaining ring (18) and bypass arm (17). Discard the retaining ring.
5. If necessary, remove and replace the control arm stop stud (21).

Inspection

1. Inspect the control arm stop stud (21) for wear or damage.
2. Inspect the control arm (23) for wear or damage.
3. Inspect the bypass arm (17) for wear or damage.

Assembly

1. Install the bypass arm (17) onto the bypass rod. Secure the bypass arm with a new retaining ring (18).
2. Replace the control arm stop stud (21) if removed. Torque according to specifications in Table 6 on page 14.
3. Install the control arm (23).
4. Install the control arm screw (25). Refer to Table 6 for screw torque specifications.

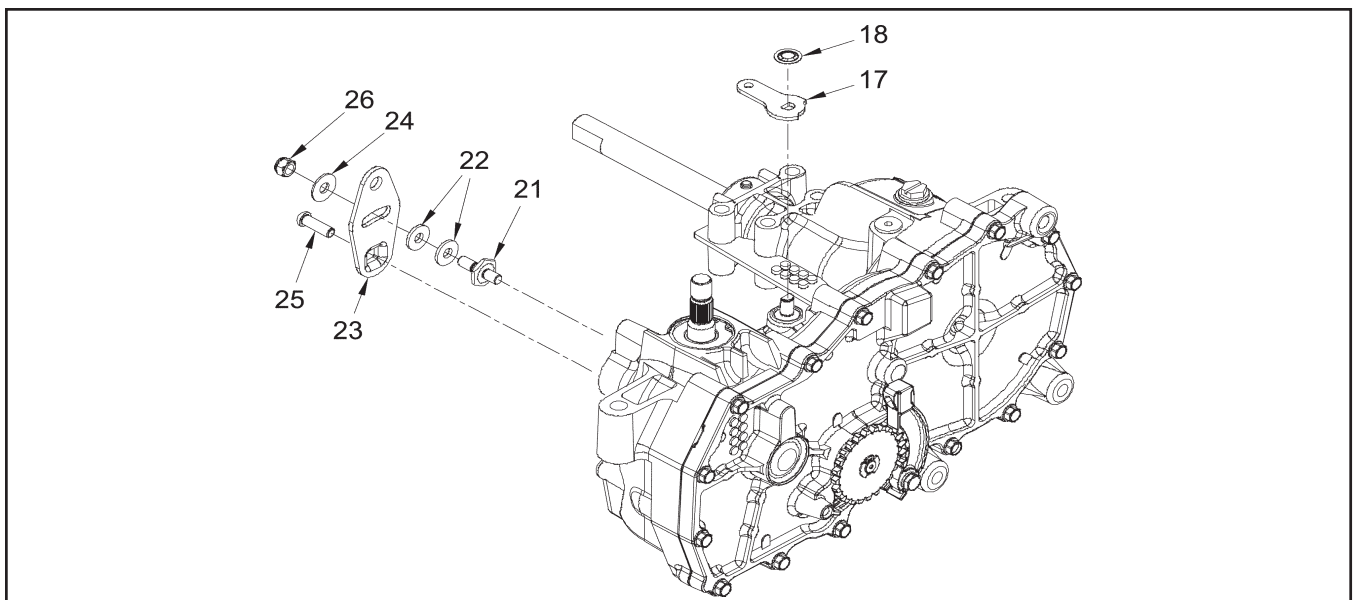


Figure 6. Control Arm and Bypass Arm

SEAL KIT REPLACEMENT

Before disassembly, wipe the unit free of any debris to avoid contamination.

Refer to Figure 7.

Input Seal

1. Remove the input pulley from the input shaft.
2. Remove the seal retaining ring (34).
3. Carefully pull the input seal (33) out of the housing bore with a “hook” type tool. Care must be taken to avoid damage to the housing bore or shaft sealing area.
4. Lubricate the new seal with petroleum jelly prior to installation.
5. Wrap the shaft keyway (splines) with cellophane to prevent damage to the seal lip during installation.
6. Slide the seal over the shaft and press it into the housing bore.
7. The seal should seat against the spacer.
8. Install the seal retaining ring (34) and make sure it is fully seated in its groove.

Output Seal

1. The seal (51) can be replaced by following steps 2-6 of the procedure used to replace the input seal.
2. Install the retaining ring (34) and make sure it is fully seated in its groove.

Motor Shaft Seal

1. Remove the cog brake. See page 17.
2. The seal (10) can be replaced by following steps 3-6 of the procedure used to replace the input shaft.

Trunnion Seal

1. Remove the control arm and any attachments to the control arm. See page 15.
2. The seal (20) can be replaced by following steps 3-6 of the procedure used to replace the input shaft.

Bypass Seal

1. Remove the bypass arm and any attachments to the bypass arm. See page 15.
2. Remove the seal retaining ring (16). Remove the bypass rod, keeping the retaining ring (14) attached. Remove the bypass rod seal (13). Deburr the bypass rod.
3. Install the seal (13). Install the bypass rod with the retaining ring (14) attached. Install the seal retaining ring (16).

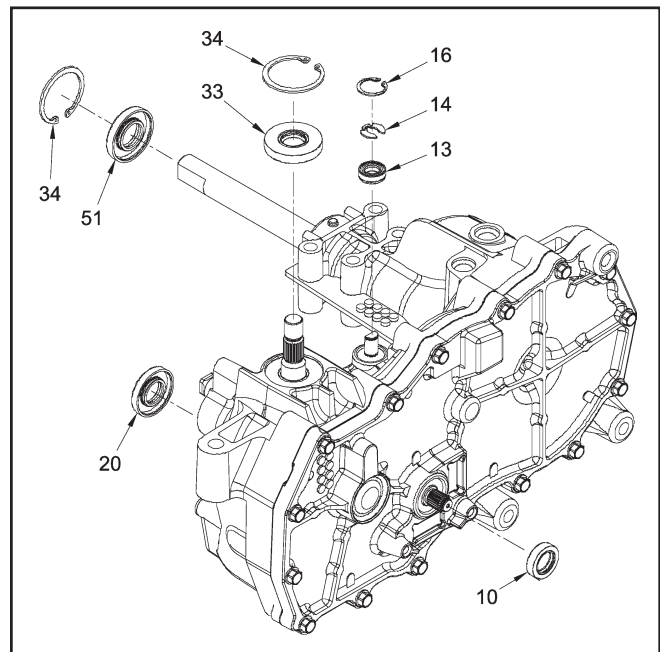


Figure 7. Seal Kit Replacement

COG BRAKE AND SIDE HOUSING

Refer to Figure 8.

Disassembly

1. Remove the control arm and bypass arm. See page 15.
2. Remove the oil from the transaxle. See page 9.
3. Remove the brake arm assembly (55), retaining ring (14) and cog brake disc (100).
4. Remove the lip seal (10).
5. Remove the housing screws (9).
6. Pull the side housing (2), leaving the axle (49) and bull gear (46) assembled in the main housing. It may be necessary to use screwdrivers at the pry points to break loose the sealant (positions H-L and M-P, Figure 8).
7. Clean off all the old sealant on the side and main housings. Take care not to damage the sealing surfaces. A wire brush and solvent is effective.

