Wheeled Compact Utility Loader Service Manual

Chain Drive / 4-Paw Gas / 4-Paw Diesel
This service manual was written expressly for Toro service technicians. The Toro Company has made every effort to make the information in this manual complete and correct.

Basic shop safety knowledge and mechanical/electrical skills are assumed. The Table of Contents lists the systems and the related topics covered in this manual.

For service information on drive systems, please refer to the Hydro-Gear BDP-10A/16A/21L Pump service manual (form no. 492-4789), Hydro-Gear P Series Pump service manual (form no. BLN 52503) and Parker-Ross TF wheel motor service manual (form no. 492-4753). For information specific to the engines used on this unit, refer to the appropriate engine manufacturer’s service and repair instructions.

Units covered on in this manual are:  
- Wheeled Chain Drive compact utility loader, model years 1998 - current  
- Wheeled 4-Paw Gas compact utility loader, model years 1999 - current  
- Wheeled 4-Paw Diesel compact utility loader, model years 1999 - current

The manual may also be specified for use on later model products.

The hydraulic power system is precision machinery. Maintain strict cleanliness control during all stages of service and repair. Cover or cap all hose ends and fittings whenever they are exposed. Even a small amount of dirt or other contamination can severely damage the system.

We are hopeful that you will find this manual a valuable addition to your service shop. If you have any questions or comments regarding this manual, please contact us at the following address:

The Toro Company  
SWS Technical Services  
8111 Lyndale Avenue South  
Bloomington, MN 55420

The Toro Company reserves the right to change product specifications or this manual without notice.
REVISIONS

Revision 000       5/01/12
## TABLE OF CONTENTS

### ALL UNITS SAFETY INFORMATION
- General Information .............................................................................................................. 1/1-1
- Think Safety First. ....................................................................................................................... 1/1-1

### ALL UNITS SPECIFICATIONS
- General Specifications ............................................................................................................... 2/1-1
- Dimensions ................................................................................................................................. 2/1-2
- Engine ....................................................................................................................................... 2/1-3
- Performance ............................................................................................................................... 2/1-4
- Hydraulic System ...................................................................................................................... 2/1-5
- Electrical System ....................................................................................................................... 2/1-6
- Drive System ............................................................................................................................. 2/1-6
- Torque Specifications ............................................................................................................... 2/1-7
- Standard Torque for Dry, Zinc Plated, and Steel Fasteners (Inch Series) ............................... 2/1-8
- Standard Torque for Dry, Zinc and Steel Fasteners (Metric Series) ....................................... 2/1-9
- Other Torque Specifications ...................................................................................................... 2/1-10
- Equivalents and Conversions .................................................................................................... 2/1-11
- U.S. to Metric Conversions ....................................................................................................... 2/1-12

### ALL UNITS GENERAL
- Raising the Traction Unit ......................................................................................................... 3/1-1
- 98-9050 Counterbalance Valve Rebuild .................................................................................. 3/1-2
- 99-3040 Counterbalance Valve Rebuild ................................................................................. 3/1-3
- 99-3070 4-Spool Valve Rebuild (Diesel) .................................................................................. 3/1-5
- 99-3072 Selector Valve Rebuild .............................................................................................. 3/1-5
- 100-4163 Hydraulic Cylinder Rebuild ...................................................................................... 3/1-13
- 104-4221 Flow Divider Valve Rebuild ...................................................................................... 3/1-17
- 105-6246 4-Spool Valve Rebuild (Chain Drive) ..................................................................... 3/1-29
- 105-7867 Hydraulic Cylinder Rebuild ...................................................................................... 3/1-33
- 108-4710 Hydraulic Tandem Pump Rebuild .......................................................................... 3/1-40
- 98-4732 cross-referenced to 104-7422 4-Spool Valve Rebuild (used on Chain Drive 22304) ..................................................................................................................... 3/1-62
- 99-3077 Auxiliary Valve Rebuild ............................................................................................ 3/1-67
- 99-3077 Auxiliary Valve Removal ............................................................................................ 3/1-67
- 99-3077 Auxiliary Valve Assembly .......................................................................................... 3/1-70

### CHAIN DRIVE DRIVE SYSTEM
- Drive Chain Replacement ......................................................................................................... 4/1-1
- Drive Chain Removal ................................................................................................................ 4/1-1
- Drive Chain Installation ............................................................................................................. 4/1-6
- Front Axle Replacement .......................................................................................................... 4/1-10
- Front Axle Removal .................................................................................................................. 4/1-10
- Front Axle Installation .............................................................................................................. 4/1-18
- Sprocket & Wheel Hub .............................................................................................................. 4/1-28
- Sprocket & Chain Inspection .................................................................................................... 4/1-28
- Rear Sprocket & Wheel Hub Removal ..................................................................................... 4/1-30
- Sprocket Replacement .............................................................................................................. 4/1-35
- Sprocket Removal .................................................................................................................... 4/1-35
- Sprocket Installation ................................................................................................................. 4/1-36
- Rear Sprocket & Wheel Hub Installation ............................................................................... 4/1-37
- Front Sprocket & Wheel Hub Installation .............................................................................. 4/1-40
- Front Axle Hub Rebuild ............................................................................................................ 4/1-46
- Front Sprocket & Wheel Hub Installation .............................................................................. 4/1-48
# TABLE OF CONTENTS

**CHAIN DRIVE DRIVE SYSTEM cont.**
- Checking the Drive Chain Tension ................................................................. 4/1-54
- Adjusting the Drive Chain Tension ................................................................. 4/1-55
- Wheel Motor Replacement .............................................................................. 4/1-56
  - Wheel Motor Removal ................................................................................. 4/1-56
  - Wheel Motor Installation ............................................................................ 4/1-64

**CHAIN DRIVE HYDRAULICS**
- Counterbalance Valve Replacement ............................................................... 4/2-1
  - Counterbalance Valve Removal ................................................................. 4/2-1
  - Counterbalance Valve Installation ............................................................. 4/2-6
- 4-Spool Valve Replacement ............................................................................. 4/2-11
  - 4-Spool Valve Removal .............................................................................. 4/2-11
  - 4-Spool Valve Installation ......................................................................... 4/2-17
- Hydraulic Filter Head Replacement ............................................................... 4/2-24
  - Hydraulic Filter Head Removal ................................................................. 4/2-24
  - Hydraulic Filter Head Installation .............................................................. 4/2-26
- Auxiliary Valve & Selector Valve Replacement ............................................ 4/2-28
  - Auxiliary Valve & Selector Valve Removal ............................................... 4/2-28
  - Auxiliary Valve & Selector Valve Installation .......................................... 4/2-31
- Lift Cylinder Replacement ............................................................................. 4/2-35
  - Lift Cylinder Removal ................................................................................ 4/2-35
  - Lift Cylinder Installation .......................................................................... 4/2-38
- Tilt Cylinder Replacement (New Style) ......................................................... 4/2-41
  - Tilt Cylinder Removal ................................................................................ 4/2-41
  - Tilt Cylinder Installation .......................................................................... 4/2-43

**CHAIN DRIVE LOADER ARM**
- Loader Arm Replacement ............................................................................. 4/3-1
  - Loader Arm Removal .................................................................................. 4/3-1
  - Loader Arm Installation .............................................................................. 4/3-7

**CHAIN DRIVE GAS ENGINE**
- Gas Engine Replacement ............................................................................. 4/4-1
  - Gas Engine Removal ................................................................................... 4/4-1
  - Gas Engine Installation .............................................................................. 4/4-14

