



# Service Manual



## Cub Cadet M48 Tank

**IMPORTANT: READ SAFETY RULES AND INSTRUCTIONS CAREFULLY**

This Service Manual is not a substitute for the Operator's Manual. You must read, understand and follow all of the directions in this manual as well as the Operator's Manual before working on this power equipment.

**CUB CADET LLC, P.O. BOX 361131, CLEVELAND, OH 44136-0019**



## TABLE OF CONTENTS

M48 Tank .....	1
About this Section .....	1
Changes for '03 and '04 .....	1
Drive System Adjustment .....	1
Hydro Pump Testing.....	4
Hydro Pump Replacement .....	6
Hydro Pump Motor Replacement .....	10
Brake Linkage Adjustment .....	13
M72 Tank .....	16
Other Tank Features .....	19
Kohler EFI .....	23
EFI Controls .....	26



## M48 Tank

### 1. ABOUT THIS SECTION:

The **M48** is part of the Cub Cadet Commercial Tank Series. The 2004 model year M48 is very similar to The 2001 model year Tank. Earlier versions of this machine have been covered in the “**2001 Cub Cadet Commercial Technical Handbook**”: Form #770-10528.

### 2. CHANGES FOR '03 AND '04

- New hydro motor frame assembly
- New hydro motors
- New brakes and brake linkages
- Finer increments of height adjustment
- Different choice of engines
- Features of the 72" TANK

The content of this section is intended to detail changes in service techniques that have occurred since the introduction of the M Series.

### 3. DRIVE SYSTEM ADJUSTMENT

- 3.1. Prior to making any adjustments to the drive system, inspect the hydro control linkages, drive belt, brake linkage, tires, fluid, and filter.
- 3.2. The hydraulic reservoir and filter are accessible beneath the seat. See Figure 3.2.

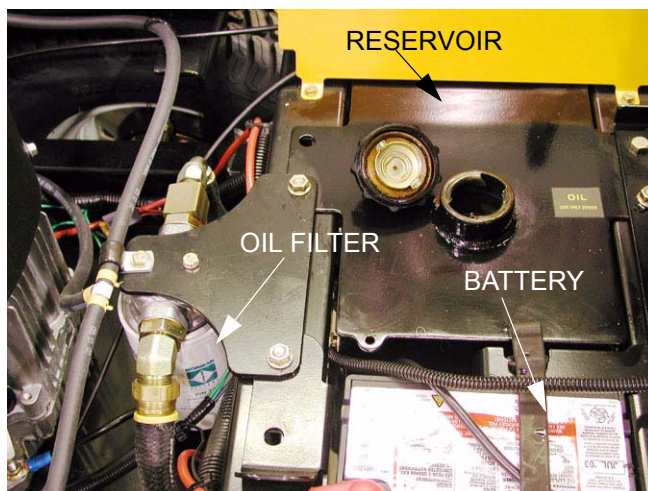


Figure 3.2

- 3.3. The hydraulic fluid level should be at the second hole in the filler neck of the reservoir. See Figure 3.3.

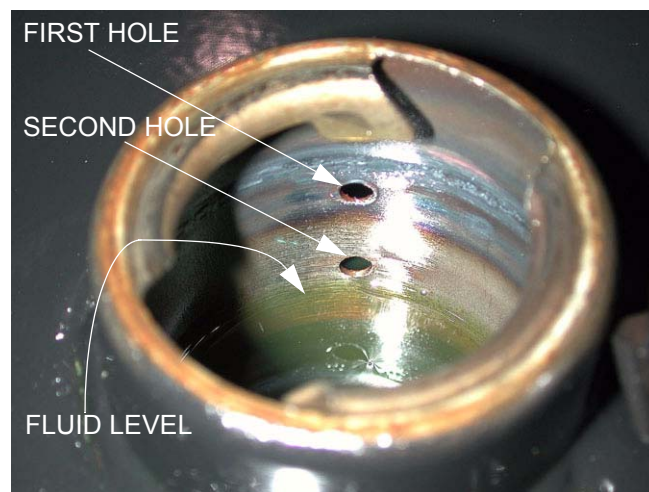


Figure 3.3

**NOTE:** It is very important that the hydraulic oil does not become contaminated. **Clean** the surrounding area thoroughly prior to opening any part of the hydraulic system.

**NOTE:** The hydraulic drive system contains roughly 3.25 gal. of **SAE 20W50** motor oil having an API rating of SJ-CD or better. **Hydraulic Drive System Fluid Plus** (P/N: 737-3121 gal.) is an acceptable premium alternative.

**NOTE:** Complete draining and filling instructions are contained in the “Operator’s and Service Manual”.

- 3.4. Tracking is effected by the circumference of the rear tires, and the amount of drag produced by the front tires.
  - **Rear tire pressure** may be adjusted within the range of **8-10 PSI** to achieve equal rear tire circumference.
  - **Front tire pressure** should be within the range of **20-25 PSI**.

## M48 Tank

- 3.5. For complete brake adjustment procedures, refer to the “Brake Adjustment” section of this manual. For the purpose of tracking, insure that the brake linkage bellcranks and rods are well lubricated, not damaged, and work as intended. See Figure 3.5.

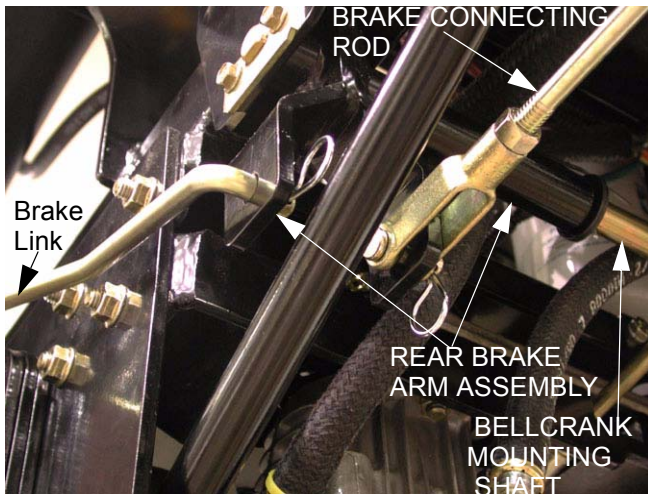


Figure 3.5

- 3.6. To check for brake drag, open the the relief valve on each hydro pump. With the parking brake released, both wheels should rotate with hand pressure. See Figure 3.6.

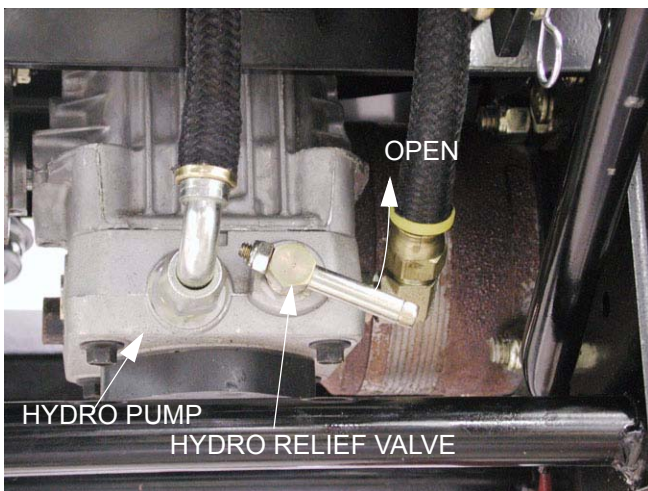


Figure 3.6

**NOTE:** Some hydraulic system drag will be present, but a dragging brake will be immediately apparent.

- 3.7. If in doubt about the source of brake drag, disconnect the brake link rod from the actuator arm on the brake assembly. The actuator arm should return to center, releasing the brakes. See Figure 3.7.

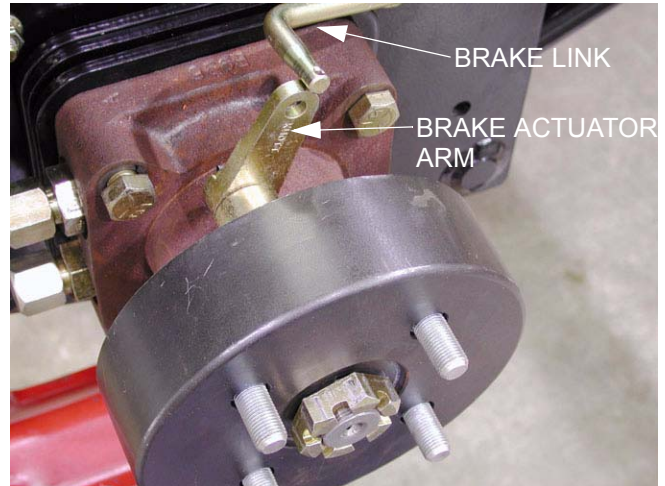


Figure 3.7

- 3.8. Check the condition of the belt tensioner and belt that drives the hydro pumps. See Figure 3.8.

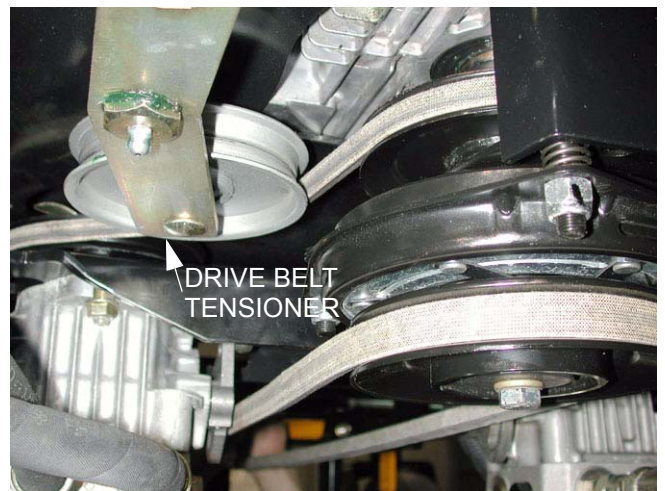


Figure 3.8

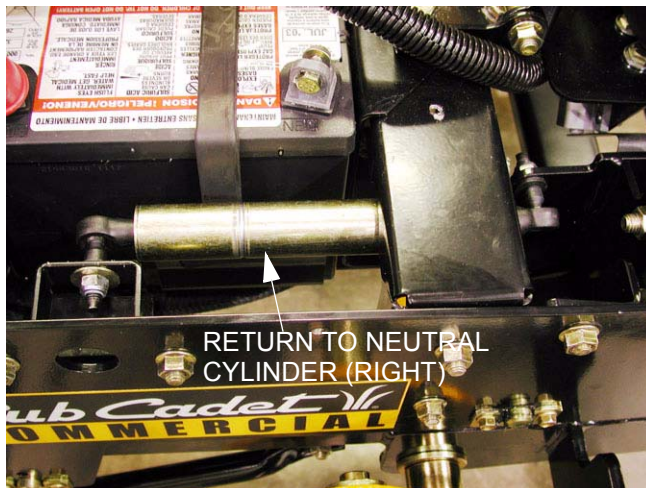
- 3.9. Before making neutral control and tracking adjustments, make sure the relief valves on both hydro pumps are fully closed.
- 3.10. To check neutral control, safely lift and support the rear wheels of the Tank.
- 3.11. Start the engine, and release the parking brake. Do not move the lap bars from the neutral position. If either wheel rotates, neutral control adjustment will be necessary. Turn off the engine.

- 3.12. If adjustment is necessary, remove the cutting deck.
- 3.13. Inspect the return to neutral cylinders, rods, and bellcranks of the hydro control linkages.
  - The bellcranks should pivot easily without too much play.
  - The rods should not be bent, and the rod ends should not be loose.

**NOTE:** The rod end and jam nut at the rear of each connector rod have left hand threads. A lock washer is placed between the control input arm on the hydro pump and the rod end.

**NOTE:** The rod end and jam nut at the front of each connector rod have right hand threads. A spacer fits between each control hub assembly (bellcrank) and the front rod end that connects to it.

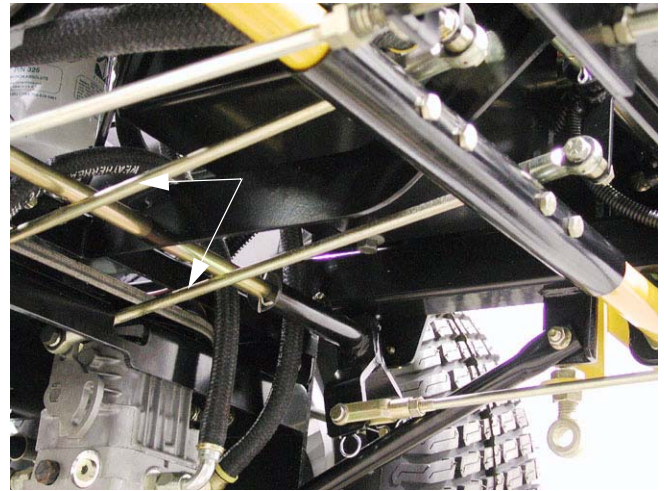
- The return to neutral cylinders should both work as advertised. See Figure 3.13.



**Figure 3.13**

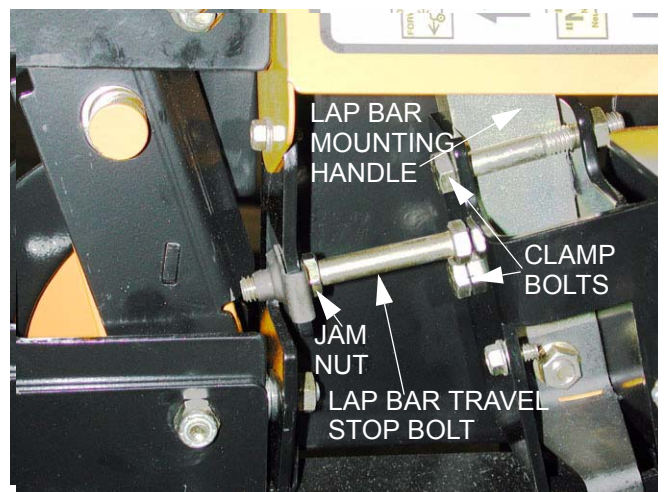
**NOTE:** Remove the control console to gain access to the return to neutral cylinder.