Inspection

1. Check the brake arm brake disc for excessive wear or teeth damage. Replace if necessary.

2. Check for excessive looseness at the arm pivot point.
3. Inspect the bearing and bushing areas in the side housing.

Assembly

1. Apply a bead of sealant around the perimeter of the side housing face. See sealant pattern on page 27.
2. Install the locating pins (8), if not already installed.
3. Install the side housing (2). Use care not to smear the sealant bead.
4. Install the side housing screws (9). Refer to the screw tightening pattern in Figure 8 and torque specification in Table 6 on page 14.
5. Install the remaining seals. Refer to page 16. Remember to use a seal protector during installation.
6. Install the brake disc (100), retaining ring (14) and brake arm assembly (55).
7. Fill the transaxle with new oil. See page 9.
8. Install the bypass arm and control arm. See page 15.

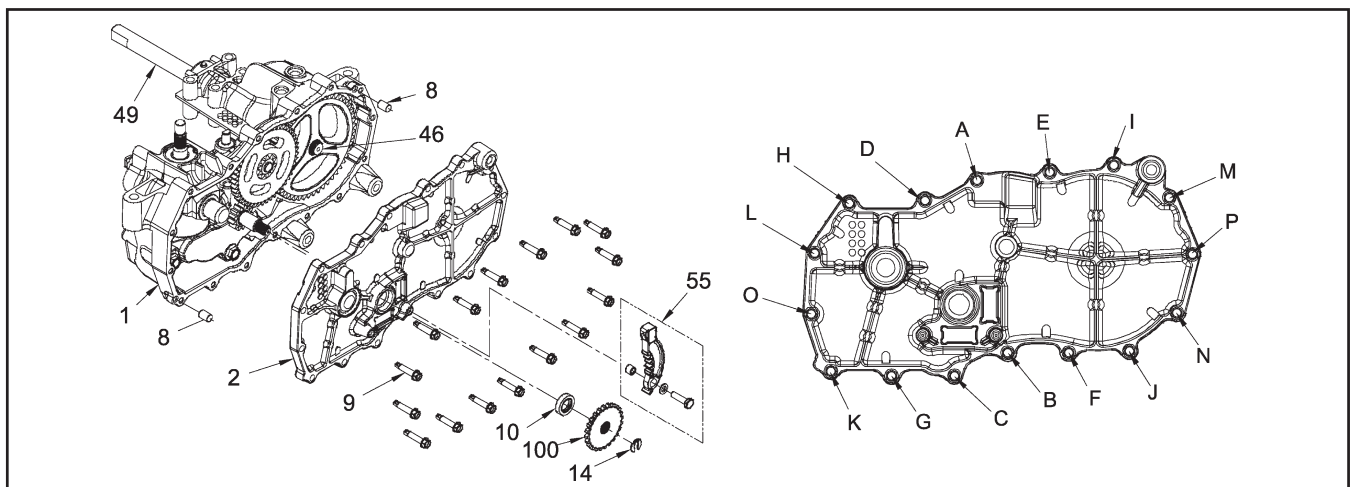


Figure 8. Cog Brake and Side Housing Assembly

AXLE SHAFT, REDUCTION GEARS AND EXPANSION PLATE

Refer to Figure 9.

Disassembly

1. Remove the bypass arm and control arm. See page 15.
2. Remove oil from the transaxle. See page 9.
3. Remove the side housing. See page 17.
4. Remove the spiral retaining ring (45), bull gear (46), inboard sleeve bearing (48) and washer (47).
5. Remove the reduction gears (42 & 43), jack shaft pin (44) and washers (41).
6. Remove seal retaining ring (34), seal (51), axle (49) and bushing (50).
7. If necessary, remove the expansion plate assembly (53).

NOTE: Expansion plate removal will typically destroy the plate. Clean all sealant from the expansion plate area.

Inspection

1. Inspect the bull gear for wear or damage.
2. Inspect the reduction gears, jack shaft pin and washers.

3. Inspect the axle shaft, bearing and bushing.
4. Inspect the expansion plate.

Assembly

1. Apply a small bead of sealant to the expansion plate area of the housing. See page 27. Install the expansion plate (53). Torque the screws according to Table 6.
2. Reassemble and install the reduction gears (42 & 43), jack shaft pin (44) and washers (41).
3. Install the bull gear (46), retaining ring (45), bearing (48) and washer (47) onto the axle (49).
4. Install the axle (49) and bushing (50) into the housing (1).
5. Install the axle seal (51) and retaining ring (34).
6. Install the side housing. See page 17.
7. Install all remaining seals. See page 16.
8. Fill the transaxle with oil. See page 9.
9. Install the bypass arm and control arm. See page 15.

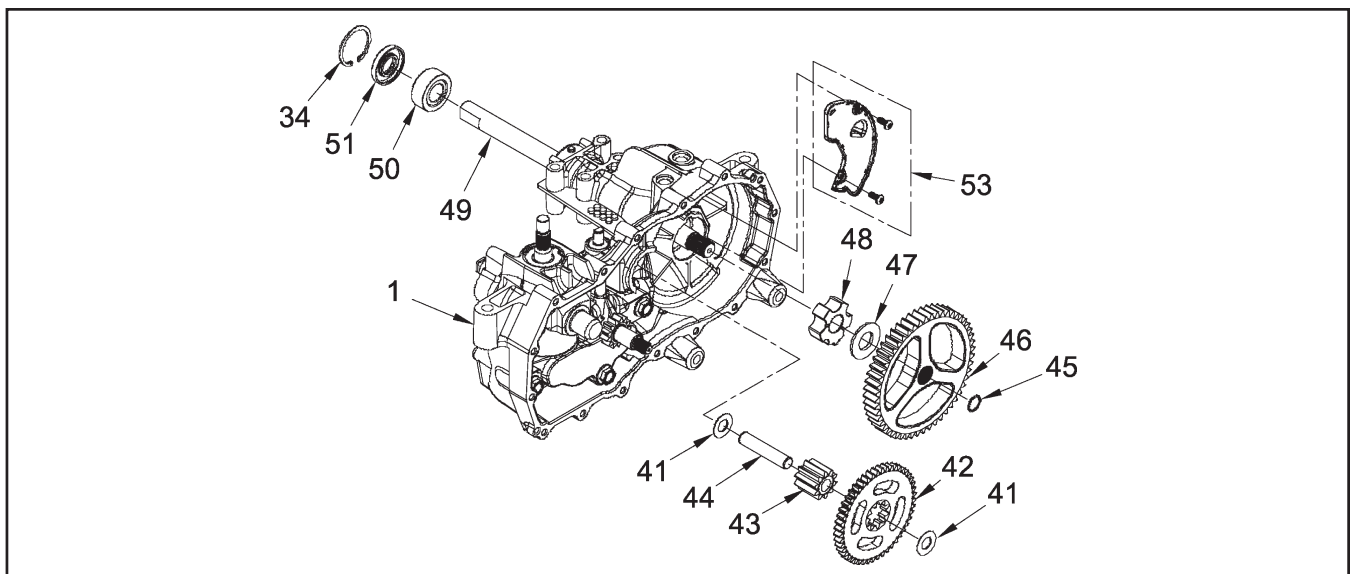


Figure 9. Axle Shaft, Reduction Gears and Expansion Plate

MOTOR SHAFT

Refer to Figure 10.