**CHAIN DRIVE ELECTRICAL**
- Ignition Switch ............................................................................................... 4/5-1
  - Purpose ......................................................................................................... 4/5-1
  - Location ......................................................................................................... 4/5-1
  - How It Works .............................................................................................. 4/5-1
  - Testing .......................................................................................................... 4/5-1
- Relay ............................................................................................................... 4/5-2
  - Purpose ......................................................................................................... 4/5-2
  - Location ......................................................................................................... 4/5-2
  - How It Works .............................................................................................. 4/5-2
  - Testing .......................................................................................................... 4/5-2
- Fuses ............................................................................................................... 4/5-3
  - Purpose ......................................................................................................... 4/5-3
  - Location ......................................................................................................... 4/5-3
  - How It Works .............................................................................................. 4/5-3
  - Testing .......................................................................................................... 4/5-3
# TABLE OF CONTENTS

## CHAIN DRIVE ELECTRICAL cont.
- Auxiliary Neutral Switch ................................................................. 4/5-4
- Purpose ......................................................................................... 4/5-4
- Location ....................................................................................... 4/5-4
- How It Works ................................................................................ 4/5-4
- Testing ............................................................................................ 4/5-4
- Hour Meter .................................................................................... 4/5-5
- Purpose ......................................................................................... 4/5-5
- Location ....................................................................................... 4/5-5
- How It Works ................................................................................ 4/5-5
- Testing ............................................................................................ 4/5-5
- Battery Replacement ..................................................................... 4/5-6
- Battery Removal ........................................................................... 4/5-6
- Battery Installation ....................................................................... 4/5-7
- Electrical Schematic ..................................................................... 4/5-9
  22311 / 22317 ................................................................................ 4/5-9

## 4-PAW GAS DRIVE SYSTEM
- Front Wheel Motor Replacement .................................................. 5/1-1
- Front Wheel Motor Removal .......................................................... 5/1-1
- Front Wheel Motor Installation ..................................................... 5/1-7
- Rear Wheel Motor Replacement .................................................... 5/1-13
- Rear Wheel Motor Removal ............................................................ 5/1-13
- Rear Wheel Motor Installation ....................................................... 5/1-20

## 4-PAW GAS HYDRAULICS
- Left Hand Counterbalance Valve Replacement ......................... 5/2-1
- Left Hand Counterbalance Valve Removal ................................. 5/2-1
- Left Hand Counterbalance Valve Installation ......................... 5/2-7
- Right Hand Counterbalance Valve Replacement ....................... 5/2-11
- Right Hand Counterbalance Valve Removal .............................. 5/2-11
- Right Hand Counterbalance Valve Installation ....................... 5/2-18

## 4-PAW GAS LOADER ARM
- Loader Arm Replacement ............................................................... 5/3-1
- Loader Arm Removal .................................................................... 5/3-1
- Loader Arm Installation ................................................................. 5/3-7

## 4-PAW GAS ENGINE
- Engine Replacement ...................................................................... 5/4-1
- Engine Removal ............................................................................ 5/4-1
- Engine Installation ...................................................................... 5/4-13

## 4-PAW GAS ELECTRICAL
- Ignition Switch (P/N 103990) ....................................................... 5/5-1
- Purpose ......................................................................................... 5/5-1
- Location ....................................................................................... 5/5-1
- How It Works ................................................................................ 5/5-1
- Testing ............................................................................................ 5/5-1
- Relay .............................................................................................. 5/5-2
- Purpose ......................................................................................... 5/5-2
## TABLE OF CONTENTS

### 4-PAW GAS ELECTRICAL cont.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start Relay</td>
<td>5/5-2</td>
</tr>
<tr>
<td>Kill Relay</td>
<td>5/5-2</td>
</tr>
<tr>
<td>Location</td>
<td>5/5-2</td>
</tr>
<tr>
<td>How It Works</td>
<td>5/5-2</td>
</tr>
<tr>
<td>Testing</td>
<td>5/5-3</td>
</tr>
<tr>
<td>Fuses</td>
<td>5/5-3</td>
</tr>
<tr>
<td>Purpose</td>
<td>5/5-4</td>
</tr>
<tr>
<td>Location</td>
<td>5/5-4</td>
</tr>
<tr>
<td>How It Works</td>
<td>5/5-4</td>
</tr>
<tr>
<td>Testing</td>
<td>5/5-4</td>
</tr>
<tr>
<td>Neutral Safety Switch</td>
<td>5/5-4</td>
</tr>
<tr>
<td>Purpose</td>
<td>5/5-5</td>
</tr>
<tr>
<td>Location</td>
<td>5/5-5</td>
</tr>
<tr>
<td>How It Works</td>
<td>5/5-5</td>
</tr>
<tr>
<td>Testing</td>
<td>5/5-5</td>
</tr>
<tr>
<td>Auxiliary Neutral Switch</td>
<td>5/5-5</td>
</tr>
<tr>
<td>Purpose</td>
<td>5/5-6</td>
</tr>
<tr>
<td>Location</td>
<td>5/5-6</td>
</tr>
<tr>
<td>How It Works</td>
<td>5/5-6</td>
</tr>
<tr>
<td>Testing</td>
<td>5/5-6</td>
</tr>
<tr>
<td>Hour Meter/Tachometer</td>
<td>5/5-6</td>
</tr>
<tr>
<td>Purpose</td>
<td>5/5-7</td>
</tr>
<tr>
<td>Location</td>
<td>5/5-7</td>
</tr>
<tr>
<td>How It Works</td>
<td>5/5-7</td>
</tr>
<tr>
<td>Testing</td>
<td>5/5-7</td>
</tr>
<tr>
<td>Electrical Schematics</td>
<td>5/5-8</td>
</tr>
<tr>
<td>22312 - 2008, 2006</td>
<td>5/5-9</td>
</tr>
<tr>
<td>22312 - 2003, 2004</td>
<td>5/5-9</td>
</tr>
<tr>
<td>22305 - 2002, 2001</td>
<td>5/5-10</td>
</tr>
<tr>
<td>22305 - 2000, 1999</td>
<td></td>
</tr>
</tbody>
</table>

### 4-PAW DIESEL DRIVE SYSTEM

<table>
<thead>
<tr>
<th>Topic</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Front Wheel Motor Replacement</td>
<td>6/1-1</td>
</tr>
<tr>
<td>Front Wheel Motor Removal</td>
<td>6/1-1</td>
</tr>
<tr>
<td>Front Wheel Motor Installation</td>
<td>6/1-7</td>
</tr>
<tr>
<td>Rear Wheel Motor Replacement</td>
<td>6/1-13</td>
</tr>
<tr>
<td>Rear Wheel Motor Removal</td>
<td>6/1-13</td>
</tr>
<tr>
<td>Rear Wheel Motor Installation</td>
<td>6/1-20</td>
</tr>
</tbody>
</table>

### 4-PAW DIESEL HYDRAULICS

<table>
<thead>
<tr>
<th>Topic</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-Spool Valve Replacement (Diesel)</td>
<td>6/2-1</td>
</tr>
<tr>
<td>4-Spool Valve Removal</td>
<td>6/2-1</td>
</tr>
<tr>
<td>4-Spool Valve Installation</td>
<td>6/2-8</td>
</tr>
<tr>
<td>Hydraulic Auxiliary, Selector &amp; Flow Divider Valves</td>
<td>6/2-14</td>
</tr>
<tr>
<td>Hydraulic Auxiliary, Selector &amp; Flow Divider Valves Removal</td>
<td>6/2-14</td>
</tr>
<tr>
<td>Hydraulic Auxiliary, Selector &amp; Flow Divider Valves Installation</td>
<td>6/2-20</td>
</tr>
<tr>
<td>Hydraulic Lift Cylinder Replacement (Old Style)</td>
<td>6/2-24</td>
</tr>
<tr>
<td>Hydraulic Lift Cylinder Removal</td>
<td>6/2-24</td>
</tr>
<tr>
<td>Hydraulic Lift Cylinder Installation</td>
<td>6/2-28</td>
</tr>
</tbody>
</table>
# TABLE OF CONTENTS