- 3.14. Loosen the jam nuts at each end of the hydro control link rods, and rotate the rods to lengthen or shorten them. See Figure 3.14.



**Figure 3.14**

- 3.15. Start the engine and release parking brake to test, then turn the engine off to make the adjustment.
- 3.16. Tighten the jam nuts against the rod ends when adjustment is complete, and make a final test to confirm.
- 3.17. After neutral control is correctly adjusted, set the travel stops to achieve correct tracking and adjust the lap bars for operator comfort. See Figure 3.17.



**Figure 3.17**

**NOTE:** The clamp bolts for the lap bar mounting handle can be used to adjust the amount of force required to move the lap bars into or out of the neutral slot.

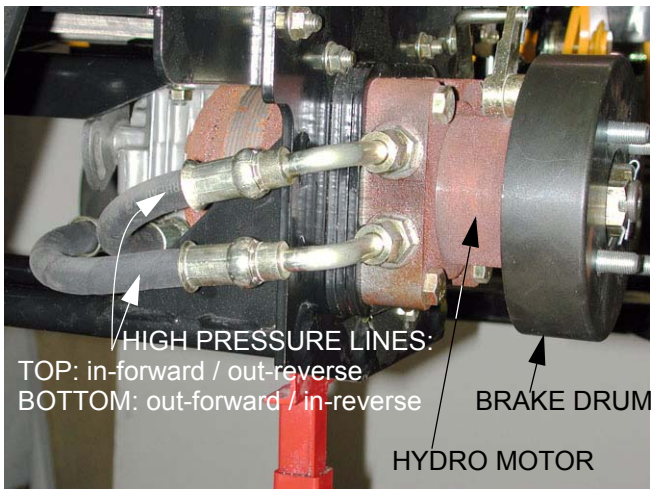
## M48 Tank

- 3.18. If one side does not drive as effectively as the other, test the output of the hydro pump to determine if the problem lies in the pump or the hydro motor. By the process of elimination, if performance is lacking, brake drag is eliminated, adjustment is correct, and the pump is O.K., then the problem is the motor. Pressure and flow tests will be used to determine if the pump is the source of the problem.

### 4. TESTING HYDRO PUMP OUTPUT

**NOTE:** The log splitter hydraulic test kit is used for this set of flow and pressure tests.

- 4.1. Safely lift and support the rear of the M48.  
4.2. If the cutting deck is currently on the unit, remove it.  
4.3. Remove the rear wheels using a 3/4" socket. See Figure 4.3.

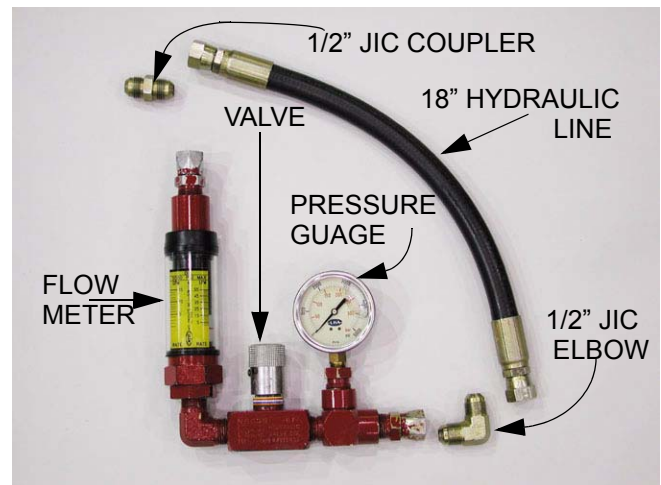


**Figure 4.3**

**NOTE:** The fittings on the lines that connect the hydro pumps to the hydro motors are 1/2" JIC.

**NOTE:** 7/8" and 13/16" wrenches will be needed for this test. A 1" wrench may be needed to hold the connector that joins the JIC line connection to the O ring connection on the hydro motor.

- 4.4. Thoroughly clean the area surrounding any hydraulic fittings to be loosened or removed.  
4.5. If the unit has been run recently, allow it to cool before doing loosening any hydraulic fittings.  
**WARNING:** Hot hydraulic fluid can cause serious burns.  
**WARNING:** Release of pressurized hydraulic fluid can cause serious or fatal injury.  
4.6. Open the relief valve on the hydro pump that is to be tested. This will relieve any residual hydraulic pressure.  
4.7. Confirm that the hydraulic pressure has been relieved by rotating the brake drum / hub assembly. If it will not rotate, confirm that the brake is released and that the brake linkage is not bound.  
4.8. Install a 1/2" JIC double male coupler in one end of the 18" hydraulic line in the test kit. Install a 90 deg. 1/2" JIC double male elbow in the other end. See Figure 4.8.



**Figure 4.8**

- 4.9. Position a catch pan beneath the hydro motor. Have the hydraulic pressure and flow test kit and two 1/2" JIC plugs within reach.  
**NOTE:** The fittings on the ends of the test kit are all 1/2" JIC.  
4.10. Disconnect the upper line from the hydro motor and quickly install a 1/2" JIC plug in the line. It only needs to be finger tight.



**NOTE:** The test can be performed at either line between the pump and the motor. The top line on the motor is the in line from the pump when driving forward. The linkage has more travel in forward than it does in reverse, so the test is most easily done on the top line of the pump, driving the pump in the forward direction forward.

- 4.11. Connect the flow meter end of the test kit to the hydro motor.
- 4.12. Remove the plug from the line coming from the outboard port on the hydro pump. Use the 18" test kit line to connect the pressure gauge end of the hydraulic test kit to the line coming from the hydro pump. See Figure 4.12.

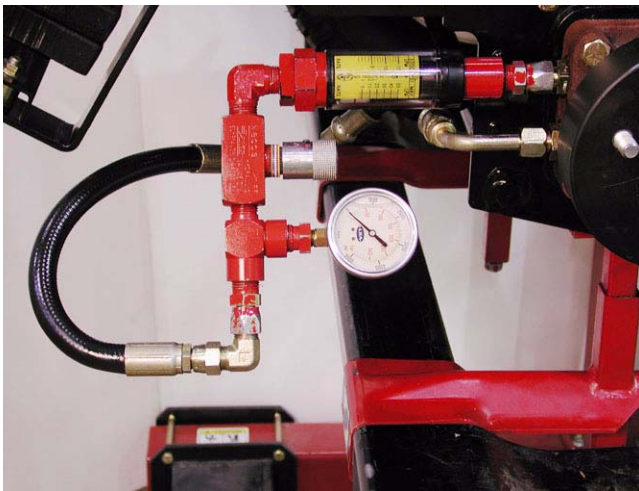


Figure 4.12

- 4.13. Tighten all the fittings.
- 4.14. Insure that no unsafe conditions will result from starting the engine and operating the drive system.

**CAUTION:** The technician will be exposed to moving parts during this procedure. They should not reach past or around any moving parts during this test, nor should they place themselves in any position where a loss of footing or balance might bring them into contact with rotating components. Loose hair or garments should be secured to avoid the possibility of entanglement with rotating components.

- 4.15. Remove the stop bolt that sets the end of the travel of the lap bar that controls the hydro pump to be tested. See Figure 4.15.

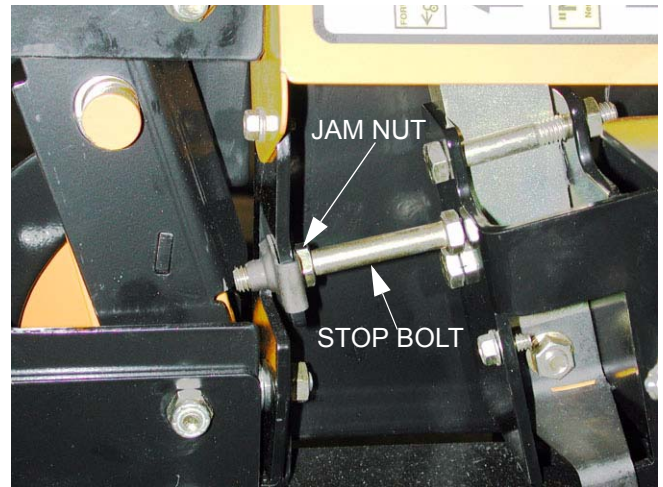


Figure 4.15

- 4.16. Confirm that the valve on the test kit is fully open.
- 4.17. Start the engine and **purge the hydraulic system as follows:**
- 4.18. Cycle the lap bar from full forward to full reverse 5 times at 10 second intervals.
- 4.19. Close the relief valve on the hydro pump and repeat the cycling process to purge any remaining air from the system.
- 4.20. Check for and repair any leaks.
- 4.21. Check the fluid level in the hydraulic reservoir. Top it up if necessary.
- 4.22. Continue to operate the drive system to warm-up the hydraulic fluid.

**NOTE:** Performing the test with cold fluid will make a significant difference in the flow readings obtained. The test will not be valid.

## M48 Tank

- 4.23. When the fluid is between 160-210 deg. f. (71-90 deg. c.) apply full forward drive pressure to the lap bar with the engine running at full speed (3600 RPM) while an assistant closes the valve to the point where pressure reaches 300 PSI (21 Bar.). See Figure 4.23.

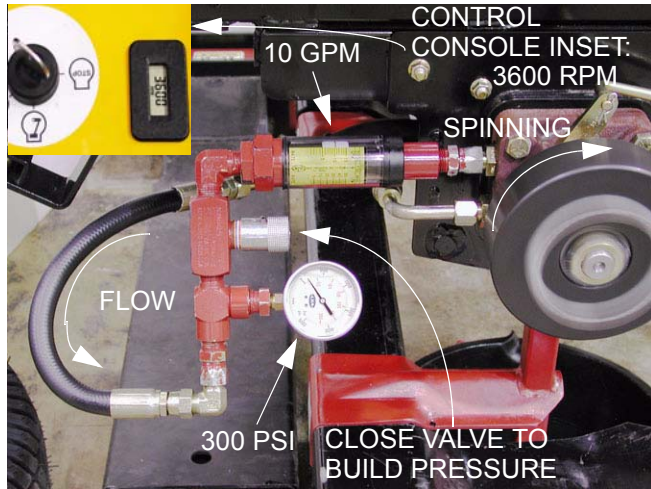


Figure 4.23

**NOTE:** It may be necessary to over-shoot 300 PSI slightly, then open the valve to reduce pressure to 300 PSI.

- 4.24. Take note of the reading on the flow meter portion of the test kit when the pressure gauge reads 300 PSI.
- 4.25. Continue closing the valve until the pressure reading reaches 1,100 PSI (76 bar.). Take note of the flow reading. See Figure 4.25.

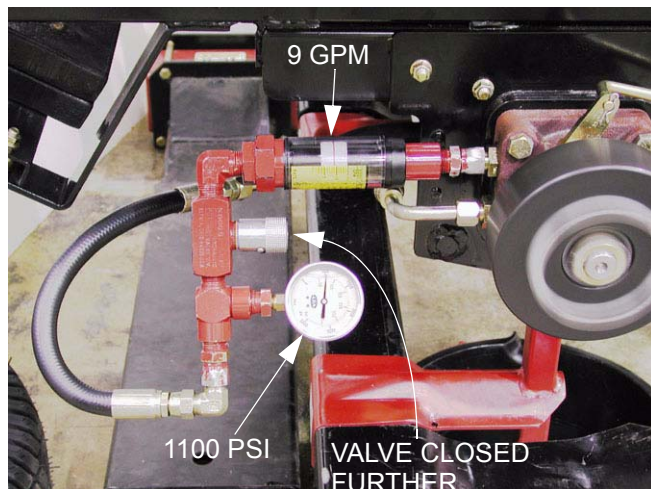


Figure 4.25

- 4.26. Subtract the 1,100 PSI flow reading from the 300 PSI flow reading. The resulting figure is called "flow droop".

- 4.27. Interpretation: flow droop greater than 1.5 GPM indicates a pump that is not performing as well as it should.

**NOTE:** A blocked filter may account for some loss of performance.

- 4.28. Within the two year Cub Cadet Commercial warranty period, replace the pump if it does not perform as specified and all other factors have been eliminated.
- 4.29. If a hydro pump requires repair, refer to Hydro-Gear publication "BLN-51337" for complete service instructions.
- 4.30. If the hydro pump and all other factors are O.K., replace the hydro motor.

**NOTE:** The hydro motor is not serviceable. Replace it as a unit if it fails.

## 5. REPLACING THE HYDRO PUMP

- 5.1. If the cutting deck is currently on the unit, remove it.
- 5.2. Safely lift and support the rear of the tank.
- 5.3. Remove the rear wheels using a 3/4" socket.
- 5.4. Tilt the seat up, and disconnect the negative battery cable.
- 5.5. Remove the screen that covers the opening over the cooling fans on the hydro pump to be removed using a 3/8" wrench. See Figure 5.5.

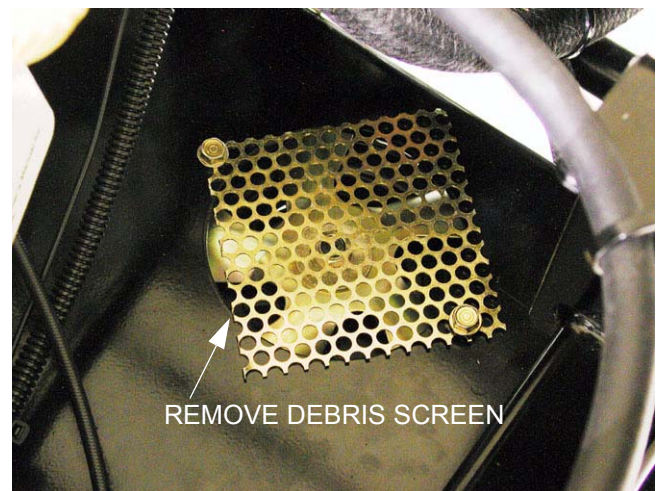


Figure 5.5

- 5.6. Remove the nut, washer, and cooling fan from the hydro pump to be replaced, using a 9/16" wrench. See Figure 5.6.