Disassembly

1. Remove the control arm and bypass arm. See page 15.
2. Drain the oil from the transaxle. See page 9.
3. Remove the side housing. See page 17.
4. Remove the reduction gears. See page 18.
5. Remove flat washer (36), motor shaft and pinion gear (39 & 38) and flat washer (40).

Inspection

1. Inspect the motor shaft (39), pinion gear (38) and flat washers (36 & 40) for wear or damage.

Assembly

1. Insert the motor shaft (39) with the pinion gear (38) and flat washers (36 & 40) into the center section (57).
2. Install the reduction gears. See page 18.
3. Install the side housing. Refer to page 17.
4. Install new seals. Refer to page 16.
5. Fill the transaxle with oil. See page 9.
6. Install the bypass arm and control arm. See page 15.

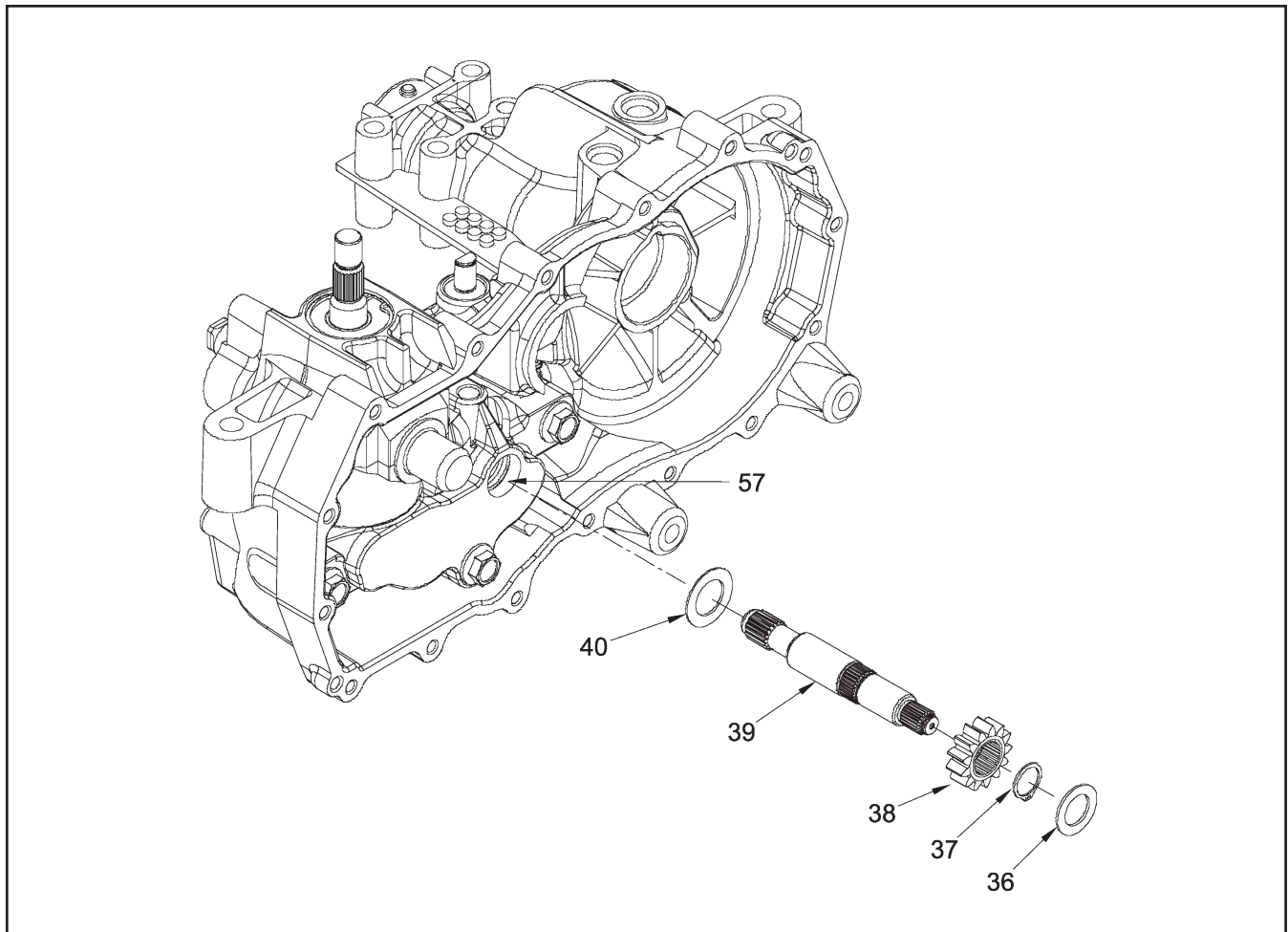


Figure 10. Motor Shaft

INPUT SHAFT AND BYPASS ROD

Refer to Figure 11.

Disassembly

1. Remove the control arm and bypass arm. See page 15.
2. Drain the oil from the transaxle. See page 9.
3. Remove the side housing. See page 17.
4. Remove the reduction gears. See page 18.
5. Remove the motor shaft. See page 17.
6. Remove the retaining ring (34) and shaft seal (33). Discard the seal.
7. Remove the spacer (32) and input shaft assembly (29, 30 & 31).
8. Remove the compression spring (27) and washer (28).
9. Remove the rings (14 & 16), bypass rod (15) and seal (13).

Inspection

1. Inspect the input shaft components and bypass rod for wear or damage.

Assembly

1. Visually ensure that the pump block is aligned concentrically with the center section running face.
2. Install the compression spring (27) and washer (28).
3. Insert the input shaft (29), with bearing (30) and retaining ring (31), into the pump block assembly. NOTE: Do not force the shaft and bearing as damage may occur. If alignment is correct, the shaft assembly will fit into place.
4. Install the washer (32), seal (33) and retaining ring (34). Use a seal protector when installing the input shaft seal.

5. Deburr the end of the bypass rod. Install the bypass rod (15), retaining ring (14), seal (13) and retaining ring (16).
6. Install the motor shaft. See page 19.
7. Install the reduction gears. See page 18.
8. Install the side housing. See page 17.
9. Install new seals in the side housing. See page 16.
10. Fill the transaxle with oil. See page 9.
11. Install the bypass arm and control arm. See page 15.