## 4-PAW DIESEL HYDRAULICS cont.
- Hydraulic Tilt Cylinder Replacement (Old Style) .......................................................... 6/2-30
- Hydraulic Tilt Cylinder Removal ................................................................................. 6/2-30
- Hydraulic Tilt Cylinder Installation .......................................................................... 6/2-30
- Left Hand Counterbalance Valve Replacement ............................................................ 6/2-32
- Left Hand Counterbalance Valve Removal ................................................................. 6/2-32
- Left Hand Counterbalance Valve Installation ......................................................... 6/2-32
- Right Hand Counterbalance Valve Replacement ....................................................... 6/2-43
- Right Hand Counterbalance Valve Removal ............................................................ 6/2-43
- Right Hand Counterbalance Valve Installation ......................................................... 6/2-43
- Hydraulic Tandem Pump Replacement ................................................................... 6/2-53
- Hydraulic Tandem Pump Removal ........................................................................... 6/2-53
- Hydraulic Tandem Pump Installation ...................................................................... 6/2-57

## 4-PAW DIESEL LOADER ARM
- Loader Arm Replacement ......................................................................................... 6/3-1
- Loader Arm Removal .............................................................................................. 6/3-1
- Loader Arm Installation .......................................................................................... 6/3-7

## 4-PAW DIESEL ENGINE
- Engine Replacement ............................................................................................... 6/4-1
- Engine Removal ...................................................................................................... 6/4-1
- Engine Installation ................................................................................................. 6/4-26
- Checking the Alternator Belt Tension ...................................................................... 6/4-60
- Fan Belt Replacement ............................................................................................. 6/4-61
- Fan Belt Removal .................................................................................................... 6/4-61
- Fan Belt Installation ............................................................................................... 6/4-66
- Fan Replacement ..................................................................................................... 6/4-72
- Fan Removal ........................................................................................................... 6/4-72
- Fan Installation ....................................................................................................... 6/4-72
- Fuel Shut Down Solenoid Replacement .................................................................. 6/4-73
- Fuel Shut Down Solenoid Removal ........................................................................ 6/4-73
- Fuel Shut Down Solenoid Installation .................................................................. 6/4-74
- Glow Plug Replacement .......................................................................................... 6/4-76
- Glow Plug Removal ............................................................................................... 6/4-76
- Glow Plug Installation ............................................................................................ 6/4-77
- Muffler Replacement ............................................................................................... 6/4-77
- Muffler Removal ..................................................................................................... 6/4-77
- Muffler Installation ............................................................................................... 6/4-84
- Radiator Replacement ............................................................................................. 6/4-92
- Radiator Removal .................................................................................................... 6/4-92
- Radiator Installation ............................................................................................... 6/4-97
- Radiator Mount Replacement .................................................................................. 6/4-101
- Radiator Mount Removal ....................................................................................... 6/4-101
- Radiator Mount Installation ................................................................................... 6/4-102
- Pump Mount Assembly Rebuild ............................................................................. 6/4-103
- Fan Drive Pulley, Rubber Coupler & Flywheel Adapter Replacement ..................... 6/4-109
- Fan Drive Pulley, Rubber Coupler & Flywheel Adapter Removal ......................... 6/4-109
- Fan Drive Pulley, Rubber Coupler & Flywheel Adapter Installation .................... 6/4-113
## TABLE OF CONTENTS

### 4-PAW DIESEL ELECTRICAL

<table>
<thead>
<tr>
<th>Component</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ignition Switch</td>
<td>6/5-1</td>
</tr>
<tr>
<td>Purpose</td>
<td>6/5-1</td>
</tr>
<tr>
<td>Location</td>
<td>6/5-1</td>
</tr>
<tr>
<td>How It Works</td>
<td>6/5-1</td>
</tr>
<tr>
<td>Testing</td>
<td>6/5-1</td>
</tr>
<tr>
<td>Relay</td>
<td>6/5-2</td>
</tr>
<tr>
<td>Purpose</td>
<td>6/5-2</td>
</tr>
<tr>
<td>Location</td>
<td>6/5-2</td>
</tr>
<tr>
<td>How It Works</td>
<td>6/5-2</td>
</tr>
<tr>
<td>Testing</td>
<td>6/5-3</td>
</tr>
<tr>
<td>Fuses</td>
<td>6/5-4</td>
</tr>
<tr>
<td>Purpose</td>
<td>6/5-4</td>
</tr>
<tr>
<td>Location</td>
<td>6/5-4</td>
</tr>
<tr>
<td>How It Works</td>
<td>6/5-4</td>
</tr>
<tr>
<td>Testing</td>
<td>6/5-4</td>
</tr>
<tr>
<td>Neutral Safety Switches</td>
<td>6/5-5</td>
</tr>
<tr>
<td>Purpose</td>
<td>6/5-5</td>
</tr>
<tr>
<td>Location</td>
<td>6/5-5</td>
</tr>
<tr>
<td>How It Works</td>
<td>6/5-5</td>
</tr>
<tr>
<td>Testing</td>
<td>6/5-5</td>
</tr>
<tr>
<td>Auxiliary Neutral Switch</td>
<td>6/5-6</td>
</tr>
<tr>
<td>Purpose</td>
<td>6/5-6</td>
</tr>
<tr>
<td>Location</td>
<td>6/5-6</td>
</tr>
<tr>
<td>How It Works</td>
<td>6/5-6</td>
</tr>
<tr>
<td>Testing</td>
<td>6/5-6</td>
</tr>
<tr>
<td>Hour Meter</td>
<td>6/5-7</td>
</tr>
<tr>
<td>Purpose</td>
<td>6/5-7</td>
</tr>
<tr>
<td>Location</td>
<td>6/5-7</td>
</tr>
<tr>
<td>How It Works</td>
<td>6/5-7</td>
</tr>
<tr>
<td>Testing</td>
<td>6/5-7</td>
</tr>
<tr>
<td>Indicator Lights</td>
<td>6/5-8</td>
</tr>
<tr>
<td>Purpose</td>
<td>6/5-8</td>
</tr>
<tr>
<td>Location</td>
<td>6/5-8</td>
</tr>
<tr>
<td>Engine Oil Pressure Light</td>
<td>6/5-8</td>
</tr>
<tr>
<td>Battery Light</td>
<td>6/5-8</td>
</tr>
<tr>
<td>Engine Temperature Light</td>
<td>6/5-8</td>
</tr>
<tr>
<td>Glow Plug Indicator Light</td>
<td>6/5-8</td>
</tr>
<tr>
<td>Testing Indicator Lights</td>
<td>6/5-9</td>
</tr>
<tr>
<td>Glow Controller</td>
<td>6/5-10</td>
</tr>
<tr>
<td>Purpose</td>
<td>6/5-10</td>
</tr>
<tr>
<td>Location</td>
<td>6/5-10</td>
</tr>
<tr>
<td>How It Works</td>
<td>6/5-10</td>
</tr>
<tr>
<td>Testing</td>
<td>6/5-11</td>
</tr>
<tr>
<td>Fuel Shut Down Solenoid</td>
<td>6/5-12</td>
</tr>
<tr>
<td>Purpose</td>
<td>6/5-12</td>
</tr>
<tr>
<td>Location</td>
<td>6/5-12</td>
</tr>
<tr>
<td>How It Works</td>
<td>6/5-12</td>
</tr>
<tr>
<td>Testing</td>
<td>6/5-13</td>
</tr>
<tr>
<td>Troubleshooting</td>
<td>6/5-13</td>
</tr>
<tr>
<td>Electrical Schematics</td>
<td>6/5-14</td>
</tr>
<tr>
<td>22303 - 2001, 2000, 1999</td>
<td>6/5-14</td>
</tr>
</tbody>
</table>
General Information

This symbol means WARNING or PERSONAL SAFETY INSTRUCTION - read the instruction because it has to do with your safety. Failure to comply with the instruction may result in personal injury or even death.