Figure 5.6

- 5.10. Use a small two-jaw puller to remove the pulley from the tapered and keyed input shaft of the hydro pump. See Figure 5.10.

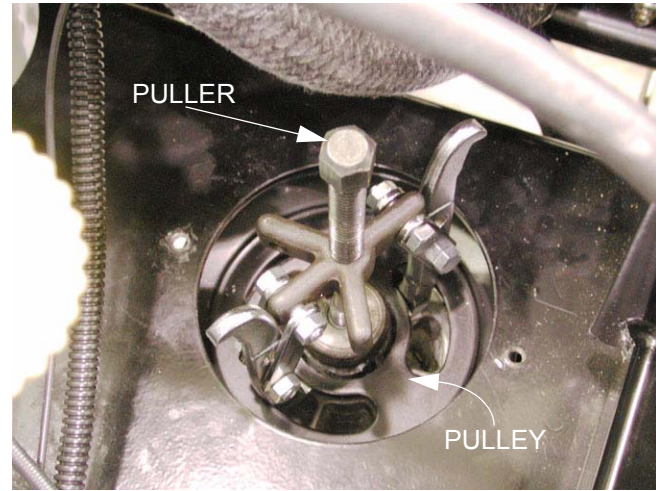


Figure 5.10

- 5.7. Use a 3/8" breaker bar to move the belt tensioner pulley arm, slipping the belt off of the pulley. See Figure 5.7.

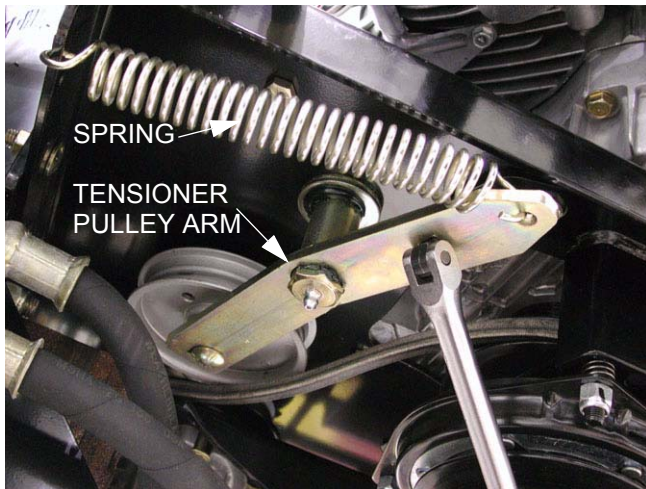


Figure 5.7

- 5.11. Disconnect the rod end on the back of the hydro control rod from the control arm on the hydro pump using a 9/16" wrench, and a 1/2" wrench. See Figure 5.11.

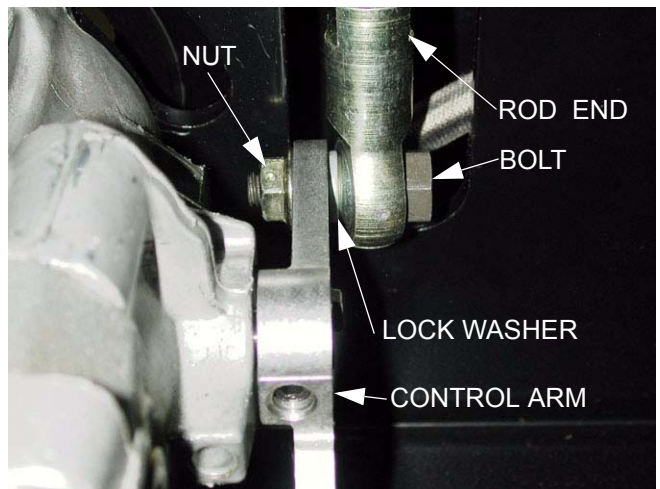


Figure 5.11

- 5.8. Unhook the spring that maintains tension on the arm. This will provide more freedom of movement.
- 5.9. Slip the belt over the drive pulley of the hydro pump to be removed.

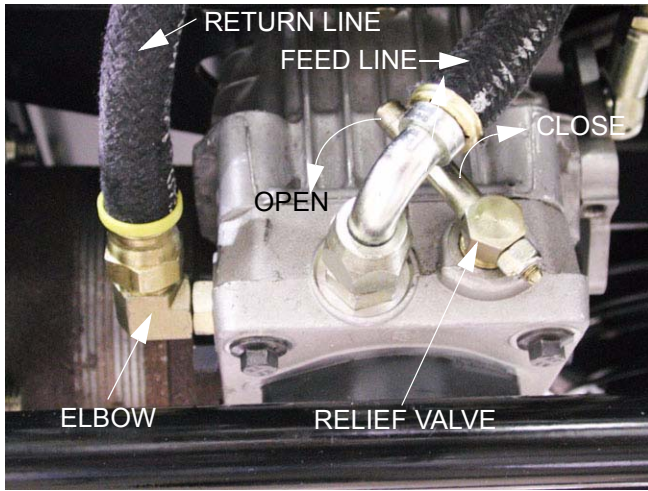
- 5.12. Thoroughly clean the area surrounding any hydraulic fittings to be loosened or removed.
- 5.13. If the unit has been run recently, allow it to cool before doing loosening any hydraulic fittings.

**WARNING:** Hot hydraulic fluid can cause serious burns.

**WARNING:** Release of pressurized hydraulic fluid can cause serious of fatal injury.

## M48 Tank

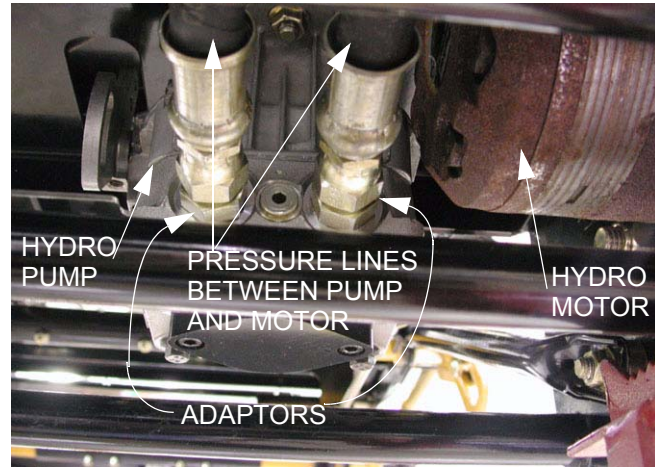
- 5.14. Open the relief valve on the hydro pump that is to be tested. This will relieve any residual hydraulic pressure. See Figure 5.14.



**Figure 5.14**

- 5.15. Confirm that the hydraulic pressure has been relieved by rotating the brake drum / hub assembly. If it will not rotate, confirm that the brake is released and that the brake linkage is not bound.
- 5.16. If there is any possibility of fluid contamination, drain and flush the system, and replace the filter before installing the new hydro pump.
- 5.17. Position a catch pan beneath the hydro pump to be removed. Have four 1/2" JIC plugs and two 1/2" JIC caps within reach.
- 5.18. Disconnect the feed line that runs from the front of the hydro pump to the filter manifold using a 7/8" wrench on the nut, and a 13/16" wrench to hold the fitting on the hydro pump. Plug the line, cap the fitting on the pump.
- 5.19. Disconnect the return line that runs from the outboard side of the hydro pump to the reservoir using a 7/8" wrench on the nut, and an 11/16" wrench to hold the fitting on the hydro pump. Plug the line, cap the fitting on the pump. See Figure 5.14.

- 5.20. Disconnect the two lines that connect the hydro motor to the back of the hydro pump using a pair of 7/8" wrenches. Plug the lines. See Figure 5.20.



**Figure 5.20**

- 5.21. Remove the two O ring to JIC adaptors from the back of the hydro pump. Replace them with the yellow shipping plugs from the replacement hydro pump.
- 5.22. Remove the 90 deg. elbow fitting that the return line was connected to using an 11/16" wrench and a 3/4" wrench. Plug the port using a yellow shipping plug removed from the replacement pump.
- 5.23. Remove the O ring to JIC adaptor that the feed line was connected using a 13/16" wrench. Plug the port using a yellow shipping plug removed from the replacement pump. See Figure 5.23.



**Figure 5.23**

- 5.24. Remove the handle from the relief valve using a 7/16" wrench and a 3/16" allen wrench.
- 5.25. Remove the nuts from the carriage bolts that hold the hydro pump to the hydro pump mounting plate. See Figure 5.25.

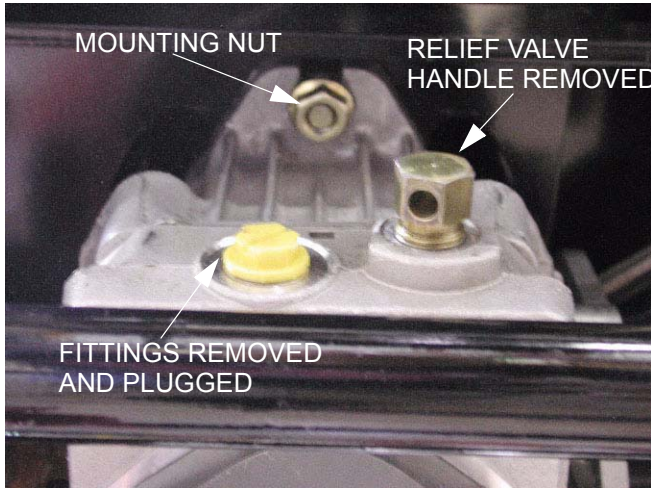


Figure 5.25

- 5.26. Carefully lower and remove the hydro pump. If it is to be returned to Cub Cadet, remove the yellow plugs and allow it to drain completely before packing and shipping it.
- 5.27. Inspect all of the fittings and O rings prior to installation in the replacement pump. See Figure 5.27.

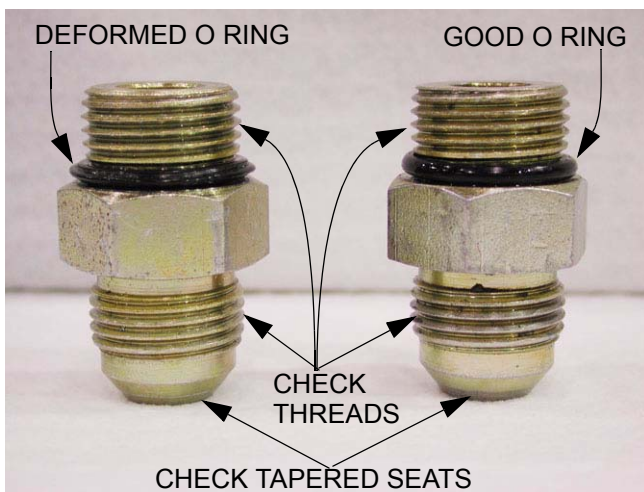


Figure 5.27

- 5.28. Prior to installation, pour oil directly into the pump inlet and high-pressure ports, then transfer yellow plugs back to the replacement pump.

- 5.29. Position the pulley over the opening in the hydro pump support plate that the pump input shaft will pass through.
- 5.30. Position the pump so that the two bolts that secure it in position line-up with the two mounting ears on the pump, and the input shaft slips into the pulley as the pump is raised up to the hydro pump support plate. See Figure 5.30.

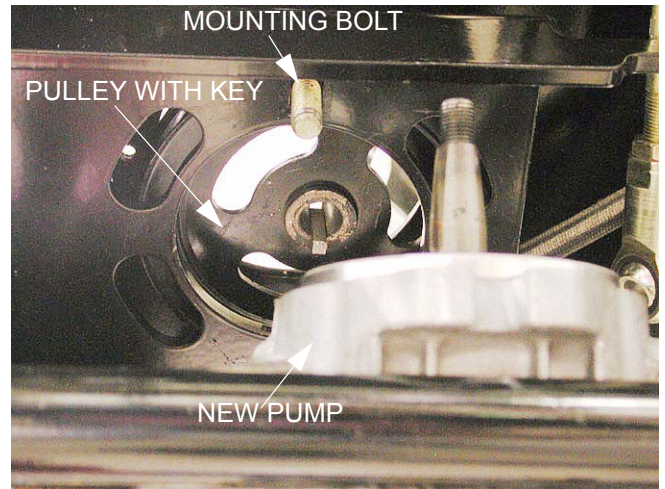


Figure 5.30

- 5.31. Start both nuts that hold the pump onto their carriage bolts.
- 5.32. As the pump is tightened into position, rotate the pulley to align the keyways, allowing the pulley to seat on the input shaft.
- 5.33. Install the fittings and lines, working quickly to minimize fluid loss.

**NOTE:** Use care not to over-tighten the O ring fittings, damaging the O rings.

**NOTE:** The lines may be installed finger tight to establish their positions, then tightened fully.

- 5.34. Install the belt, tension arm spring, steering linkage.
- 5.35. Install the fan, washer and nut to the input shaft. Torque the nut to 240 inch/lbs.
- 5.36. Install the debris screen.
- 5.37. Check the fluid level in the reservoir, purge the system as described in the test instructions.
- 5.38. If the hydraulic system has been drained and flushed with 20W50, install a new filter and follow the instructions for refilling the hydraulic system in the "Operator's and Service Manual".

## M48 Tank

5.39. Install the wheels, lower the TANK to the ground, and test run it in a safe area. Make any necessary adjustments before installing the cutting deck.