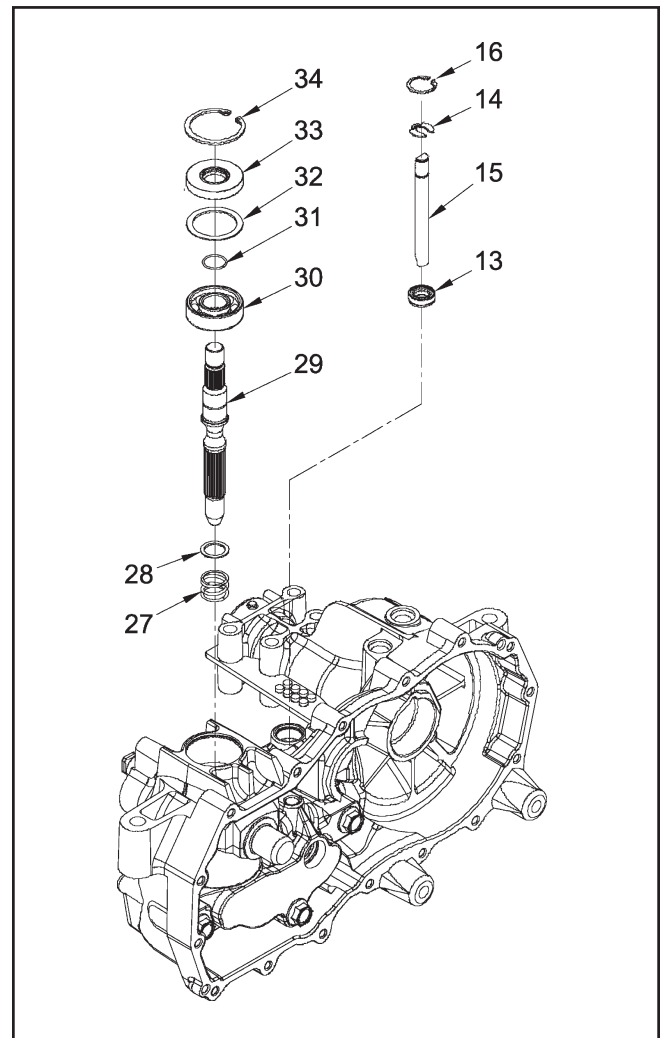


Figure 11. Input Shaft and Bypass Rod Assembly

HYDRAULIC COMPONENTS

Refer to Figures 12-21.

Disassembly

1. Remove the bypass arm and control arm. See page 15.
2. Drain the oil from the transaxle. See page 9.
3. Remove the side housing. See page 17.
4. Remove the reduction gears. See page 18.
5. Remove the motor shaft. See page 19.
6. Remove the input shaft and bypass rod. See page 20.
7. **(See Figure 12)** Remove the swashplate (19) and pump cylinder block (4) as one assembly. NOTE: Removal will be aided by applying a small amount of pressure on the trunnion mounted swashplate towards the center section. Also note that the control arm (23, page 28) may be loosely assembled at this point to assist in swashplate removal. While gently removing the swashplate and block assembly, keep the block face flush with the center section to minimize damage to the running surface.
8. **(See Figure 13)** Disassemble the pump cylinder block (4) from the swashplate (19).
9. **(See Figure 14)** Check each piston for proper operation by pressing the pistons in and releasing them in the block bore. Disassemble the pump cylinder block. Check for piston/block wear in the cylinder bore. Inspect the pistons (A), piston springs (C) and thrust washers (B) for excessive wear or damage. NOTE: Thrust washers may be held in place in the piston by residual oil.
10. Reassemble the pistons, springs and washers into the cylinder block and set aside.
11. **(See Figure 15)** Remove the thrust bearing assembly (35) from the swashplate (19).

(Center Section/Filter)

12. **(See Figure 16)** Remove the center section mounting screws (12). NOTE: The center section is under motor block piston spring pressure. These screws are factory installed to 700 lb-in (80 Nm) and use an anaerobic thread adhesive. A breaker bar will be required at this step. Clean the internal threads of the mounting holes with compressed air.
13. Remove the center section and filter assembly (57, Figure 17). NOTE: Bypass plate (Figure 17) may slide out of the center section.
14. Remove the filter cover by pressing in and down on the filter cover tabs. Discard the cover.
15. Note the location of both check plugs (56) before removal for correct replacement during reassembly. Remove and inspect the check plug assemblies (56) for debris or damage.
16. Remove the filter base (61) and discard it. NOTE: The filter base is included in the filter kit to be installed during reassembly of the unit.

(Motor Block)

17. **(See Figure 19)** Remove the motor cylinder block assembly (4) from the housing (1).
18. Disassemble the motor cylinder block assembly (4). Check each piston for proper operation by pressing the pistons in and releasing them in the block bore. Disassemble the motor cylinder block. Check for piston/block wear in the cylinder bore. Inspect the pistons, piston springs and thrust washers for excessive wear or damage. NOTE: Thrust washers may be held in place in the piston by residual oil.
19. Reassemble the pistons, springs and thrust washers into the cylinder block and set aside.

20. Remove the thrust bearing assembly (35) from the housing (1). Inspect the thrust bearing and thrust bearing cavity in the housing.

Inspection

1. Inspect the pump cylinder block running surface for wear or damage.
2. Inspect the swashplate and thrust bearing assemblies for wear or damage.
3. Inspect the center section block running surfaces. NOTE: These “sealing” surfaces should be smooth in appearance without scratches, scoring, nicks or abrasions. Drag a fingernail across the surface to detect uneven wear or scratches which may not be visible.
4. Inspect the threaded check plug ports of the center section for debris or damage.
5. Inspect the motor cylinder block running surface for damage and wear.
6. Inspect all bearing, bushing and wear areas in the housing.

Assembly

(Motor Block)

1. **(See Figure 19)** Turn the housing (1) so the motor thrust bearing cavity is facing up. This will assist in the installation of the motor thrust bearing assembly (35) keeping it in the bearing cavity during installation of the center section assembly (57, Figure 17).
2. Insert the thrust bearing (35) in the housing (1). NOTE: Place the thin race of the bearing towards the housing bearing cavity. The thick race must face the pistons.

(Center Section/Filter)

3. **(See Figure 18)** Install the new filter base (61) onto the center section (57).
4. It will be necessary to clean the check plugs prior to re-assembly. Install the check plugs (56), in their correct location, into the center section (57). Tighten the check plugs according to Table 6.
5. Align the tabs on the filter cover with the slots in the filter base and carefully press the cover onto the base until the tabs snap into place. Insure the bypass plate (Figure 18) is located properly in the center section.
6. **(See Figures 10 & 20)** Install the motor shaft (39), pinion gear (38) and flat washers (36 & 40) into the center section (57).
7. Assemble the motor block assembly (4) onto the motor shaft (39).
8. **(See Figure 20)** Install the motor shaft, center section and motor block assembly into the housing so that the motor block pistons contact the thrust bearing race. NOTE: Hold in place and insure all pistons are still positioned correctly in the cylinder bore by confirming spring bias against the center section.
9. **(See Figure 16)** After applying thread adhesive, insert the center section mounting screws (12) while holding downward pressure on the center section assembly (57, Figure 20).
10. Tighten the center section mounting screws (12) to the proper torque. Refer to Table 6. NOTE: The center section must be fully seated into the pilot bore before the screws are tightened. The center section will not self

locate.