This manual is intended as a service and repair manual only. The safety instructions provided herein are for troubleshooting, service, and repair of the Sitework Systems wheeled compact utility loader.

The wheeled loader and attachment operator’s manual contain safety information and operating tips for safe operating practices. Operator’s manuals are available online at www.toro.com or:

The Toro Company
Publications Department
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Bloomington, MN  55420

Think Safety First

Avoid unexpected starting of engine...

Always turn off the engine and disconnect the spark plug wire(s) before cleaning, adjusting, or repair.

Avoid lacerations and amputations...

Stay clear of all moving parts whenever the engine is running. Treat all normally moving parts as if they were moving whenever the engine is running or has the potential to start.

Avoid burns...

Do not touch the engine, muffler, or other components which may increase in temperature during operation, while the unit is running or shortly after it has been running.

Avoid fires and explosions...

Avoid spilling fuel and never smoke while working with any type of fuel or lubricant. Wipe up any spilled fuel or oil immediately. Never remove the fuel cap or add fuel when the engine is running. Always use approved, labeled containers for storing or transporting fuel and lubricants.

Avoid asphyxiation...

Never operate an engine in a confined area without proper ventilation.

Avoid injury from batteries...

Battery acid is poisonous and can cause burns. Avoid contact with skin, eyes, and clothing. Battery gases can explode. Keep cigarettes, sparks, and flames away from the battery.

Avoid injury due to inferior parts...

Use only original equipment parts to ensure that important safety criteria are met.

Avoid injury to bystanders...

Always clear the area of bystanders before starting or testing powered equipment.

Avoid injury due to projectiles...

Always clear the area of sticks, rocks, or any other debris that could be picked up and thrown by the powered equipment.

Avoid modifications...

Never alter or modify any part unless it is a factory approved procedure.

Avoid unsafe operation...

Always test the safety interlock system after making adjustments or repairs on the machine. Refer to the Electrical section in this manual for more information.
SAFETY INFORMATION

Hydraulics Safety

• Inspect all hydraulic line connectors and fittings. Make sure all hydraulic hoses and lines are in good condition before applying pressure to the system.

• Keep body and hands away from pin hole leaks or nozzles that eject high pressure hydraulic fluid. Use cardboard or paper to find hydraulic leaks. Hydraulic fluid escaping under pressure can penetrate the skin and cause injury. Fluid accidentally injected into the skin must be surgically removed within a few hours by a doctor or gangrene may occur.

• Before disconnecting or performing any work on the hydraulic system, lower the loader arm/attachment to the ground and stop the engine so all pressure is relieved.

• Be sure you understand a service procedure before working on the machine.
## SPECIFICATIONS

### General Specifications

<table>
<thead>
<tr>
<th>Model</th>
<th>220</th>
<th>222</th>
<th>220D, 320D</th>
<th>322</th>
<th>323</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>22311</td>
<td>22317</td>
<td>22300</td>
<td>22302</td>
<td>22305</td>
</tr>
<tr>
<td>Spark plug</td>
<td>Champion Premium Gold 2071 or Champion RC12YC (or equivalent)</td>
<td>All Years: Champion RC12YC (or equivalent) or 2001: Champion Premium Gold 2071</td>
<td>n/a</td>
<td>All years: Champion RC12YC (or equivalent) or 2001/2002: Champion Premium Gold 2071</td>
<td>Champion Premium Gold 2071 or Champion RC12YC (or equivalent) or 2010: Champion XC12YC (RFI type) (or equivalent)</td>
</tr>
<tr>
<td>Spark plug Gap</td>
<td>0.030&quot; (0.76mm)</td>
<td>n/a</td>
<td>0.030&quot; (0.76mm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fuel Tank Capacity</td>
<td>4.0 gallon (15.1 liter)</td>
<td>8.0 gallon (30.2 liter) 2 tanks, 4 gallons (15.1 liters) each</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fuel Shut-off</td>
<td>On the bottom of the fuel tank</td>
<td>In fuel line near tank</td>
<td>On the bottom of the fuel tank</td>
<td>In fuel line near tank</td>
<td>On the bottom of each tank</td>
</tr>
<tr>
<td>Fuel Filter</td>
<td>In-line 15 micron filtration rating</td>
<td>3 micron filtration rating w/water separator</td>
<td>In-line 15 micron filtration rating</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fuel Pump</td>
<td>Vacuum pulse</td>
<td>mechanical</td>
<td>Vacuum pulse</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Specifications

Dimensions

A. Overall operating height, fully raised / 91.2” (2317mm)
B. Hinge pin height, fully raised / 66.0” (1676mm)
C. Overall height / 48.7” (1237mm)
D. Overall length / 82.2” (2088mm)
E. Dump angle / 34°
F. Dump height / 47.0” (1194mm)
G. Reach, fully raised / 26.0” (660mm)
H. Bucket rollback, ground position / 19°
I. Bucket rollback, fully raised / 97°
J. Wheelbase / 28.0” (711mm)
K. Overall width / 40.5” (1029mm)
X. Ground Clearance, front / 5.8” (147mm)
X. Ground Clearance, rear / 5.8” (147mm)
X. Reach, maximum / 28.0” (711mm)
X. Bucket rollback, carry position / 20°

X. = Dimension not shown

Fig A
## Engine

<table>
<thead>
<tr>
<th>Model</th>
<th>220</th>
<th>222</th>
<th>220D, 320D</th>
<th>322</th>
<th>323</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>22311</td>
<td>22317</td>
<td>22300 22304</td>
<td>22302 22303</td>
<td>22305</td>
</tr>
<tr>
<td>220D</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>320D</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>322</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>323</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Specifications

- **Engine Model Specifications**
  - **220 22311 22317**: Kohler Command model CH20S, 4-cycle, air cooled, 2 cylinder, horizontal crankshaft, overhead valves, 12VDC solenoid shift electric starter, 15 amp alternator and voltage regulator, high capacity air cleaner
  - **222 22300 22304**: Kohler Command CH22, 4-cycle, air cooled 2 cylinder, horizontal crankshaft, overhead valve, hydraulic valve lifters, cast iron cylinder liners, 12VDC solenoid shift electric starter, 15 amp alternator and voltage regulator, high capacity air cleaner
  - **220D 320D 22302 22303**: Kubota Super Mini Diesel model D722-E, High capacity dry-type remote air cleaner
  - **322 22305**: Kohler Command CH22, 4-cycle, air cooled, 2 cylinder, horizontal crankshaft, overhead valve, hydraulic valve lifters, cast iron cylinder liners, 12VDC solenoid shift electric starter, 15 amp alternator and voltage regulator, high capacity air cleaner
  - **323 22312 22318**: Kohler Command CH23, 4-cycle, air cooled, 2 cylinder, horizontal crankshaft, overhead valve, hydraulic valve lifters, cast iron cylinder liners, 12VDC solenoid shift electric starter, 15 amp alternator and voltage regulator, high capacity air cleaner