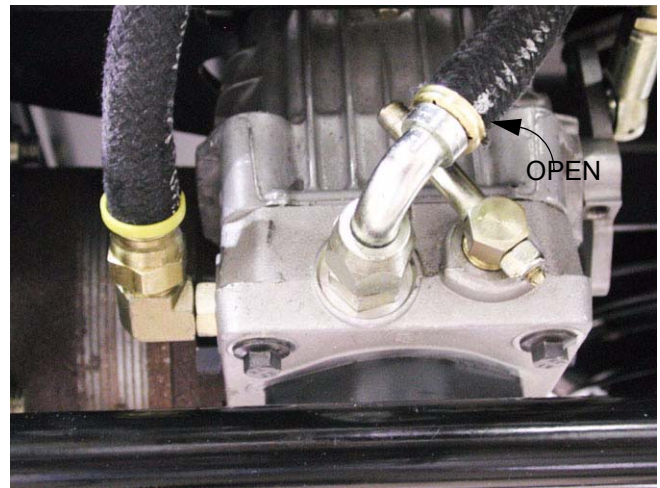
### 6. REPLACING THE HYDRO MOTOR

- 6.1. If the cutting deck is currently on the unit, remove it.
- 6.2. Safely lift and support the rear of the tank.
- 6.3. Remove the rear wheels using a 3/4" socket.
- 6.4. Tilt the seat up, and disconnect the negative battery cable.
- 6.5. Thoroughly clean the area surrounding any hydraulic fittings to be loosened or removed.
- 6.6. If the unit has been run recently, allow it to cool before doing loosening any hydraulic fittings.

**WARNING:** Hot hydraulic fluid can cause serious burns.

**WARNING:** Release of pressurized hydraulic fluid can cause serious or fatal injury.

- 6.7. Open the relief valve on the hydro pump. This will relieve any residual hydraulic pressure. See Figure 6.7.



**Figure 6.7**

- 6.8. Confirm that the hydraulic pressure has been relieved by rotating the brake drum / hub assembly. If it will not rotate, confirm that the brake is released and that the brake linkage is not bound.

- 6.9. If the brake assembly is to be transferred to the new hydro motor: remove the cotter pin from the castle nut that holds the hub to the axle.
- 6.10. Loosen, but do not remove the castle nut from the axle using a 11/2" socket.

**NOTE:** It may be necessary to set the parking brake while loosening the nut. Release the parking brake afterward.

**NOTE:** The studs are pressed into the brake drum. The brake drum effectively is the drive hub. The drive hub mounts on an narrow taper.

- 6.11. Remove the hairpin clip that secures the brake link to the brake arm. Pivot the arm out of the way. See Figure 6.13.

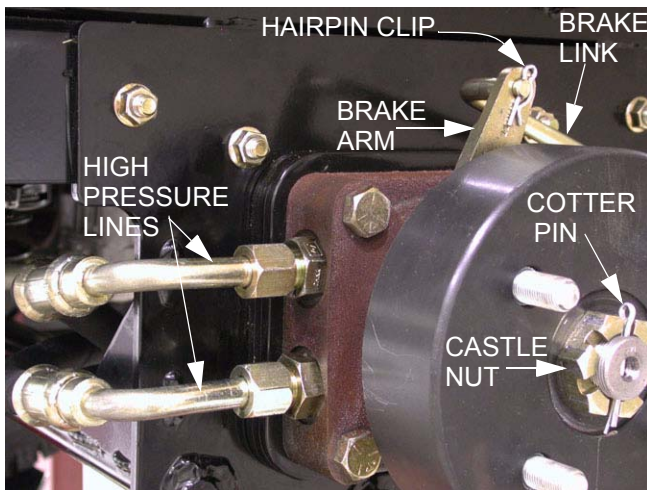


Figure 6.11

- 6.12. Place a catch pan under the hydro motor, and have two 1/2" JIC plugs within reach.

- 6.13. Disconnect the high pressure lines from the the hydro motor one at a time using a 7/8" wrench. A 1" wrench may be required to hold the fittings on the hydro motor. Plug the lines. See Figure 6.13.

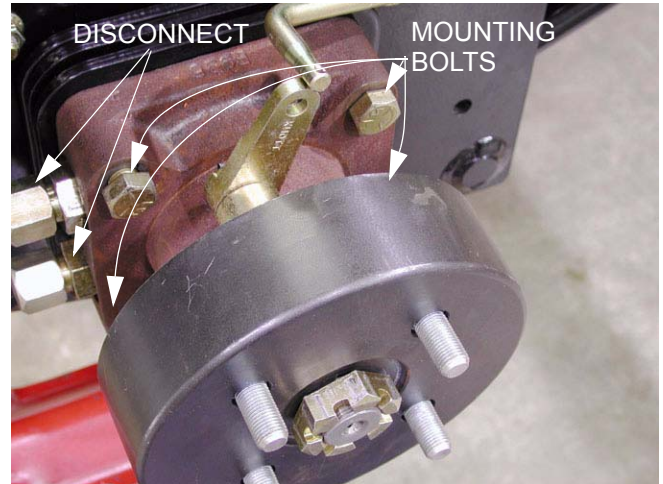


Figure 6.13

- 6.14. Remove the four sets of nuts and bolts that hold the hydro motor to the hydro motor frame assembly using 3/4" wrenches.
- 6.15. Lift the motor slightly and carefully pull it out far enough to remove the motor plate from the end of the four bolts. See Figure 6.15.

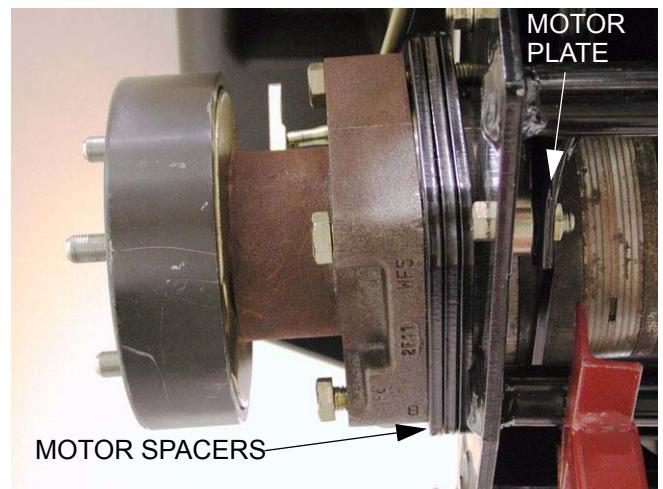


Figure 6.15

**NOTE:** The hydro motor weighs nearly 50 lbs.

## M48 Tank

- 6.16. Withdraw the hydro motor, along with the three motor spacers, and place them gently on a work bench. See Figure 6.16.

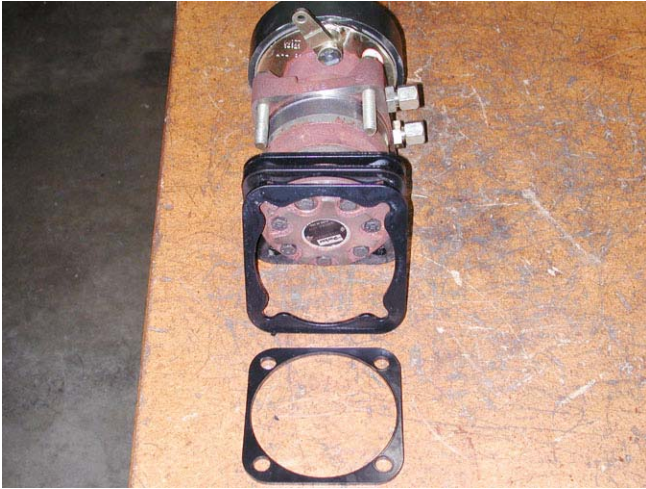


Figure 6.16

- 6.17. If the brake is to be removed, remove the clip that holds the brake arm on the splined shaft, and mark the location of the brake arm on the splined shaft.

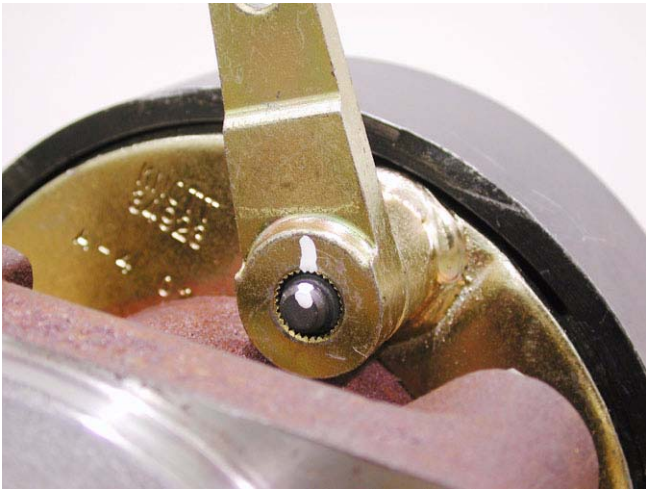


Figure 6.17

- 6.18. Remove the brake arm from the splined shaft.  
**NOTE:** The Hydro motor can be ordered with or without the brake assembly. If an appropriate size press is not available, the dealer should consider ordering hydro motor with the brake assembly attached.

- 6.19. Safely fixture the hydro motor and brake assembly in a minimum 20 Ton press so that the ram presses against the end of the axle, and the assembly is supported by the edge of the brake drum. Press the drum off of the tapered shaft.

- 6.20. Remove the castle nut and brake drum from the axle. See Figure 6.20.

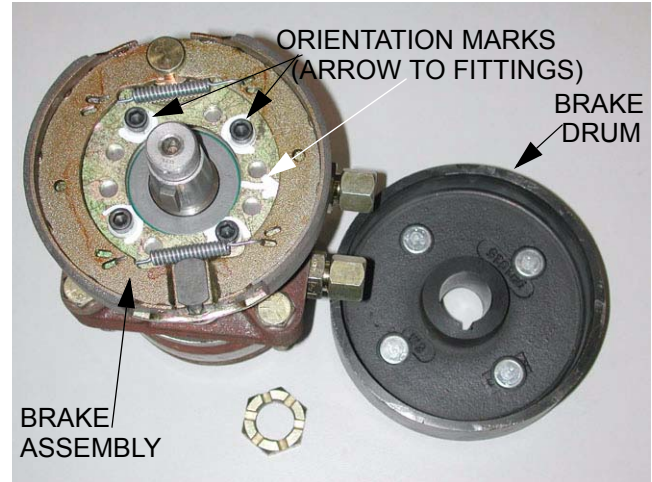
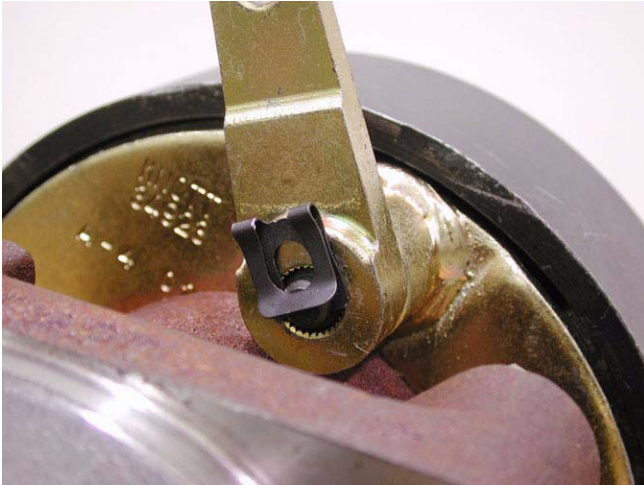


Figure 6.20

- 6.21. Mark the orientation of the brake assembly on the hydro motor.
- 6.22. Remove the four socket head cap screws that hold the brake assembly to the hydro motor using a 1/4" allen wrench.
- 6.23. Transfer the four mounting bolts from the old hydro motor to the new one. Replace any that show signs of wear or damage.
- 6.24. Position the three motor spacers on the bolts, and install the hydro motor in the TANK.
- 6.25. Place the motor plate over the end of the bolts, apply Loctite 242 (blue) to the bolts, and install the four nuts. Tighten the bolts to 450-550 in.-lbs.
- 6.26. Inspect the brake assembly. If there are not signs of significant wear or damage, install the brake on the new hydro motor, using the match marks to maintain the same orientation.
- 6.27. Use new lock washers and / or Loctite 242 (blue) when installing the brake assembly. Torque the socket head cap screws to 160-200 in.-lbs.



- 6.28. Install the brake arm and clip on the new hydro motor. See Figure 6.28.



**Figure 6.28**

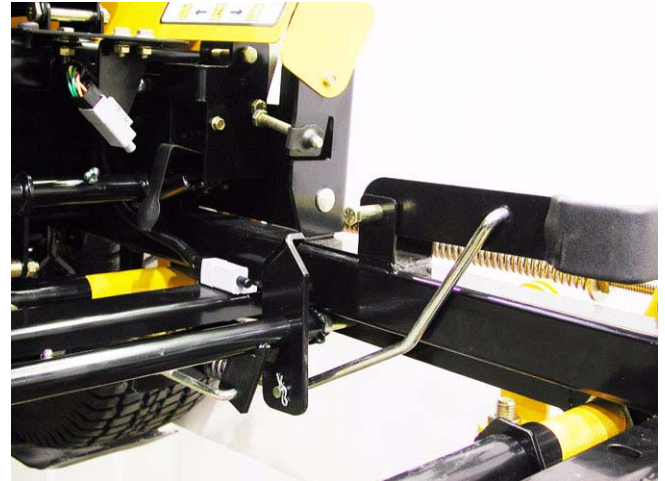
- 6.29. Transfer the O ring to flare adaptor fittings from the old hydro motor to the new hydro motor, using a 1" wrench. Inspect the fittings and O rings. If there is any doubt about their condition, replace them. Lightly lubricate the O rings with oil on assembly.
- 6.30. Apply a small amount of anti-seize compound to the taper of the brake drum, and install the brake drum on the axle.
- 6.31. Install the castle nut on the axle, and lock it with a fresh cotter pin.
- 6.32. Connect the brake linkage.
- 6.33. Install the rear wheels, and torque the lug nuts to 50-70 ft.-lbs.
- 6.34. Check the fluid level in the reservoir, purge the system as described in the pressure and flow test instructions.