(Swashplate/Pump Block)

11. **(See Figure 15)** Install the pump thrust bearing (35) in the trunnion machined swashplate (19). NOTE: Place the thin race of the bearing towards the swashplate. The thick race must face the pistons.
12. **(See Figure 13)** Place the pump block assembly (4), pistons down, on top of the thrust bearing in the swashplate (19).
13. Coat the pump running surface with clean motor oil.
14. *Care must be taken to prevent the scaring or scratching of the center section sealing face during this step.* Insert the shaft of the swashplate/pump block assembly (Figure 21) into the housing while simultaneously compressing the pistons in the block. NOTE: To assist in the installation of these components, insert the assembly until 3/4 of the pump block is covered by the center section. Then slightly press the shaft end toward the center section while pushing the shaft into its bore.
15. Install the input shaft and bypass rod. See page 20.
16. Install the axle shaft, reduction gears and expansion plate, if removed. Refer to page 18.
17. Install the side housing and brake. See page 17.
18. Fill the transaxle with new oil. See page 9.
19. Install the bypass arm and control arm. See page 15.

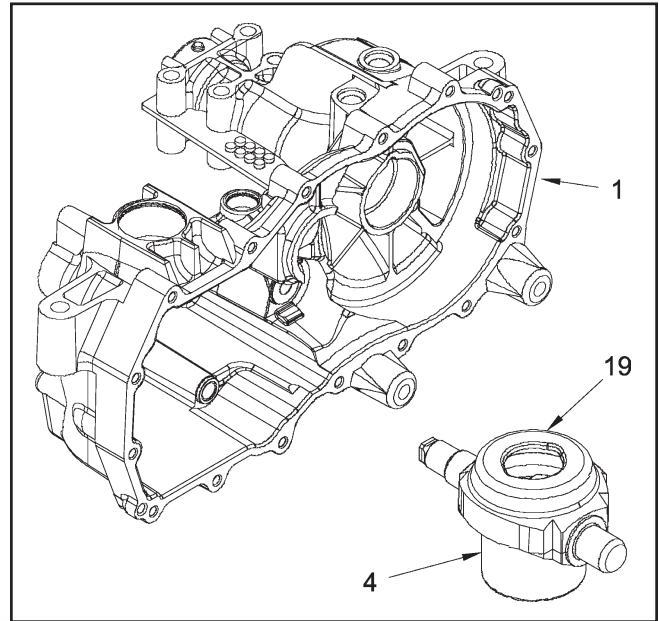


Figure 12.

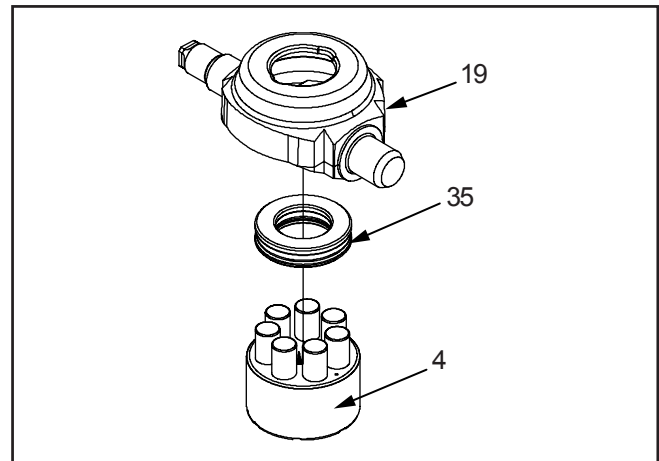


Figure 13.

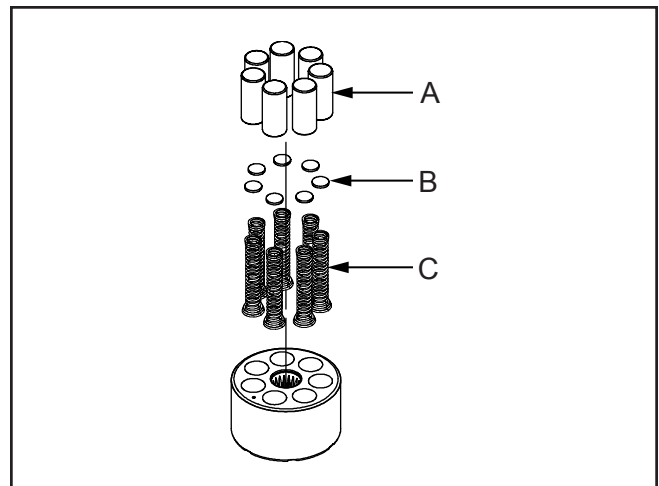


Figure 14.

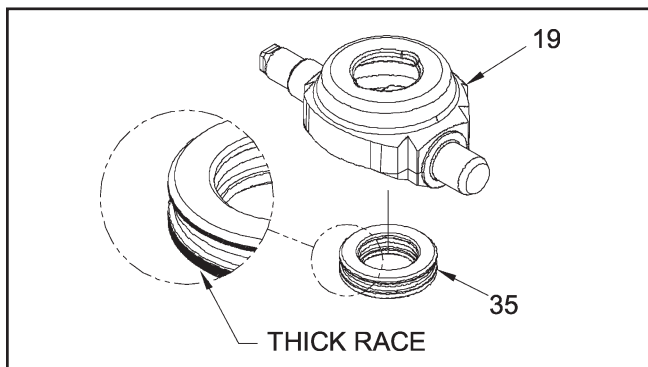


Figure 15.

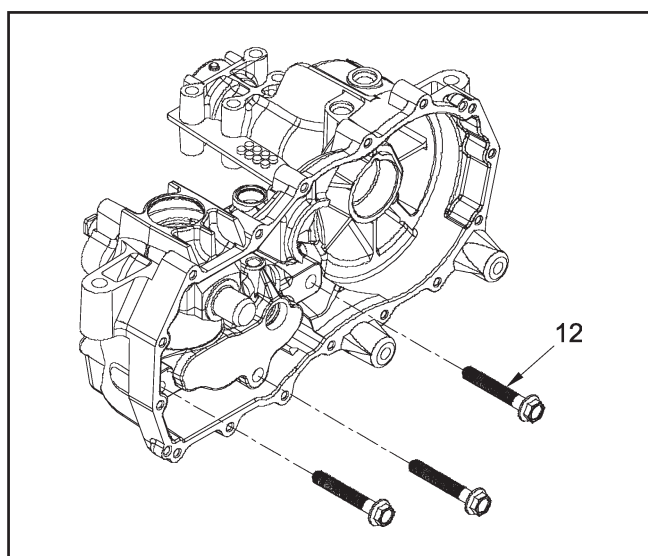


Figure 16.

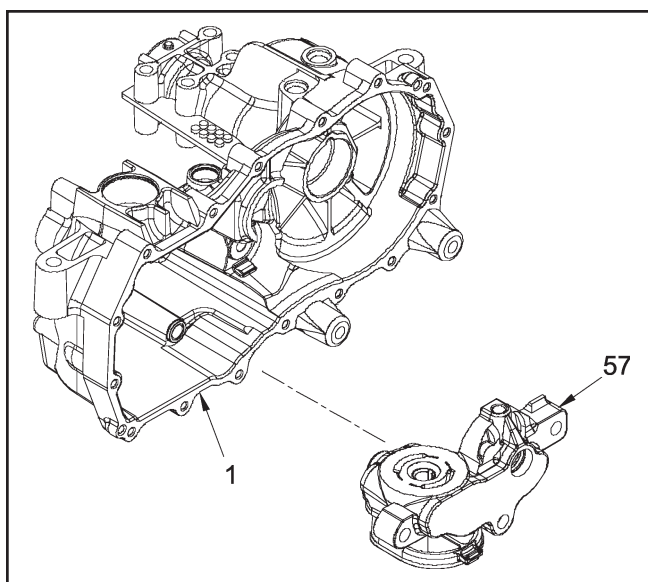


Figure 17.