<table>
<thead>
<tr>
<th>Model</th>
<th>220</th>
<th>222</th>
<th>220D, 320D</th>
<th>322</th>
<th>323</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>22311</td>
<td>22317</td>
<td>22300 22304</td>
<td>22302 22303</td>
<td>22305</td>
</tr>
<tr>
<td>Compression Ratio</td>
<td>8.5:1</td>
<td>23.5:1</td>
<td>38.1 in³ (624cm³)</td>
<td>38.1 in³ (624cm³)</td>
<td>38.1 in³ (624cm³)</td>
</tr>
<tr>
<td>Displacement</td>
<td>38.1 in³ (624cm³)</td>
<td>43.88 in³ (719 cm³)</td>
<td>38.1 in³ (624cm³)</td>
<td>41.0 in³ (674 cm³)</td>
<td></td>
</tr>
<tr>
<td>Bore</td>
<td>3.03&quot; (77mm)</td>
<td>2.64&quot; (67mm)</td>
<td>3.03&quot; (77mm)</td>
<td>3.15&quot; (80mm)</td>
<td></td>
</tr>
<tr>
<td>Stroke</td>
<td>2.64&quot; (67mm)</td>
<td>2.68&quot; (68mm)</td>
<td>2.64&quot; (67mm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power (RPM)</td>
<td>20 HP (14.9kW) @ 3600 (Gross)</td>
<td>22 HP (16.4kW) @ 3600 (Gross)</td>
<td>20 HP (14.9kW) @ 3600 (Gross)</td>
<td>22 HP (16.4kW) @ 3600 (Gross)</td>
<td></td>
</tr>
<tr>
<td>Peak Torque (RPM)</td>
<td>32 ft-lbs (43 Nm) @ 2500 (Gross)</td>
<td>36.8 ft-lbs (50 Nm) @ 2600 (Gross)</td>
<td>33 ft-lbs (45 Nm) @ 2500 (Gross)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No-load Speed (RPM)</td>
<td>3600 ± 75</td>
<td>3700 +50/-100 (Installed)</td>
<td>3600 ± 75</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Idle Speed (RPM)</td>
<td>1400 ± 200</td>
<td>1200 ± 75</td>
<td>1300 ± 100</td>
<td>1200 ± 75</td>
<td>1400 ± 200</td>
</tr>
<tr>
<td>Oil Capacity</td>
<td>2 quarts (1.9 L) with filter</td>
<td>0.84 US gallons (3.2 L)</td>
<td>2 quarts (1.9 L)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dry Weight</td>
<td>90 lbs (41kg)</td>
<td>154.3 lbs (70kg)</td>
<td>90 lbs (41kg)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## SPECIFICATIONS

### Performance

<table>
<thead>
<tr>
<th>Model</th>
<th>220</th>
<th>222</th>
<th>220D, 320D</th>
<th>322</th>
<th>323</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>22311</td>
<td>22317</td>
<td>22300</td>
<td>22302</td>
<td>22305</td>
</tr>
<tr>
<td></td>
<td>22304</td>
<td></td>
<td>22303</td>
<td>22312</td>
<td>22318</td>
</tr>
</tbody>
</table>

| Tip Capacity (per SAE J732) | 760 lbs (345kg) w/o operator  
1030 lbs (467kg) with  
200 lbs (91kg) operator |

| Operating Capacity (per SAE J818) | 380 lbs (172kg) w/o operator  
515 lbs (234kg) with 200 lbs (91kg) operator |

<table>
<thead>
<tr>
<th>Speed</th>
<th>0-3 mph (0-4.8km/hr) forward or reverse (infinitely variable)</th>
<th>0-3.7 mph (0-6.0km/hr) forward or reverse (infinitely variable)</th>
<th>0-3.7 mph (0-6.0km/hr) forward or reverse (infinitely variable)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-0.3 mph (0-0.48km/hr)</td>
<td>0-0.3.7 mph (0-0.6km/hr) forward or reverse (infinitely variable)</td>
<td>0-0.3 mph (0-0.48km/hr) forward or reverse (infinitely variable)</td>
<td>0-0.3.7 mph (0-0.6km/hr) forward or reverse (infinitely variable)</td>
</tr>
</tbody>
</table>

| Weight                  | 1430 lbs (649kg) w/o attachment  
1576 lbs (715kg) with std. bucket |
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1722 lbs (781kg) w/o attachment</td>
<td></td>
</tr>
<tr>
<td>1868 lbs (847kg) with std. bucket</td>
<td></td>
</tr>
</tbody>
</table>

| Weight                  | 1567 lbs (711kg) w/o attachment  
1713 lbs (777kg) with std. bucket |
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1722 lbs (781kg) w/o attachment</td>
<td></td>
</tr>
<tr>
<td>1868 lbs (847kg) with std. bucket</td>
<td></td>
</tr>
</tbody>
</table>
## Hydraulic System

<table>
<thead>
<tr>
<th>Model</th>
<th>220</th>
<th>222</th>
<th>220D, 320D</th>
<th>322</th>
<th>323</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>22311</td>
<td>22317</td>
<td>22300</td>
<td>22302</td>
<td>22303</td>
</tr>
<tr>
<td>Pressure</td>
<td>3000 psi (207 bar) system relief pressure</td>
<td>3250 psi (224 bar) system relief pressure</td>
<td>3000 psi (207 bar) system relief pressure</td>
<td>3225 psi (222 bar) system relief pressure</td>
<td>3000 psi (207 bar) system relief pressure</td>
</tr>
<tr>
<td>Low Flow</td>
<td>3.7 GPM (14.0 L/min)</td>
<td>4.0 GPM (15.3 L/min)</td>
<td>3.7 GPM (14.0 L/min)</td>
<td>4.0 GPM (15.3 L/min)</td>
<td></td>
</tr>
<tr>
<td>High Flow (@3600 RPM)</td>
<td>8.5 GPM (32.2 L/min)</td>
<td>10.8 GPM (40.9 L/min)</td>
<td>8.5 GPM (32.2 L/min)</td>
<td>10.8 GPM (40.9 L/min)</td>
<td></td>
</tr>
<tr>
<td>Hydraulic Pump</td>
<td>Tandem Gear Pump</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Displacements</td>
<td>0.55 &amp; 0.24 in³/rev (9.0 &amp; 4.0 cm³/rev)</td>
<td>0.69 &amp; 0.26 in³/rev (11.2 &amp; 4.3 cm³/rev)</td>
<td>0.55 &amp; 0.24 in³/rev (9.0 &amp; 4.0 cm³/rev)</td>
<td>0.69 &amp; 0.26 in³/rev (11.2 &amp; 4.3 cm³/rev)</td>
<td></td>
</tr>
<tr>
<td>Hydraulic Tank Capacity</td>
<td>14.8 gallon (56.0 L)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hydraulic Filter</td>
<td>Spin-on 10 micron nom. Filtration rating</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hydraulic Fluid</td>
<td>SAE10W-30 or 15W-40 diesel oil (API Service CH-4 or higher)</td>
<td>Mobil 424 hydraulic oil</td>
<td>SAE10W-30 or 15W-40 diesel oil (API Service CH-4 or higher)</td>
<td>Mobil 424 hydraulic oil</td>
<td>SAE10W-30 or 15W-40 diesel oil (API Service CH-4 or higher)</td>
</tr>
<tr>
<td>Hydraulic Cylinders</td>
<td>2 loader arm</td>
<td>1 bucket curl</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Auxiliary Connectors</td>
<td>Flush face type</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## SPECIFICATIONS