**NOTE:** If the hydraulic system has been drained and flushed with 20W50, install a new filter and follow the instructions for refilling the hydraulic system in the "Operator's and Service Manual".

- 6.35. Install the wheels, lower the TANK to the ground, and test run it in a safe area. Make any necklaces adjustments before installing the cutting deck.

## 7. BRAKE LINKAGE ADJUSTMENT

- 7.1. With the TANK parked on firm level ground, lift and safely support the back of the unit.
- 7.2. Remove the hairpin clips that hold the floor panel in position.
- 7.3. Lift the floor panel up using the grip opening at the top rear edge, slide it to the left, and remove it. See Figure 7.3.



**Figure 7.3**

- 7.4. Release the hydro relief valves and release the parking brake.
- 7.5. Rotate each wheel to confirm that the brakes are not dragging or binding.
- 7.6. Remove the rear wheels using a 3/4" socket.

**NOTE:** It may be necklaces to set the parking brake while loosening the lug nuts.

## M48 Tank

- 7.7. Loosen the jam nut that locks the shoulder nut in position on the brake connector rod using a 9/16" wrench and a 3/4" wrench. See Figure 7.7.

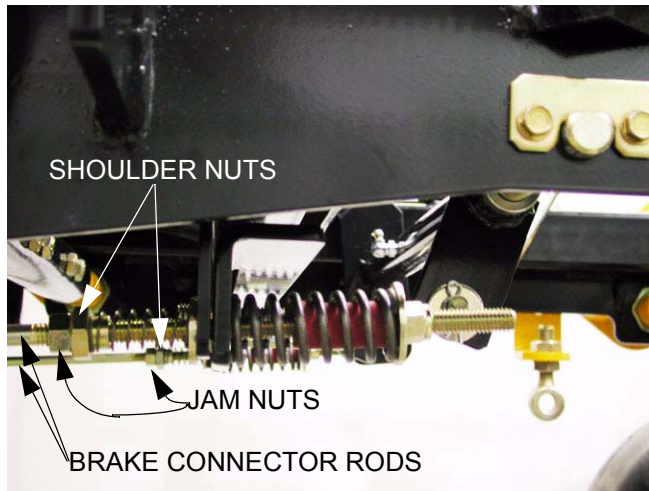


Figure 7.7

- 7.8. Remove the hairpin clip that secures the brake link rod to the brake arm on the brake assembly.
- 7.9. Repeat on other side.
- 7.10. Disconnect the brake link rods (left and right). See Figure 7.10.

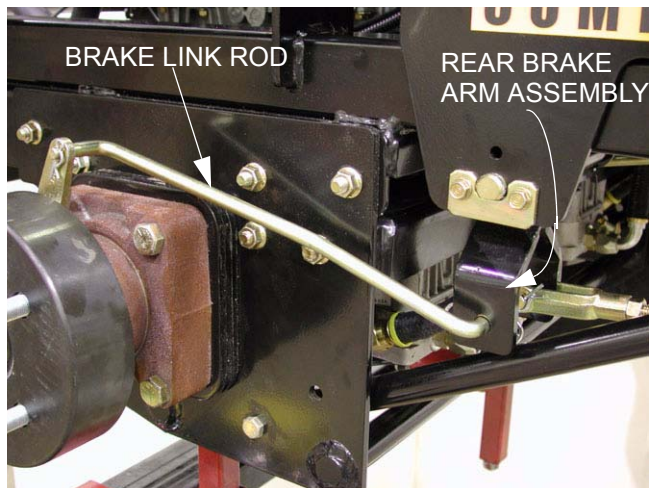


Figure 7.10

- 7.11. Remove the hairpin clip and clevis pin that secures the clevis on the end of the brake connector rod to the rear brake arm assembly on both sides. See Figure 7.11.

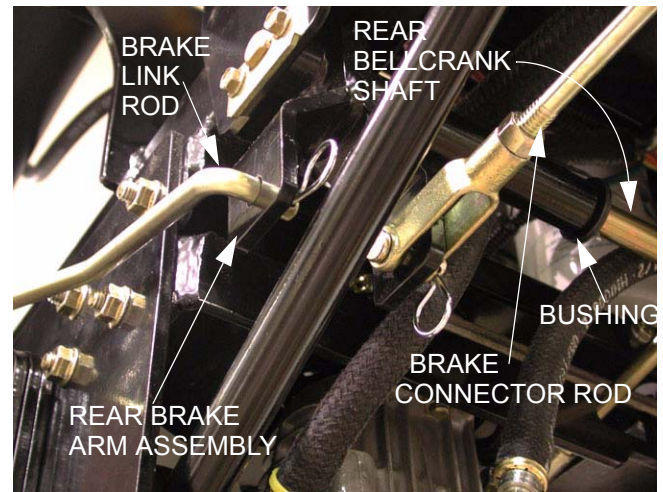


Figure 7.11

- 7.12. Confirm that the rear brake arm assembly moves freely on the rear bellcrank shaft, is sufficiently well lubricated, and is free from excessive play caused by worn busings. See Figure 7.12.

Figure 7.12

**NOTE:** If rear brake arm assembly service is needed, the rear bell crank shaft that the arms pivot on can be easily removed by unbolting the brake shaft holders, removing the cotter pins and washers that locate the brake arm assemblies on the shaft.

**NOTE:** Both washers that fit next to each rear brake arm go between the arm and the cotter pin.

- 7.13. Confirm that the brake bearing hub, brake handle, and the brake rod that connects them move freely on the front bellcrank shaft.
- 7.14. Confirm the position of the brake bearing hub: the top of the arm that the brake rod (to the brake handle) connects to should line-up directly with the parking brake switch, and the brake rod should be parallel to the frame. When this is true, the front brake connector rods should also be parallel to the frame. See Figure 7.14.

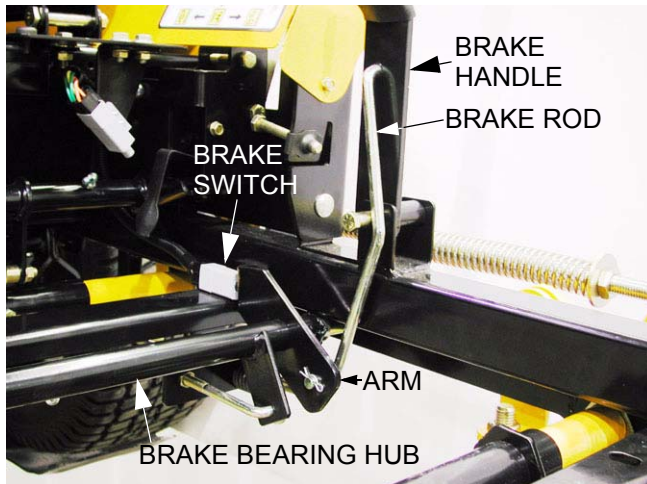


Figure 7.14

- 7.15. If adjustment is necklaces, loosen the two collars on the front bellcrank shaft using a 1/8" allen wrench. Re-position the bearing hub and collars as necklaces, and tighten the collars. See Figure 7.15.

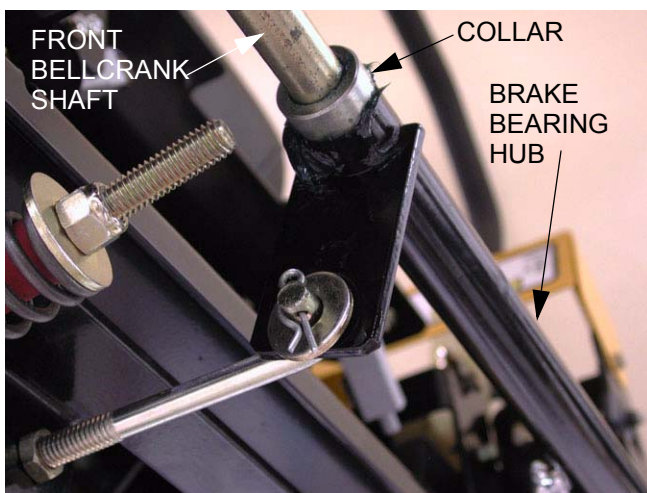


Figure 7.15

**NOTE:** The left edge of the brake bearing hub will usually be even with the inner edge of the frame when correctly adjusted.

- 7.16. Check the brake arm on the brake assembly for freedom of movement. It should return to center.
- 7.17. Reconnect the brake link rods and brake connecting rods to the rear brake arm assemblies.
- 7.18. Apply light rearward pressure to each brake connecting rod. The clevis pin at the rear end of the rod should just contact the back of the hole that it passes through to connect the clevis to the rear brake arm assembly.
- 7.19. Loosen or tighten the nylock nut at the front of the connecting rod to bring the heavy spring lightly into contact with the brake bracket. See Figure 7.19.

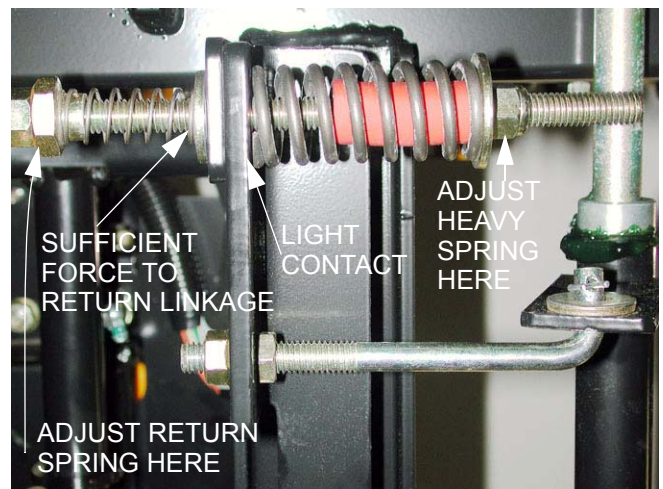


Figure 7.19

- 7.20. Apply the parking brake. The gap between the bottom edges of the brake bracket and the cross member that it rests against in the released position should be roughly 1 3/4". See Figure 7.20.

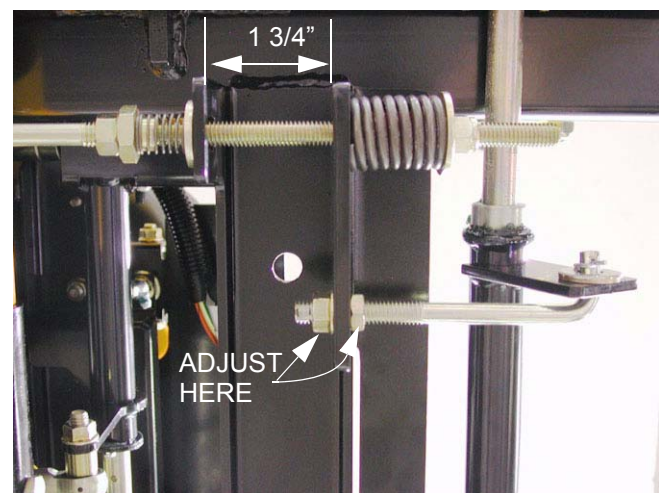


Figure 7.20

## M48 Tank

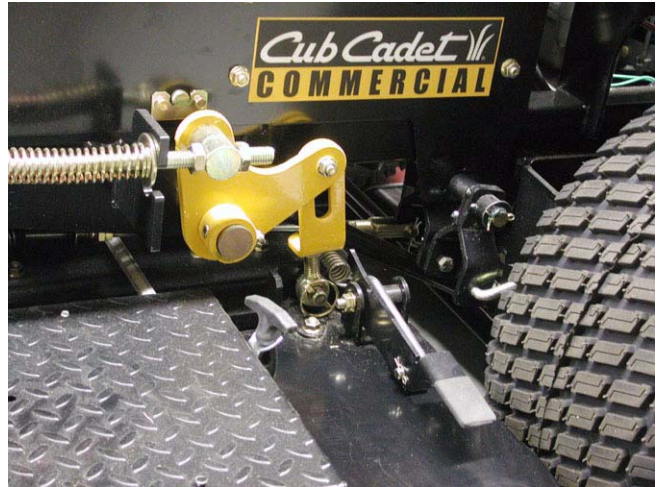
- 7.21. Release the parking brake.
- 7.22. The brake bracket should draw up against the frame cross member. If this reaction is not consistent, tighten the shoulder nut slightly. There should be roughly 1 1/2" between the head of the shoulder nut and the brake bracket when the brakes are applied.
- 7.23. Tighten the jam nut.
- 7.24. If brake application is uneven from left to right, adjust the length of the short connector rods between the brake bracket and the brake bearing hub.
- 7.25. If brake release action is inconsistent, check for bent or misaligned rods and links.
- 7.26. Install the rear wheels, tightening the lug nuts to 50-70 ft.-lbs. Lower the TANK to the ground.
- 7.27. Install the floor panel.
- 7.28. Test run the TANK in a safe area before returning it to service. Check the function of the parking brakes.

**NOTE:** A dragging parking brake will cause tracking issue and drive noise on the effected side.

## 8. M72 TANK

The **M72** is based on the same frame design as the smaller members of the **TANK** series. Some changes have been made to accommodate the larger deck.

- 8.1. Heavier brackets to suspend the deck. See Figure 8.1.



**Figure 8.1**

- 8.2. Heavier duty deck belt tension release mechanism. See Figure 8.2.