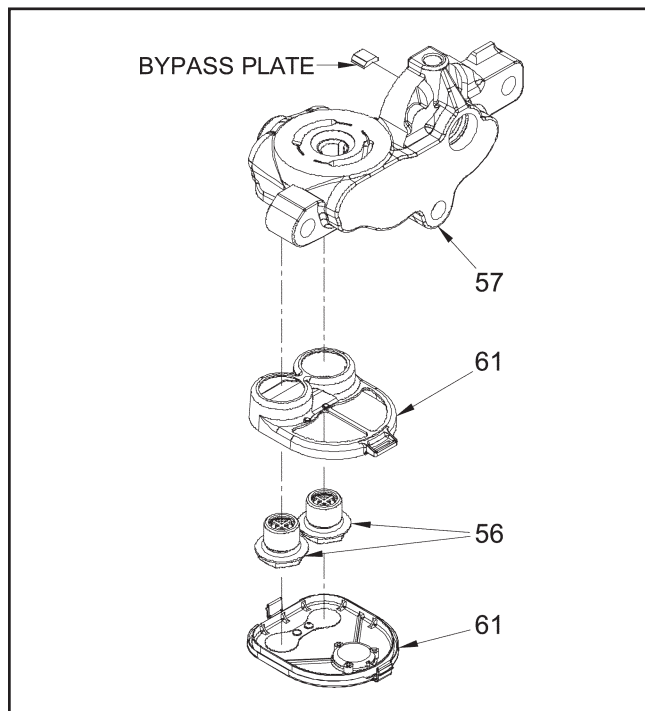


Figure 18.

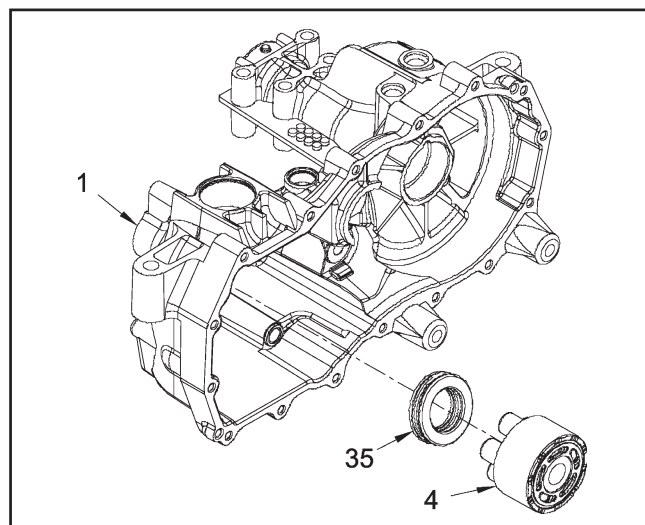


Figure 19.

TRANSAXLE INSTALLATION

Use the following procedure to complete the installation of the transaxle on the vehicle.

1. Install and secure the transaxle on the vehicle according to the instructions in the vehicle owner's manual.
2. With the vehicle raised, install the wheels on the axles, and snug the wheel hardware.
3. Lower the vehicle wheels to the ground and torque the wheel hardware per the vehicle owner's manual.

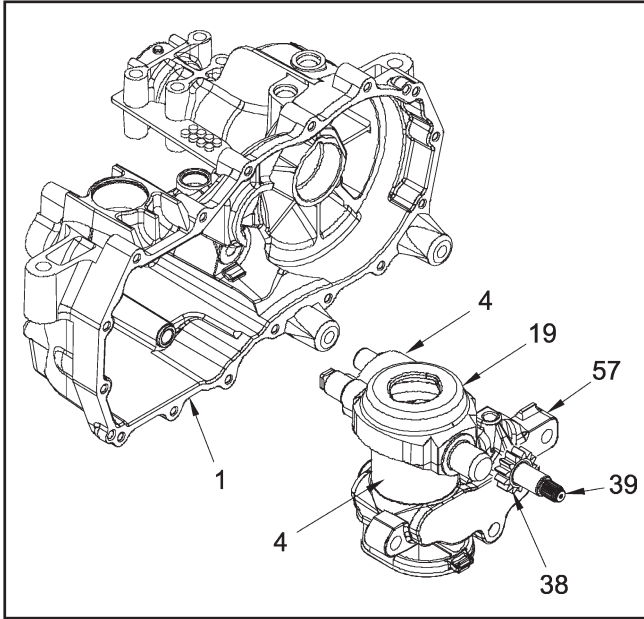


Figure 20.

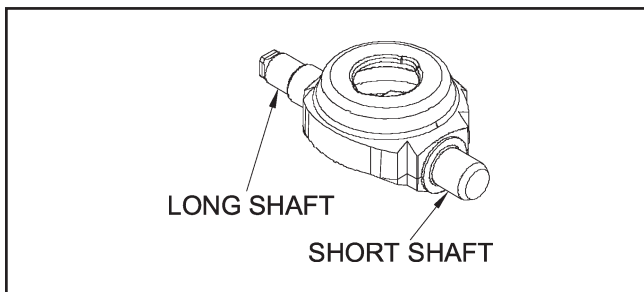


Figure 21.

ASSEMBLY AFTER A COMPLETE TEARDOWN

If the unit has been torn down completely, the following summary identifies the assembly procedures necessary to completely assemble the unit. Each assembly procedure is located by a page reference.

The part reference numbers provided in each assembly procedure are keyed to the individual exploded views, and are also keyed to the complete unit exploded view on page 26.