### Electrical System

<table>
<thead>
<tr>
<th>Model</th>
<th>220</th>
<th>222</th>
<th>220D, 320D</th>
<th>322</th>
<th>323</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>22311</td>
<td>22317</td>
<td>22300, 22304</td>
<td>22302, 22303</td>
<td>22305</td>
</tr>
<tr>
<td>Battery</td>
<td>12 volt, 380cca min. @ 0ºF (-18ºC)</td>
<td>12 volt, 340cca min. @ 0ºF (-18ºC)</td>
<td>12 volt, 380cca min. @ 0ºF (-18ºC)</td>
<td>12 volt, 435cca @ 0ºF (-18ºC)</td>
<td>12 volt, 380cca min. @ 0ºF (-18ºC)</td>
</tr>
<tr>
<td>Alternator</td>
<td>12 VDC 15 amp with regulator</td>
<td>12 VDC 14.0 amp w/regulator</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interlock</td>
<td>Auxiliary power control lever must be in neutral position for starting engine</td>
<td>Auxiliary &amp; traction valves neutral to start</td>
<td>Auxiliary power control lever must be in neutral position for starting engine</td>
<td></td>
<td>Auxiliary and traction valves neutral to start</td>
</tr>
<tr>
<td>Fuses</td>
<td>25 amp 30 amp</td>
<td>30 amp 10 amp 25 amp</td>
<td>25 amp 30 amp</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gages</td>
<td>Hourmeter on back of control panel Hourmeter with service reminder indicator</td>
<td>Hourmeter on back of control panel</td>
<td>Warning light cluster</td>
<td>Hourmeter on back of control panel</td>
<td>Hourmeter / tachometer with service reminder indicator</td>
</tr>
</tbody>
</table>

### Drive System

<table>
<thead>
<tr>
<th>Model</th>
<th>220</th>
<th>222</th>
<th>220D, 320D</th>
<th>322</th>
<th>323</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>22311</td>
<td>22317</td>
<td>22300, 22304</td>
<td>22302, 22303</td>
<td>22305</td>
</tr>
<tr>
<td>Chain Drive</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4-Paw</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Chain Drive Models:
All four wheels are powered. The two rear wheels are individually driven by hydraulic rotor vane motors. Each front wheel is chain driven from the rear wheels via #60H chain.

### 4-Paw Models:
All four wheels are powered. Each wheel is individually driven by a hydraulic roller vane motor.
Torque Specifications

Recommended fastener torque values are listed in the following tables. For critical applications, as determined by Toro, either the recommended torque or a torque that is unique to the application is clearly identified and specified in the service manual.

These torque specifications for the installation and tightening of fasteners shall apply to all fasteners which do not have a specific requirement identified in the service manual. The following factors shall be considered when applying torque: cleanliness of the fastener, use of a thread sealant (Loctite), degree of lubrication on the fastener, presence of a prevailing torque feature, hardness of the surface underneath of the fastener’s head, or similar condition which affects the installation.

As noted in the following tables, torque values should be reduced by 25% for lubricated fasteners to achieve the similar stress as a dry fastener. Torque values may also have to be reduced when the fastener is threaded into aluminum or brass. The specific torque value should be determined based on the aluminum or brass material strength, fastener size, length of thread engagement, etc.

The standard method of verifying torque shall be performed by marking a line on the fastener (head or nut) and mating part, then back off fastener 1/4 of a turn. Measure the torque required to tighten the fastener until the lines match up.

### Inch Series bolts and Screws

<table>
<thead>
<tr>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>(A) Grade 1 &amp; 2</td>
</tr>
<tr>
<td>(B) Grade 5</td>
</tr>
<tr>
<td>(C) Grade 8</td>
</tr>
</tbody>
</table>

### Metric Bolts and Screws

<table>
<thead>
<tr>
<th>Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>(A) Class 8.8</td>
</tr>
<tr>
<td>(B) Class 10.9</td>
</tr>
</tbody>
</table>
### SPECIFICATIONS

#### Standard Torque for Dry, Zinc Plated, and Steel Fasteners (Inch Series)

<table>
<thead>
<tr>
<th>Thread Size</th>
<th>Grade 1, 5, &amp; 8 with Thin Height Nuts</th>
<th>SAE Grade 1 Bolts, Screws, Studs, &amp; Sems with Regular Height Nuts (SAE J995 Grade 2 or Stronger Nuts)</th>
<th>SAE Grade 5 Bolts, Screws, Studs, &amp; Sems with Regular Height Nuts (SAE J995 Grade 2 or Stronger Nuts)</th>
<th>SAE Grade 8 Bolts, Screws, Studs, &amp; Sems with Regular Height Nuts (SAE J995 Grade 2 or Stronger Nuts)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>In-lb</td>
<td>N-cm</td>
<td>In-lb</td>
<td>N-cm</td>
</tr>
<tr>
<td># 6 - 32 UNC</td>
<td>10 ± 2</td>
<td>13 ± 2</td>
<td>15 ± 2</td>
<td>170 ± 20</td>
</tr>
<tr>
<td># 6 - 40 UNF</td>
<td>13 ± 2</td>
<td>25 ± 5</td>
<td>29 ± 3</td>
<td>330 ± 30</td>
</tr>
<tr>
<td># 8 - 32 UNC</td>
<td>18 ± 2</td>
<td>30 ± 5</td>
<td>42 ± 4</td>
<td>475 ± 45</td>
</tr>
<tr>
<td># 8 - 36 UNF</td>
<td>10 ± 2</td>
<td>13 ± 2</td>
<td>17 ± 2</td>
<td>190 ± 20</td>
</tr>
<tr>
<td># 10 - 24 UNF</td>
<td>48 ± 7</td>
<td>53 ± 7</td>
<td>100 ± 10</td>
<td>1125 ± 100</td>
</tr>
<tr>
<td>1/4 - 28 UNF</td>
<td>53 ± 7</td>
<td>65 ± 10</td>
<td>115 ± 10</td>
<td>1300 ± 100</td>
</tr>
<tr>
<td>5/16 - 18 UNC</td>
<td>115 ± 15</td>
<td>105 ± 17</td>
<td>200 ± 25</td>
<td>2250 ± 280</td>
</tr>
<tr>
<td>5/16 - 24 UNF</td>
<td>138 ± 17</td>
<td>128 ± 17</td>
<td>225 ± 25</td>
<td>2540 ± 280</td>
</tr>
<tr>
<td>3/8 - 16 UNC</td>
<td>16 ± 2</td>
<td>16 ± 2</td>
<td>30 ± 3</td>
<td>41 ± 4</td>
</tr>
<tr>
<td>3/8 - 24 UNF</td>
<td>27 ± 3</td>
<td>37 ± 4</td>
<td>50 ± 5</td>
<td>68 ± 7</td>
</tr>
<tr>
<td>7/16 - 14 UNC</td>
<td>29 ± 3</td>
<td>39 ± 4</td>
<td>55 ± 5</td>
<td>75 ± 7</td>
</tr>
<tr>
<td>7/16 - 20 UNF</td>
<td>30 ± 3</td>
<td>48 ± 7</td>
<td>75 ± 8</td>
<td>102 ± 11</td>
</tr>
<tr>
<td>1/2 - 13 UNC</td>
<td>32 ± 3</td>
<td>53 ± 7</td>
<td>85 ± 8</td>
<td>115 ± 11</td>
</tr>
<tr>
<td>5/8 - 11 UNC</td>
<td>65 ± 10</td>
<td>88 ± 12</td>
<td>119 ± 16</td>
<td>150 ± 15</td>
</tr>
<tr>
<td>5/8 - 18 UNC</td>
<td>75 ± 10</td>
<td>95 ± 15</td>
<td>129 ± 20</td>
<td>170 ± 15</td>
</tr>
<tr>
<td>3/4 - 10 UNC</td>
<td>93 ± 12</td>
<td>140 ± 20</td>
<td>190 ± 27</td>
<td>265 ± 25</td>
</tr>
<tr>
<td>3/4 - 16 UNF</td>
<td>115 ± 15</td>
<td>165 ± 25</td>
<td>300 ± 25</td>
<td>407 ± 34</td>
</tr>
<tr>
<td>7/8 - 9 UNC</td>
<td>140 ± 20</td>
<td>225 ± 25</td>
<td>305 ± 34</td>
<td>430 ± 45</td>
</tr>
<tr>
<td>7/8 - 14 UNF</td>
<td>155 ± 25</td>
<td>260 ± 30</td>
<td>353 ± 41</td>
<td>475 ± 45</td>
</tr>
</tbody>
</table>