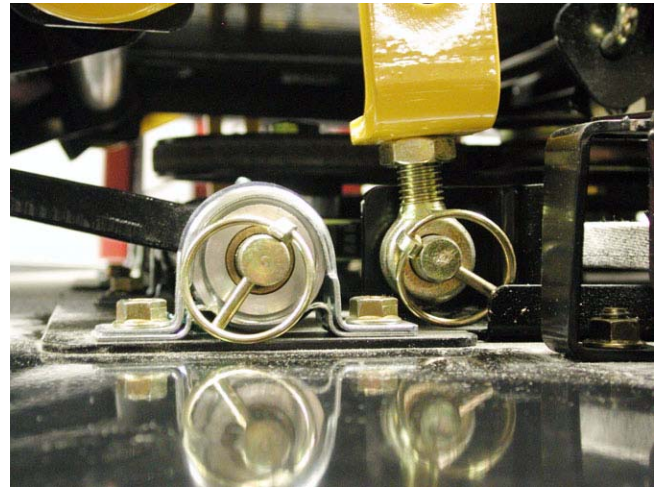
**Figure 8.2**

8.3. The deck lift goes has finer increments of adjustment. See Figure 8.3.



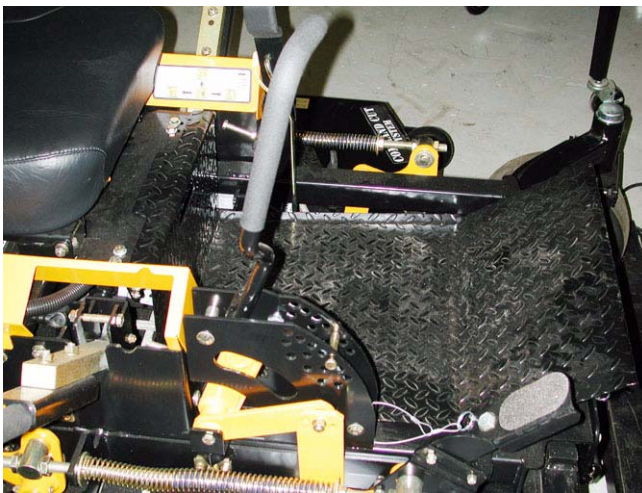
**Figure 8.3**

8.5. Heavier hardware connects the deck to the hangers. See Figure 8.5.



**Figure 8.5**

8.4. The larger, heavier decks have a foot assist pedal to help raise and lower the deck. See Figure 8.4.



**Figure 8.4**

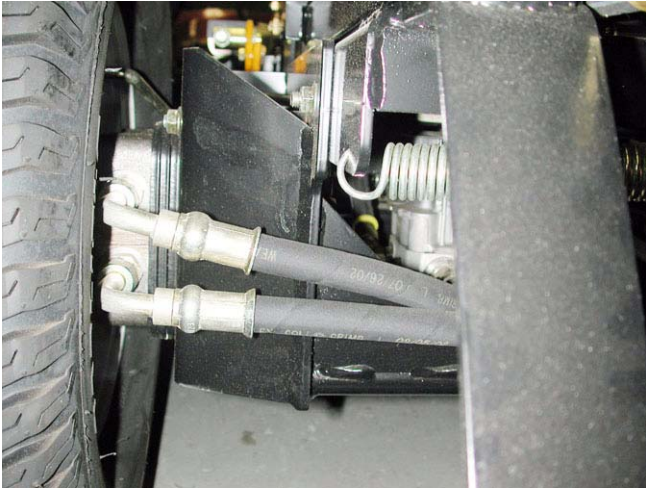
8.6. Heavier front pivot bar and wider front track. See Figure 8.6.



**Figure 8.6**

## M48 Tank

8.7. The track at the rear has also increased. Extra brackets have been added to the frame to step the hydro motors out. See Figure 8.7.



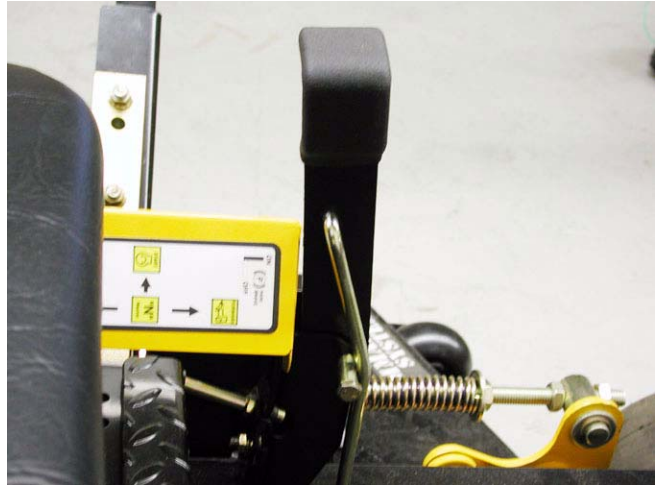
**Figure 8.7**

8.8. To enable the brake linkage to reach the repositioned hydro motor, the rear brake arm assemblies have been doubled-up on each side. Instead of a single rear brake arm assembly per side, two are used in tandem. See Figure 8.8.



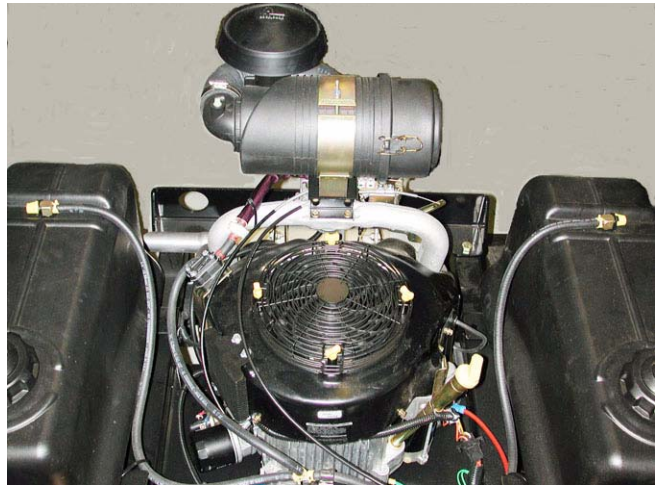
**Figure 8.8**

8.9. The parking brake lever has been moved up to a more convenient location.



**Figure 8.9**

8.10. A larger engine is required to power the larger deck and heavier total weight of the mower. A 28 H.P. Generac Guardian engine is employed. See Figure 8.10.



**Figure 8.10**

## 9. OTHER TANK FEATURES

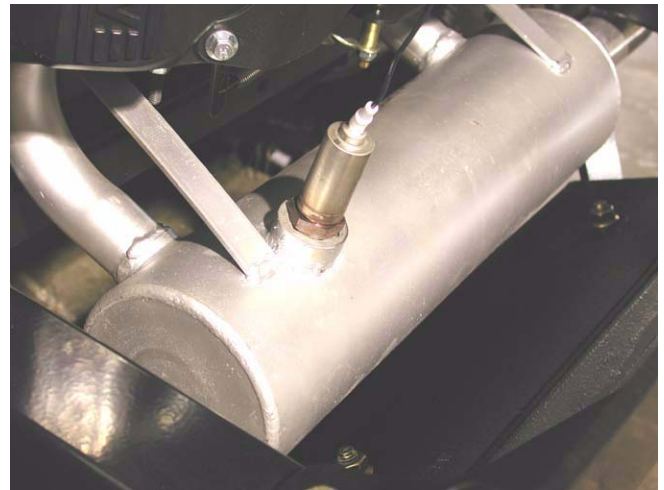
9.1. Honda Power is offered on the M48-HN and M54-HN. The M48-HN has a 20 H.P. Honda V-twin engine. The M54-HN has a 24 H.P. Honda V-twin. See Figure 9.1.

**Figure 9.1**

9.2. ROPS is offered on the M60-KW (Kawasaki) and M60-KH (Kohler). This is not a bolt-on option. It is integrated into the frame. The option is primarily aimed at government bid specifications. See Figure 9.2.

**Figure 9.2**

9.3. The TANK exhaust systems all feature a new aluminized finish. This finish resists corrosion better than the heat paint that is more commonly used. It also dissipates heat more effectively, producing noticeable improvements on chassis dynamometers. See Figure 9.3.



**Figure 9.3**

9.4. Some features of the 72" deck have been extended throughout the TANK model range. Looking at the 60" model as an example, these features include:

9.5. More easily adjustable hydro control link. See Figure 9.5.



**Figure 9.5**

## M48 Tank

- 9.6. 1/4" increments on the height adjuster, with foot assist deck lift. See Figure 9.6.

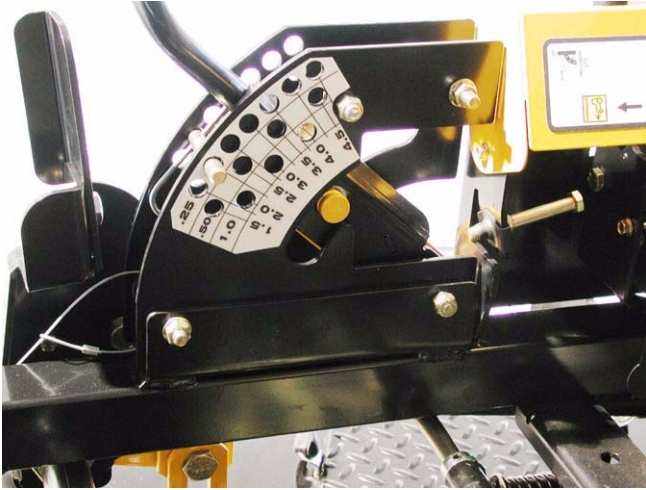


Figure 9.6

- 9.7. The deck belt release operates in a vertical plane. It can be tensioned with foot pressure, and the rear wheel does not interfere with its travel. See Figure 9.7.



Figure 9.7

- 9.8. Heavy duty spherical rod ends on the arms at the front of the deck. See Figure 9.8.



Figure 9.8

- 9.9. The arms themselves are cast iron, and the lift-shaft is heavier. See Figure 9.9.

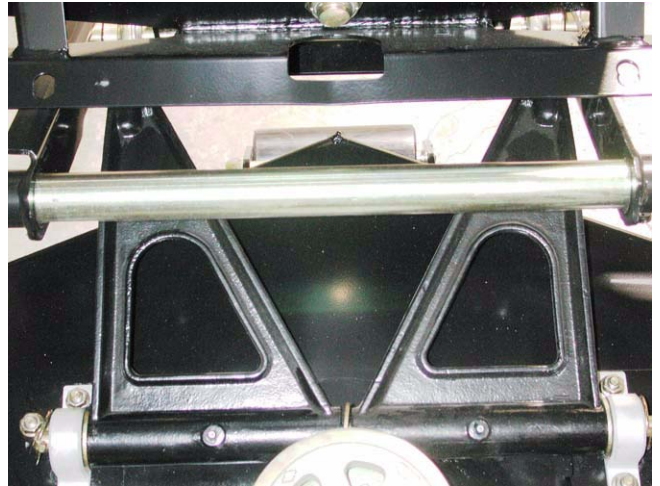


Figure 9.9

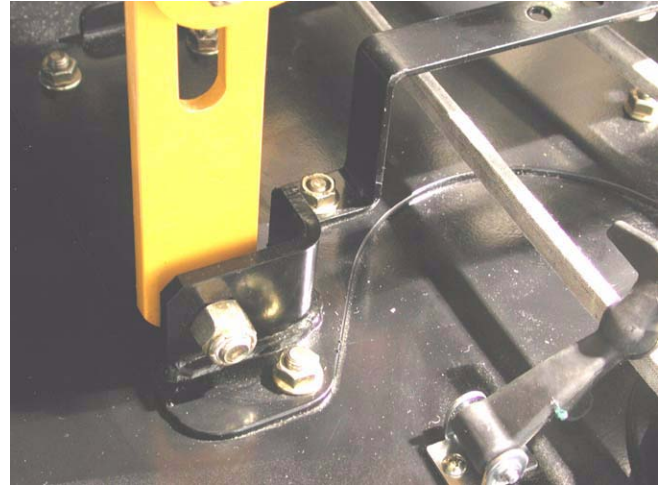


9.10. The deck itself features reversible caster wheel brackets. The same part number applies to both the left and the right brackets. See Figure 9.10.



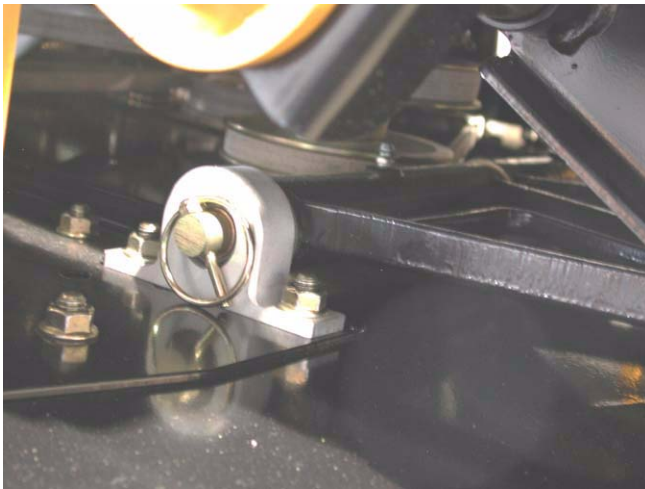
**Figure 9.10**

9.12. The deck support plates are larger this year, to prevent plate bending and separation. See Figure 9.12.



**Figure 9.12**

9.11. Improved self-aligning pillow blocks now suspend the deck. See Figure 9.11.



**Figure 9.11**

9.13. The baffling, airflow, and strength of the deck have all received some improvements this year.

9.14. The trailing edge of the discharge opening has been swept back, and the bar that prevents foot penetration has been modified. Both changes improve strength and airflow. See Figure 9.14.



**Figure 9.14**

## M48 Tank

9.15. A guiding baffle near the rear of the opening helps direct the clippings out from under the deck. See Figure 9.15.



**Figure 9.15**

9.17. The under-deck baffling has been reinforced, and a "stealth baffle" has been added between the second and third blades. See Figure 9.17.