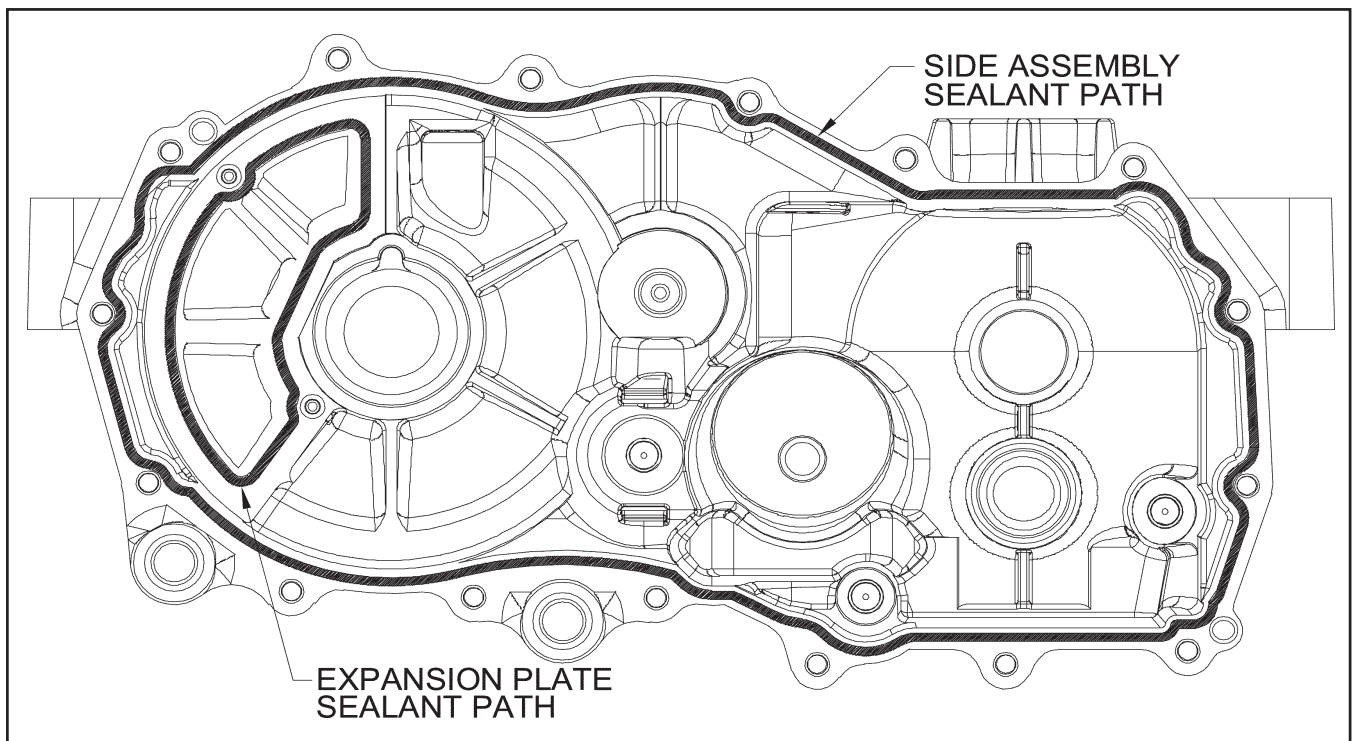
1. Install the hydraulic components. See pages 21-25.
2. Install the input shaft and bypass rod. See page 20.
3. Install the axle shaft, reduction gears and expansion plate. See page 18.
4. Install the cog brake and side housing. See page 17.
5. Fill the transaxle with new oil. See page 9.
6. Install the bypass arm and control arm. See page 15.
7. Install the transaxle onto the vehicle.
8. Perform the purge procedures listed on page 10.

SEALANT APPLICATION

NOTE: Prior to applying the new sealant, the old sealant must be removed from all surfaces.

A small consistent bead of the sealant around the housing face will be sufficient. Use sparingly.

The illustration below indicates the correct areas.