**Note:** Reduce torque values listed in the table above by 25% for lubricated fasteners. Lubricated fasteners are defined as threads coated with a lubricant such as oil, graphite, or thread sealant such as Loctite.

**Note:** Torque values may have to be reduced when installing fasteners into threaded aluminum or brass. The specific torque value should be determined based on the fastener size, the aluminum or base material strength, length of thread engagement, etc.
**Standard Torque for Dry, Zinc and Steel Fasteners (Metric Series)**

<table>
<thead>
<tr>
<th>Thread Size</th>
<th>Class 8.8 Bolts, Screws, and Studs with Regular Height Nuts (Class 8 or Strong Nuts)</th>
<th>Class 10.9 Bolts, Screws, and Studs with Regular Height Nuts (Class 10 or Strong Nuts)</th>
</tr>
</thead>
<tbody>
<tr>
<td>M5 X 0.8</td>
<td>57 ± 5 in-lb 640 ± 60 N-cm</td>
<td>78 ± 7 in-lb 885 ± 80 N-cm</td>
</tr>
<tr>
<td>M6 X 1.0</td>
<td>96 ± 9 in-lb 1018 ± 100 N-cm</td>
<td>133 ± 13 in-lb 1500 ± 150 N-cm</td>
</tr>
<tr>
<td>M8 X 1.25</td>
<td>19 ± 2 ft-lb 26 ± 3 N-m</td>
<td>27 ± 2 ft-lb 36 ± 3 N-m</td>
</tr>
<tr>
<td>M10 X 1.5</td>
<td>38 ± 4 ft-lb 52 ± 5 N-m</td>
<td>53 ± 5 ft-lb 72 ± 7 N-m</td>
</tr>
<tr>
<td>M12 X 1.75</td>
<td>66 ± 7 ft-lb 90 ± 10 N-m</td>
<td>92 ± 9 ft-lb 125 ± 12 N-m</td>
</tr>
<tr>
<td>M16 X 2.0</td>
<td>166 ± 15 ft-lb 225 ± 20 N-m</td>
<td>229 ± 22 ft-lb 310 ± 30 N-m</td>
</tr>
<tr>
<td>M20 X 2.5</td>
<td>325 ± 33 ft-lb 440 ± 45 N-m</td>
<td>450 ± 37 ft-lb 610 ± 50 N-m</td>
</tr>
</tbody>
</table>

**Note:** Reduce torque values listed in the table above by 25% for lubricated fasteners. Lubricated fasteners are defined as threads coated with a lubricant such as oil, graphite, or thread sealant such as Loctite.

**Note:** Torque values may have to be reduced when installing fasteners into threaded aluminum or brass. The specific torque value should be determined based on the fastener size, the aluminum or base material strength, length of thread engagement, etc.

**Note:** The nominal torque values listed above are based on 75% of the minimum proof load specified in SAE J1199. The tolerance is approximately ± 10% of the nominal torque value. Thin height nuts include jam nuts.
### Other Torque Specifications

#### SAE Grade 8 Steel Set Screws

<table>
<thead>
<tr>
<th>Thread Size</th>
<th>Recommended Torque</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Square Head</td>
</tr>
<tr>
<td>1/4 - 20 UNC</td>
<td>140 ± 20 in-lb</td>
</tr>
<tr>
<td>5/16 - 18 UNC</td>
<td>215 ± 35 in-lb</td>
</tr>
<tr>
<td>3/8 - 16 UNC</td>
<td>35 ± 10 ft-lb</td>
</tr>
<tr>
<td>1/2 - 13 UNC</td>
<td>75 ± 15 ft-lb</td>
</tr>
</tbody>
</table>

#### Wheel Bolts and Lug Nuts

<table>
<thead>
<tr>
<th>Thread Size</th>
<th>Recommended Torque**</th>
</tr>
</thead>
<tbody>
<tr>
<td>7/16 - 20 UNF</td>
<td>65 ± 10 ft-lb</td>
</tr>
<tr>
<td>Grade 5</td>
<td></td>
</tr>
<tr>
<td>1/2 - 20 UNF</td>
<td>80 ± 10 ft-lb</td>
</tr>
<tr>
<td>Grade 5</td>
<td></td>
</tr>
<tr>
<td>M12 X 1.25</td>
<td>80 ± 10 ft-lb</td>
</tr>
<tr>
<td>Class 8.8</td>
<td></td>
</tr>
<tr>
<td>M12 X 1.5</td>
<td>80 ± 10 ft-lb</td>
</tr>
<tr>
<td>Class 8.8</td>
<td></td>
</tr>
</tbody>
</table>

** For steel wheels and non-lubricated fasteners.

#### Thread Cutting Screws (Zinc Plated Steel)

<table>
<thead>
<tr>
<th>Thread Size</th>
<th>Baseline Torque*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type 1, Type 23, or Type F</td>
<td></td>
</tr>
<tr>
<td>No. 6 - 32 UNC</td>
<td>20 ± 5 in-lb</td>
</tr>
<tr>
<td>No. 8 - 32 UNC</td>
<td>30 ± 5 in-lb</td>
</tr>
<tr>
<td>No.10 - 24 UNC</td>
<td>38 ± 7 in-lb</td>
</tr>
<tr>
<td>1/4 - 20 UNC</td>
<td>85 ± 15 in-lb</td>
</tr>
<tr>
<td>5/16 - 18 UNC</td>
<td>110 ± 20 in-lb</td>
</tr>
<tr>
<td>3/8 - 16 UNC</td>
<td>200 ± 100 in-lb</td>
</tr>
</tbody>
</table>

#### Thread Cutting Screws (Zinc Plated Steel)

<table>
<thead>
<tr>
<th>Thread Size</th>
<th>Baseline Torque*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type A</td>
<td>Type B</td>
</tr>
<tr>
<td>No. 6</td>
<td>18</td>
</tr>
<tr>
<td>No. 8</td>
<td>15</td>
</tr>
<tr>
<td>No. 10</td>
<td>12</td>
</tr>
<tr>
<td>No. 12</td>
<td>11</td>
</tr>
</tbody>
</table>

*Hole size, material strength, material thickness and finish must be considered when determining specific torque values. All torque values are based on non-lubricated fasteners.