**Figure 9.17**

9.16. The addition of a "California Gap" at the leading edge also improves airflow, and products the internal shape of the deck from damage if something is hit hard enough to bend the reinforced leading edge. See Figure 9.16.



**Figure 9.16**

## 10. KOHLER EFI

Fuel injection is nothing new. The Wright flyer that made history above the dunes at Kitty hawk, North Carolina was fuel injected. That was a hundred years ago this past summer. That system was only slightly more complex than a cam-driven Windex bottle. All diesel engines are fuel injected, though the principles of operation are considerably different.

Electronic fuel injection is not an especially recent development either. In 1956, Chrysler marketed the first car with electronic fuel injection. The fuel injection system used was made by Bendix, and was called "The Bendix Electrojector System". It was operated by a large Electronic Control Module that took up most of the trunk. The ECM used relatively delicate tubes, generated a lot of heat, and was susceptible to moisture, temperature changes, vibration, and shock. Most of these systems were discarded, and the cars retrofitted with carburetors.

There were mechanical gasoline fuel injection systems on the market before the Bendix system was introduced. Rochester and Bosch were fairly prominent.

The auto industry made the transition to electronic fuel injection in the 1970s and 80s, in response to emission control and fuel economy standards.

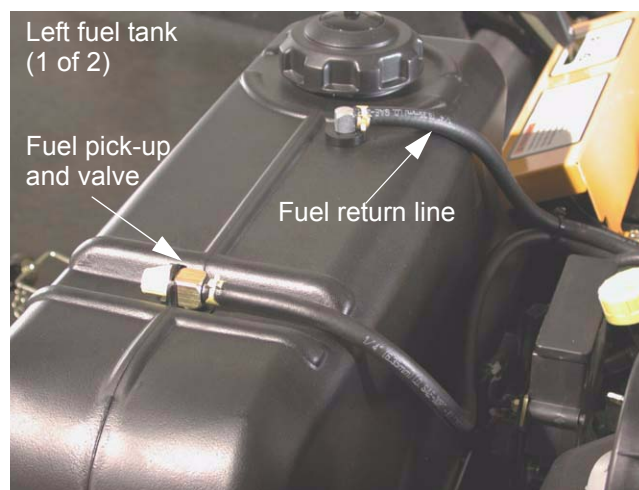
Even the best-tuned carburetion system only offers and approximation of the correct fuel mixture for any given operating condition. They can be tuned to provide "sweet spots", but generally cannot maintain an ideal mixture for all speeds, loads, temperatures, and conditions.

Carburetors also cost efficiency by "working" the air. the venturi effect that is used to atomize the fuel requires a pressure drop within the throat of the carburetor. The venturi that creates this pressure drop is a partial obstruction of the path into the engine.

Until recently, the advantage offered by fuel injection have not been worth the expense that they add to outdoor power equipment. Fuel injection systems have become less expensive and more dependable in the past two decades. At the same time, commercial turf equipment in specific, and outdoor power equipment in general have become more sophisticated and more expensive. Performance and expectations have improved. The final factor is the increase in the price of fuel.

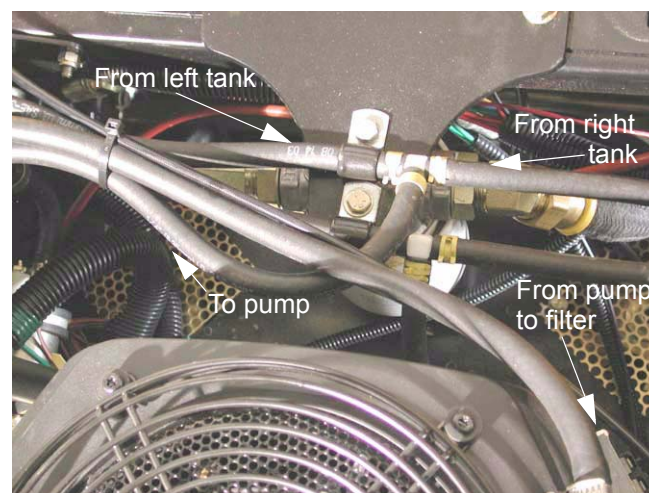
All of these factors combine to make EFI worthwhile for some applications. The improved fuel economy reduces fuel expense for heavy (Commercial) users. It also increases range, requiring fewer stops to replenish fuel.

- 10.1. For 2004, one model of TANK will be offered with a Kohler 28 H.P. EFI engine. That unit is a 60" Wide-Track model. That model is built on the widened M72 frame, but features a 60" deck.
- 10.2. The fuel injection system used on the the Kohler powered TANK uses a high pressure electric fuel pump. The pump generates 3 bars. of pressure (roughly 40 PSI.), and is capable of moving 25 liters per hour of fuel. This is more fuel volume than the engine will consume, but it is necessary in order to maintain pressure under all fuel demand conditions.
- 10.3. Because there is more fuel supplied to the injectors than the engine will consume, return lines route the excess volume back to the fuel tanks. See Figure 10.3.



**Figure 10.3**

- 10.4. The fuel lines from each tank Tee into a single line that feeds the fuel pump. See Figure 10.4.



**Figure 10.4**

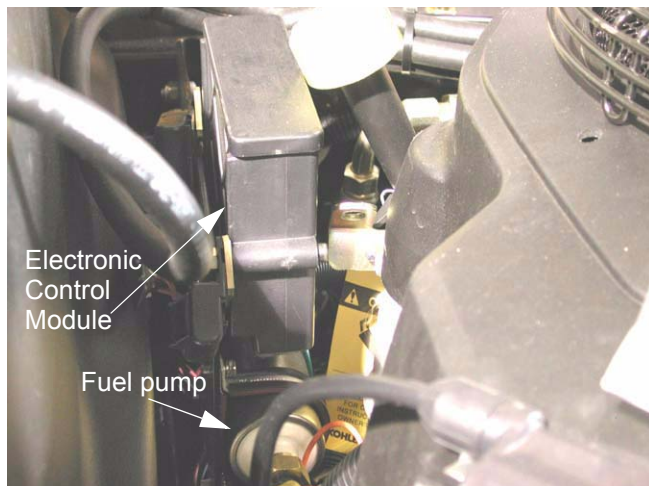
## M48 Tank

10.5. The return lines each lead back to the tank from a tee fitting just beneath the tee fitting for the fuel feed lines. The return fuel comes from the fuel pressure regulator.

**NOTE:** If one branch of the return line becomes crushed, kinked, or blocked, a disproportionate amount of fuel will return to the opposite tank.

- If one fuel tank consistently empties before the other, check the return lines.
- If this situation should occur with full tanks, an over-flow will result.

10.6. The fuel feed line leads from the tanks and tee down to a high pressure fuel pump located beneath the ECM. See Figure 10.6.



**Figure 10.6**

**CAUTION:** Before disconnecting any fuel line:

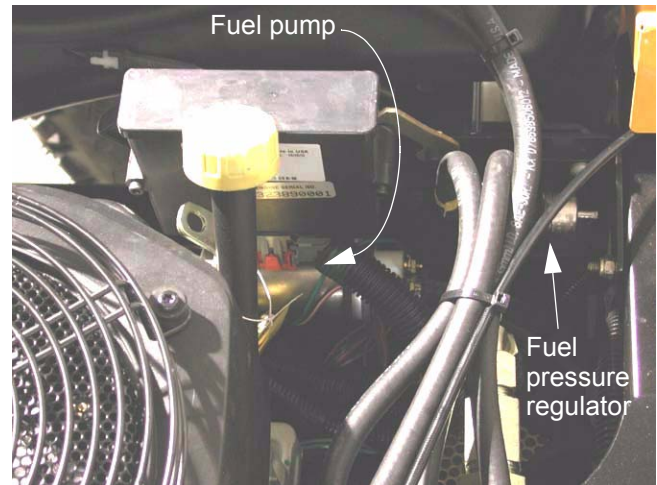
- Allow the engine to cool, and be sure the area is clear of any potential fire hazards, and has adequate ventilation.
- Have a catch pan handy to contain any spillage
- Relieve pressure from the any fuel lines between the fuel pump and the fuel rail.

**NOTE:** The fuel pump uses the fuel as a coolant. If the engine runs out of fuel, turn the key off immediately. Running dry will damage the pump.

**NOTE:** The fuel pump will run briefly each time the key switch is turned on. This pressurizes the system. If fuel pressure is absent, and the fuel pump cannot be heard when the key switch is turned on, the fuel pump may not be getting electricity. Check for power before condemning the fuel pump.

**NOTE:** The fuel pump is protected by an internal 60 $\mu$  filter.

10.7. The pump sends pressurized fuel to the fuel pressure regulator. The regulator maintains a constant down-stream pressure of between 36 and 42 PSI. See Figure 10.7.

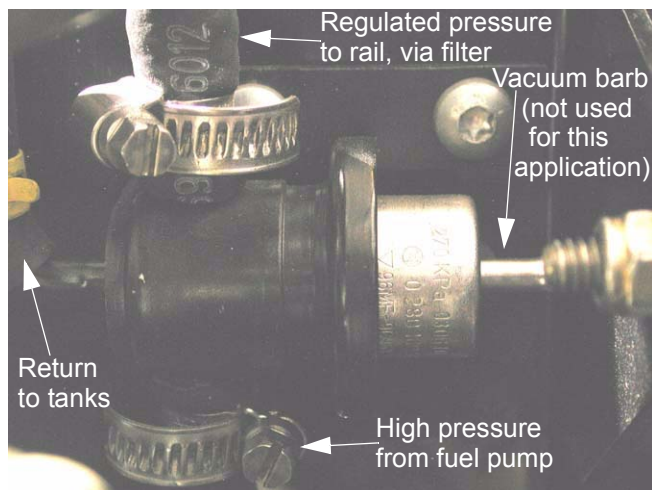


**Figure 10.7**

**NOTE:** High pressure fuel lines (SAE R9 rating) and Oetiker style hose clamps must be used between the fuel pump, pressure regulator, fuel filter, and fuel injector rail.

**CAUTION:** Substitution of fuel system components that are not capable of handling the pressure generated by this fuel system will lead to rapid failure of those components. Component failure (hose, clamps, filter, etc...) in the high pressure portion of the system poses a significant fire hazard.

10.8. There are two lines exiting the pressure regulator. One is a regulated pressure line that feeds the fuel rail via the fuel filter. The second line is a return line. The third line is a high pressure feed from the fuel pump. See Figure 10.8.



**Figure 10.8**

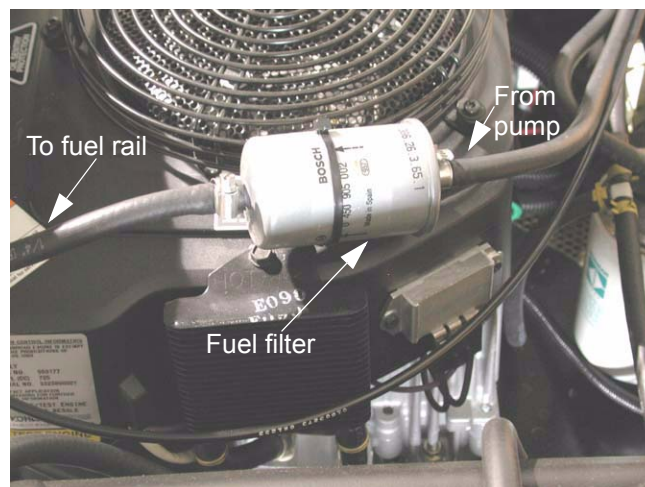
**NOTE:** There are two potential failure modes for pressure regulators. They may reduce the pressure too far, or they may not reduce the pressure far enough. The second mode is more common.

**NOTE:** If too much pressure is delivered to the injectors, the engine will run extremely rich. The problem will be very pronounced at idle, but will clear up to some extent under high load / open throttle conditions.

**NOTE:** When an engine has run dramatically rich, correct the core problem and change the oil before continued operation. Oil dilution that may result from the rich condition may cause hydro-lock and/or catastrophic engine failure.

**NOTE:** Check fuel pressure by connecting a fuel pressure gauge of adequate range (eg. NAPA / Balkamp part number BK.700-1089) to the Schrader valve on the fuel rail. This will check regulated fuel pressure. If fuel pressure at the Schrader valve is below 36 PSI, isolate the fuel pump, and check output pressure and volume.

10.9. The fuel filter is easily accessible. See Figure 10.9.



**Figure 10.9**

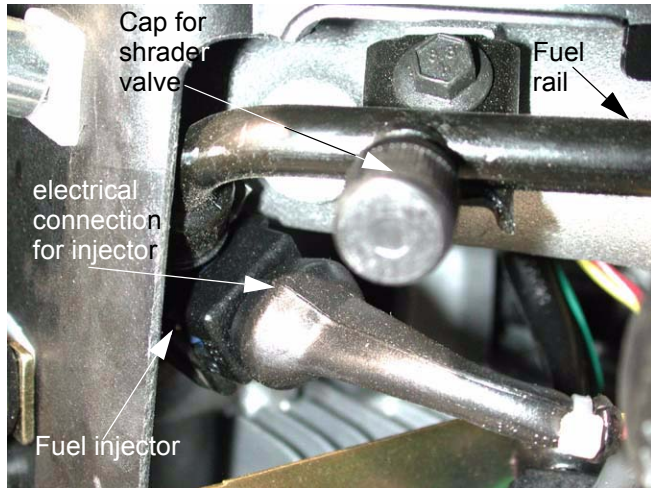
**NOTE:** Use only identical factory replacement fuel filters. Filters that are not capable of functioning at 3 bar. may rupture, leak, or disintegrate internally.

**NOTE:** Prime the fuel filter with a few ounces of fuel when installing it. The initial pressure surge into a dry filter may damage filtering medium.

**NOTE:** Fuel filters should be replaced at regular intervals specified in the Operator's Manual. A blocked fuel filter puts extra load on the pump, creating extra heat. This may lead to shortened fuel pump life. Fuel pumps are much more expensive than fuel filters. A blocked filter may not present symptoms until the blockage is substantial enough to damage the fuel pump.