EZT® EXPLODED VIEW

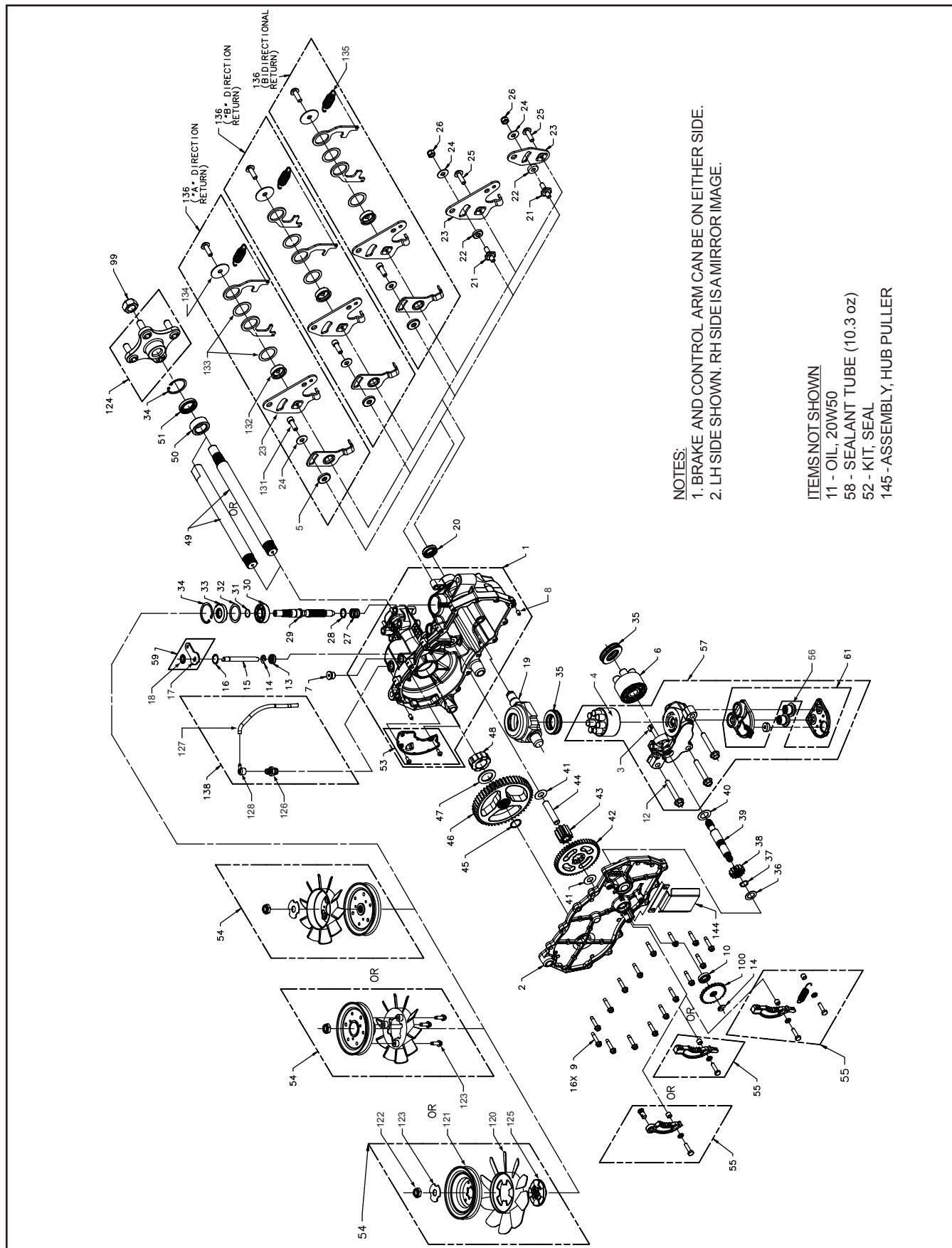


Figure 22. EZT®

EZT® ITEMS LIST

No.	DESCRIPTION
1	ASSEMBLY, MAIN HOUSING
	HOUSING, MAIN
	BUSHING
	PLATE, EXPANSION
	SCREW, 10-32 X 1/2 (SELF TAPPING)
	PIN, STANDARD, HEADLESS
	SEAL, LIP
2	ASSEMBLY, SIDE
	HOUSING, SIDE
	BUSHING
	BUSHING
3	PLATE, BYPASS
4	ASSEMBLY, PUMP BLOCK
	BLOCK, CYLINDER
	PISTON
	SPRING, COMPRESSION
	WASHER, THRUST
5	SPACER
6	ASSEMBLY, MOTOR BLOCK
7	PLUG, 9/16-18
8	PIN, STAINLESS, HEADLESS
9	HFHCS 1/4-20 X 1.25 (SELF-TAPPING)
10	SEAL, LIP
12	BOLT, HEX FLANGE 3/8-24 X 2.5
13	SEAL, LIP
14	RING, RETAINING
15	ROD, BYPASS
16	RING, RETAINING
17	ARM, BYPASS
18	RING, RETAINING (PUSHNUT)
19	SWASHPLATE, TRUNNION, MACHINED
20	SEAL, LIP
21	STUD
22	WASHER
23	ARM, CONTROL
24	WASHER, FLAT
25	TWHCS 5/16-24 X 1.0
26	NUT, HEX LOCK 5/16-24 UNJF
27	SPRING-HELICAL COMPRESSION
28	WASHER
29	SHAFT, INPUT
30	BEARING, BALL
31	RING, RETAINING WIRE
32	SPACER
33	SEAL, LIP
34	RING, RETAINING
35	BEARING, THRUST
36	WASHER, FLAT
37	RING, RETAINING
38	GEAR, PINION, 13T
39	SHAFT, MOTOR
40	WASHER, MOTOR SHAFT
41	WASHER, HT
42	GEAR, 10T/48T
43	GEAR, 10T JACKSHAFT
44	PIN, JACKSHAFT
45	RING, SPIRAL RETAINING
46	GEAR, 52T BULL

No.	DESCRIPTION
47	WASHER
48	BEARING, SLEEVE (INBOARD)
49	AXLE
50	BUSHING
51	SEAL, LIP
52	KIT, SEAL
53	KIT, EXPANSION PLATE
	PLATE EXPANSION
	SCREW, 10-32 X 1/2 (SELF-TAPPING)
54	KIT, FAN-PULLEY
55	KIT, BRAKE ARM
	ARM, PARKING BRAKE
	WASHER
	BOLT, 1/4-20 X 1 W/PATCH
	BUSHING
	PIN, CLEVIS
56	CHECK PLUGS
57	KIT, CENTER SECTION-FILTER
	CENTER SECTION, MACHINED
	BUSHING
	PLATE, BYPASS
	BOLT, HEX FLANGE 3/8-24 X 2.5
	FILTER, BASE
	CHECK PLUG ASSEMBLY
	ASSEMBLY, COVER
	ASSEMBLY, PUMP BLOCK
59	KIT, BYPASS ARM
	ARM, BYPASS
	RING, RETAINING (PUSHNUT)
61	KIT, FILTER
	FILTER, BASE
	ASSEMBLY, COVER
	MAGNET, RING
99	NUT, HEX 3/4-16 LOCK
100	DISC, COG BRAKE
120	FAN
121	PULLEY
122	HEX LOCK NUT, 1/2-20 (NYLON INSERT)
123	WASHER, OD SLOTTED
	HEX WASHER HEAD TAPPING SCREW 1/4-20 X .25
124	ASSEMBLY, HUB
125	HUB, PULLEY
126	ASSEMBLY, FITTING, 7/16 VENT W/ O-RING
127	HOSE, EXPANSION TANK
128	CAP, BARBED VENT
131	SHCS, 5/16-24 X 1.00 (PATCH)
132	BUSHING, PILOT
133	WASHER, PLASTIC
134	WASHER
135	SPRING, EXTENSION
136	KIT, RTN ASSEMBLY
138	KIT, BREATHER ASSEMBLY
144	DEFLECTOR, BELT

GLOSSARY OF TERMS

Axial Piston: Type of design for hydraulic motors and pumps in which the pistons are arranged parallel with the spindle (input or output shaft).

Bantam Duty: A descriptive term relating to the product capacity (meaning: light duty).

Bypass Valve: A valve whose primary function is to open a path for the fluid to bypass the motor or pump. Also referred to occasionally as the freewheel valve or dump valve.

Case Drain Line (Return Line): A line returning fluid from the component housing to the reservoir.

Cavitation: A concentrated gaseous condition within the fluid causing the rapid implosion of a gaseous bubble.

Center Section: A device which acts as the valve body and manifold of the transmission.

Charge Pump: A device which supplies replenishing fluid to the fluid power system (closed loop).

Charge Pressure: The pressure at which replenishing fluid is forced into a fluid power system.

Charge Relief Valve: A pressure control valve whose primary function is to limit pressure in the charge circuit.

Check Valve: A valve whose primary function is to restrict flow in one direction.

Closed Loop: A sealed and uninterrupted circulating path for fluid flow from the pump to the motor and back.

Decay Rate: The ratio of pressure decay over time.

End Cap: See “Center Section”

Entrained Air: A mechanically generated mixture of air bubbles having a tendency to separate from the liquid phase.

Gerotor: A positive displacement pump frequently used as a charge pump.

Hydraulic Motor: A device which converts hydraulic fluid power into mechanical force and motion by transfer of flow under pressure.

Hydraulic Pump: A device which converts mechanical force and motion into hydraulic fluid power by producing flow.

Hydrostatic Pump: See “Hydraulic Pump”

Hydrostatic Transaxle: A multicomponent assembly including a gear case and a hydrostatic transmission.

Hydrostatic Transmission: The combination of a hydraulic pump and motor in one housing to form a device for the control and transfer of power.

Inlet Line: A supply line to the pump.

Integrated Zero-Turn Transaxle: The combination of a hydrostatic transmission and gear case in one housing to form a complete transaxle.

Manifold: A conductor which provides multiple connection ports.

Neutral: Typically described as a condition in which fluid flow and system pressure is below that which is required to turn the output shaft of the motor.

Pressure Decay: A falling pressure.

Priming: The filling of the charge circuit and closed loop of the fluid power system during start up, frequently achieved by pressurizing the fluid in the inlet line.

Purging: The act of replacing air with fluid in a fluid power system by forcing fluid into all of the components and allowing the air a path of escape.

Rated Flow: The maximum flow that the power supply system is capable of maintaining at a specific operating pressure.

Scoring: Scratches in the direction of motion of mechanical parts caused by abrasive contaminants.

Swash Plate: A mechanical device used to control the displacement of the pump pistons in a fluid power system.

System Charge Check Valve: A valve controlling the replenishing flow of fluid from a charge circuit to the closed loop in a fluid power system.

System Pressure: The pressure which overcomes the total resistance in a system, including all efficiency losses.

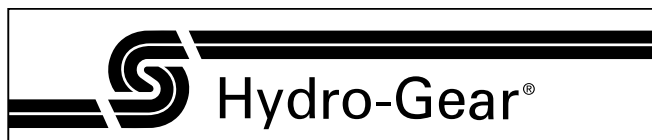
Valve: A device which controls fluid flow direction, pressure, or flow rate.

Variable Displacement Pump: A pump in which the displacement per revolution can be varied.

Volumetric Displacement: The volume for one revolution.

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