10.10. After the filter, the fuel reaches the fuel rail. The fuel rail feeds the injectors. See Figure 10.10.

## M48 Tank



**Figure 10.10**

10.11. The shradar valve can be used for checking fuel pressure. Fuel pressure readings obtained at the shradar valve can help pin-down problems with the fuel pump or the fuel pressure regulator. See Figure 10.11.



**Figure 10.11**

10.12. Before any service is performed on the pressurized portion of the fuel system, the engine must be allowed to cool, and the pressure should be relieved.

10.13. To relieve pressure from the fuel system:

- Turn the key switch off.
- Remove the 10A in-line fuse that protects the fuel pump.
- Start the engine normally. It will run for only a few seconds.
- Turn the key switch off.

## 11. EFI CONTROLS

The Fuel injection system used by Kohler is an adapted version of the Bosch Motronic automotive system.

**NOTE:** Do not connect or disconnect any electrical components with the key switch in the “on” position. The resulting arc could cause immediate and severe damage to the ECU.

**NOTE:** If using a circuit tester, use only a high impedance tester (eg. Thexton model 125). Conventional testers pass the current they are checking through a small incandescent bulb. In some cases, the bulb draws more power than the circuit in the computer, over-loading the circuit and complicating the diagnostic process by inducing a circuit failure. High impedance testers do not actually pass much current, and the LED indicator will not draw enough power to damage the circuitry. See Figure 11.0.



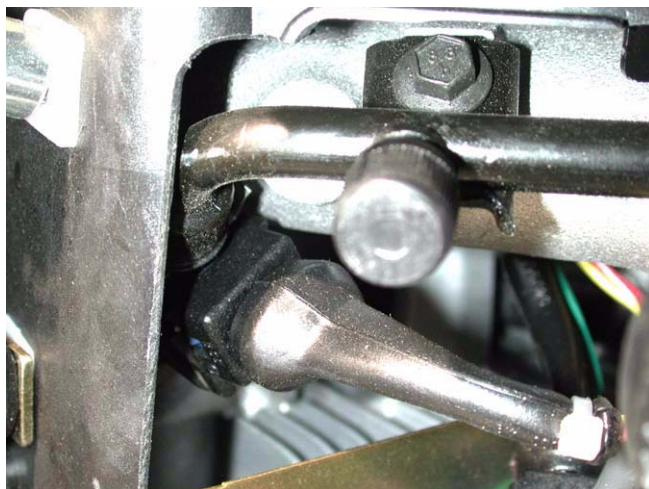
**Figure 11.0**

11.1. The EFI engine has a throttle valve or “air valve” similar to that of a carburetor. There is no fuel mixed into the air at this point. The throttle valve only regulates the amount of air that enters the engine.

11.2. The throttle responds to the governor just like it would with a carburetor.

11.3. The computer (ECU) takes in information from various sensors, and decides how much fuel the engine should have to maintain a correct fuel/air mixture. The ECU then sends electrical pulses to the individual injectors, triggering them to spray fuel into the intake tract.

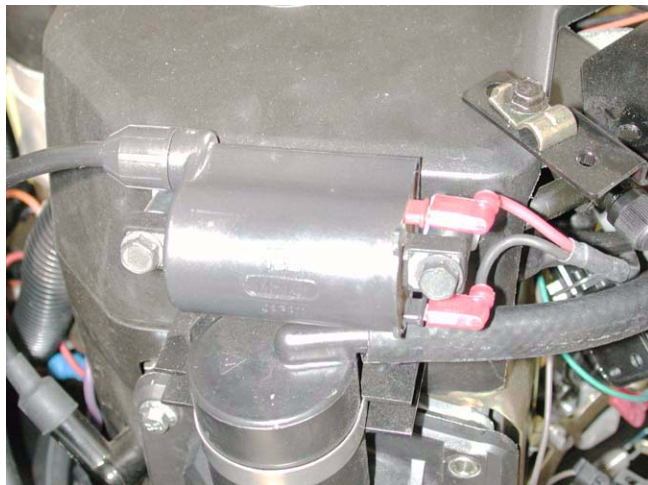
- 11.4. The fuel pressure at the injectors is held constant by the fuel pressure regulator. The amount of fuel delivered to the cylinders is controlled by the length of time that the individual fuel injectors are triggered. The length of time the injectors are triggered varies from 1.5 to 8.0 milliseconds.
- 11.5. Both injectors are triggered simultaneously. Each triggering causes the injector to spray half the amount of fuel required by the corresponding cylinder on the next cycle.
- 11.6. The injectors are “hot” as long as the key switch is on. The injection is triggered by the completion of a ground path within the ECU.
- 11.7. The injectors make an audible “click” each time they are triggered. If this click cannot be heard or felt, there may be a problem with the injector itself, or there may be a problem in the wiring harness.



**Figure 11.7**

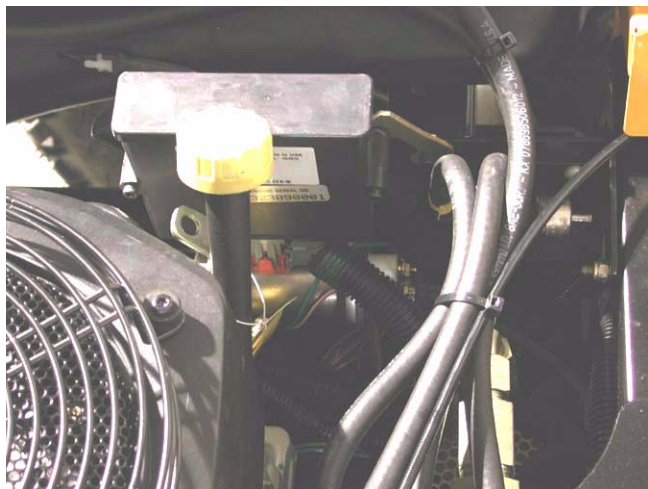
- 11.8. If a fuel injector is suspect, the circuit may be tested with a commonly available “noid” light, or the injector may be triggered using an electronic fuel injection pulse timer (eg. Thexton model number 139) in conjunction with a fuel pressure gauge. With the key switch off, triggering the injector should result in a measured drop in fuel pressure.

- 11.9. The ignition coils are also controlled by the ECU. Each cylinder has its own coil. See Figure 11.9.



**Figure 11.9**

- 11.10. The plastic-cased ECU is mounted to the frame, above the fuel pump. See Figure 11.10.



**Figure 11.10**

- 11.11. The ECU is the brain of the engine control system. It is very durable, but there are some rules to follow in order to avoid damage to the ECU:
- If you diagnose a faulty ECU, do not replace it without calling Cub cadet Technical Support for specific handling instructions.
  - Previously mentioned: do not use a conventional test light to look for power in the engine control circuit.
  - Previously mentioned: do not disconnect any electrical devices while the engine is running.
  - Do not reverse the battery terminal connections.

## M48 Tank

- Do not connect a battery charger to the TANK with the key switch turned on.
- The ECU requires at least 7.0 volts to function.
- If the battery goes dead, or is disconnected, the adaptive memory in the ECU will be cleared. It will take 10-15 minutes of running, at normal operating temperatures, under a variety of loads and throttle settings to re-learn the full envelope of performance. Clearing the memory will also clear diagnostic trouble codes.
- The ECU receives signals from a variety of sensors. These include: crankshaft speed and position, throttle position, engine temperature, oxygen content of the exhaust gas, battery voltage.
- There is an indicator light that flashes diagnostic codes in the event that there is a malfunction. If the signal from any of the sensors are not in the range that the ECU is expecting from comparison to its adaptive memory, a code will flash.
- In the event of a malfunction, the ECU has a "limp home" mode that will allow it to plug in a fixed value in place of the reading from the malfunctioning sensor.

11.12. The Throttle Position Sensor tells the ECU what the position of the throttle plate is. It is essentially a potentiometer. See Figure 11.12.



**Figure 11.12**

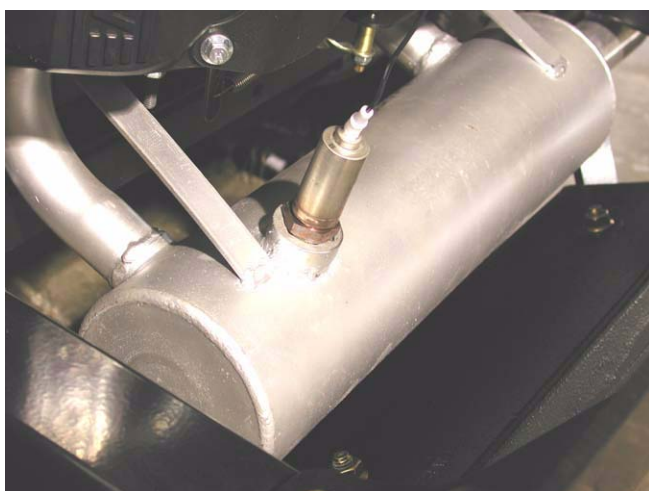
- If a TPS fails, it will result in rough or erratic engine performance. If a "dead" spot develops in the potentiometer, the engine will run badly whenever the throttle is in a position that corresponds with the "dead" range of the TPS.

- The TPS can be checked with an Ohm meter, looking for "jumps" as the throttle is swept through its full range of travel.
  - If the TPS mounting is disturbed for any reason, there is a Kohler-specified initialization procedure that must be performed.
- 11.13. The engine temperature has a bearing on the fuel/air mixture and ignition timing. The ECU "takes the engine's temperature" with a thermometer in the engine oil.
- When the engine is cold, the oil temperature is the same as the ambient temperature. Being an air-cooled engine, as the engine warms-up, the oil temperature reflects a balance between engine load and ambient temperature when operating normally. This is sufficient for the purposes of the ECU.
  - A bad temperature sender may result in rich fuel/air mixture accompanied by an erratic idle and somewhat reduced WOT power.
  - At 68deg. f, (20deg. c), the Ohm reading across the terminals of the oil temperature sensor should be in the 2375-2625  $\Omega$  range.
- 11.14. In order to coordinate the timing of the fuel injector triggering, as well as tune the fuel delivery and ignition timing to match the load applied to the engine, the ECU needs to know the speed that the crankshaft is spinning and the position of the crankshaft.
- There is a 60 tooth ferrite ring gear on the flywheel. This ring gear is separate from the starter motor ring gear. A Hall-effect pick-up mounted .049"-.069" from the ring gear generates a pulse as each tooth passes by. The ECU counts the pulses to determine engine RPM.
  - There are two consecutive teeth missing from the ring gear. The ECU gets a signal from each of the present teeth every 6 degrees of crankshaft rotation. The 12 degree gap is positioned 84 degrees before cylinder #1 reaches TDC. This tells the ECU where the engine is in terms of piston position.
  - Each time the engine is started, it will take 720 degrees of crankshaft rotation for the ECU to "find" the piston and begin working.
  - Comparing engine speed to throttle position, the ECU can interpolate the engine load.
  - If the cranks trigger signal fails to reach the ECU, the engine will not run.



- Crank triggers are generally an all-or-nothing proposition: they work perfectly or not at all. In extremely rare instances, a failed crankshaft trigger will not keep-up with the speed of the engine. It will work at low speed, but cause intermittent ignition and injector action at higher speeds. This will result in staccato misses and backfires.

11.15. The exhaust gas oxygen (O<sub>2</sub>) sensor contains a palladium insert. When oxygen passes by palladium, an electrical current is generated. Depending on the amount of oxygen flowing by the sensor, it will generate between 0.10 and 1.00 volts. See Figure 11.15.



**Figure 11.15**

- By measuring the amount of oxygen in the exhaust gas, the ECU knows how much air is passing through the engine un-burned. It can make adjustments to the injector pulse length to adjust the mixture until the ideal fuel air proportions are reached. This ratio is known as “stoichiometric ratio” and is theoretically 14.7 parts air to 1 part fuel (14.7:1).
- Adjustments the ECU makes to the fuel/air mixture are the result of what is called “closed loop” operation. The ECU is getting feedback on its performance from the oxygen sensor, and making adjustments based on that feedback.
- Oxygen sensors do not work below about 700 deg. F (375 deg. C). Because of this the engine will not go into closed-loop operation until it is warmed-up.
- Because of inconsistent gas flow at idle speed, most engines fall out of closed-loop operation at idle speed.

- Reaching a conclusion from the previous two bullet points, a bad oxygen sensor will not cause idle problems or cold-running problems.
- There is only one wire on the oxygen sensor used in this application. It does not have a heating element in it, nor does it have a ground wire. Some automotive applications have both of these features. Because it does not have a ground wire, it grounds through the body of the sensor, and back through the engine exhaust system.
- Oxygen sensors are susceptible to contamination from: leaded fuel, some RTV silicone sealants, some cleaning solvents. Look for the words “O<sub>2</sub> Sensor safe” on any of these products to be introduced up-stream of the oxygen sensor.

11.16. Oxygen sensors can be easily tested using a good quality, high impedance DVOM or an oscilloscope.

- Engine turned off, hot sensor (normal operating temperature) should have a resistance from the disconnected wire to the housing or 2.0KΩ. Cold sensor should have a resistance of 1.0MΩ.
- Engine running, (above idle speed) voltage measured from the disconnected wire (remember, do not disconnect or connect an wires while the engine is running), should fluctuate between 0.1 volt and 1.0 volt. This roughly approximates a sine-wave on an oscilloscope. A “blip” of the throttle should produce a momentary increase in voltage as the engine leans-out slightly then re-established correct mixture.
- A steadily declining voltage that recovers from a throttle blip without fluctuating may indicate an improperly positioned TPS.

11.17. This is a simplified introduction to the EFI system used on the Kohler engine found on the TANK. Complete diagnostic and service instructions can be found in the Kohler CH26 manual, section 5B.