#### Conversion Factors

- in-lb $\times 11.2985 = N$-cm
- ft-lb $\times 1.3558 = N$-m
- N-cm $\times 0.08851 = in$-lb
- N-cm $\times 0.73776 = ft$-lb
## Equivalents and Conversions

### Decimal and Millimeter Equivalents

<table>
<thead>
<tr>
<th>Fractions</th>
<th>Decimals</th>
<th>mm</th>
<th>Fractions</th>
<th>Decimals</th>
<th>mm</th>
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</thead>
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1 mm = 0.03937 in. 

0.001 in. = 0.0254 mm
### U.S. to Metric Conversions

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<th>To Convert</th>
<th>Into</th>
<th>Multiply By</th>
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<td>Yards</td>
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<td>Meters</td>
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<tr>
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<td></td>
<td>Centimeters</td>
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<td>Cubic Meters</td>
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<tr>
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<td>Cubic Inches</td>
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</tr>
<tr>
<td>Pounds</td>
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<tr>
<td>Ounces</td>
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<td>Grams</td>
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<tbody>
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<thead>
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<tr>
<td>Foot-pounds</td>
<td></td>
<td>Kilogram-Meters</td>
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<tr>
<td>Inch-pounds</td>
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</tr>
<tr>
<td>Gallons</td>
<td></td>
<td>Liters</td>
<td>3.785</td>
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<th></th>
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<tbody>
<tr>
<td>Gallons/Minute</td>
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<td>Liters/Minute</td>
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<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Fahrenheit</td>
<td></td>
<td>Celsius</td>
<td></td>
</tr>
</tbody>
</table>

1. Subtract 32°
2. Multiply by 5/9
Raising the Traction Unit

1. Raise the loader arm 6” – 12” (15 – 30cm) off the ground.

2. Turn off the machine and remove the key.

3. Lift the rear of the machine (Fig. 0001).

4. Position jackstands under the rear 2 corners of the machine. Remove the floor jack (Fig. 0002).

5. Raise the front of the machine (Fig. 0003).

6. Position jackstands under the front 2 corners of the machine. Remove the floor jack (Fig. 0004).

7. Lower the loader arm.
98-9050 Counterbalance Valve Rebuild

1. Secure the counterbalance valve in a vise.

2. Remove both cartridges from the valve (Fig. 0005).

3. Replace the o-rings and back-up rings on each of the cartridges (Fig. 0006).

4. Install the two cartridges into the counterbalance valve body (Fig. 0007).

A. O-rings (3)  
B. Back-up rings (3)
99-3040 Counterbalance Valve Rebuild

1. Secure the counterbalance valve in a vise.

2. Remove both cartridges from the valve (Fig. 0008).

3. Remove the needle valve assembly (Fig. 0009).

4. Replace the o-rings and back-up rings on both cartridges (Fig. 0010).

5. Replace the o-ring on the needle valve (Fig. 0011).

Fig. 0008

Fig. 0009

Fig. 0010

Fig. 0011
6. Install the needle valve into the valve body (Fig. 0012).

7. Install the two cartages into the valve body (Fig. 0013).
99-3070 4-Spool Valve Rebuild (Diesel)

1. Remove the two neutral safety switches from the spring covers (Fig. 0014).

2. Remove the 4 return spring covers from the bottom of the 4-spool valve (Fig. 0015).

3. Remove the 4-spool return springs (Fig. 0016).

4. Remove the 2 switch block mounts from the 4-spool valve (Fig. 0017).
5. Remove the 2 detents for the neutral safety switches (Fig. 0018).

6. Remove the 4 operator assemblies from the spool valve (Fig. 0019). Remove the gaskets from the operator assemblies.

7. Remove the 4-spool valves from the valve body (Fig. 0020).

8. Remove the relief valve from the valve body (Fig. 0021).
9. Remove the 3 check valves from the valve body (Fig. 0022).

10. Remove check valve located on the bottom of the valve body (Fig. 0023).

11. Remove the plug from the valve body (Fig. 0024).

12. Remove the 8 o-rings from the valve ports (Fig. 0025). Check the o-rings for cuts and/or chafing. If there are signs of damage, the spools may be damaged and need replacing. Discard the o-rings after inspection.

13. Flush and clean the valve housing with a cleaning solvent and air dry. Inspect the valve and valve components. Replace if nicks, scratches, wear, or contamination are present.
4-Spool Valve Assembly (Fig. 0026):

A. Return spring cover (4)
B. Return spring cover o-ring (2)
C. Neutral safety switch detent (2)
D. Return spring (4)
E. Neutral safety switch mounting block (2)
F. Spool (4)
G. Check valve (4)
H. Plug
I. Spool o-ring (8)
J. Check valve o-ring (4, only one shown in photo)
K. Valve body
L. Operator assembly (4)
M. Gasket (4)
N. Relief valve
14. Install new o-rings into the grooves in the valve bores (Fig. 0027).

15. Disassemble the relief valve and inspect it for wear or damage. Avoid changing the location of the pressure adjusting screw. Reassembly as shown (Fig. 0028).

16. Replace the o-ring on the pressure relief valve and install it into the 4-spool valve housing (Fig. 0029).

17. Make an initial adjustment of the pressure relief valve if the original setting was changed during disassembly, or if the relief valve was replaced. The initial adjustment of the pressure relief valve screw should be 3/8" (9.5mm) from the shoulder of the relief valve body (Fig. 0030).

A. Relief valve

A. 3/8" (9.5mm)
18. Replace the o-ring on the plug and install the plug into the 4-spool valve body (Fig. 0031).

19. Replace the o-ring on the 3 check valves and install them into the 4-spool valve body (Fig. 0032).

20. Replace the o-ring on the remaining check valve and install it in the port on the bottom of the valve body (Fig. 0033).

21. Lubricate the 4-spools and carefully insert them through the o-rings and into the valve body (Fig. 0034).
22. Inspect the rubber boot for cracks and damage; replace as needed. Apply grease to the ball on all 4 of the operator assemblies (Fig. 0035).

23. Install a gasket onto each of the 4 operator assemblies. Install each operator assembly onto the 4-spool valve body (Fig. 0036).

24. Install the 2 detents for the neutral safety switches (Fig. 0037).

25. Install new o-rings onto the two switch block mounts. Install the 2 switch block mounts onto the 2 center spools (Fig. 0038).
26. Lubricate and install the 4-spool return springs (Fig. 0039).

28. Install the 2 inside spool return spring covers onto the 2 switch block mounts (Fig. 0041).

27. Install the o-rings on the 2 outer return spring covers. Install the two outside return spring covers onto the 4-spool valve body (Fig. 0040).

29. Install the two neutral safety switches in the two switch block mounts (Fig. 0042).
99-3072 Selector Valve Rebuild

1. Remove the two Allen cap screws securing the detent cover to the valve body (Fig. 0043).

2. Remove the detent assembly (Fig. 0044).

3. Remove the two Allen screws that secure the actuator lever (Fig. 0045).
4. Lift up on the actuator arm assembly (Fig. 0046). This will release the actuator lever from the spool (Fig. 0047).

5. Carefully remove the spool from the valve body (Fig. 0048).

6. Remove the plug and o-ring from the valve body (Fig. 0049).
7. Carefully remove the 2 spool seal o-rings from the groove in each end of the valve body and discard (Fig. 0050).

8. Flush and clean the valve housing with a cleaning solvent and air dry. Inspect the valve and valve components. Replace if nicks, scratches, wear, or contamination are present.

9. Apply a coating of hydraulic oil to the new o-rings and install them in the groove in each end of the valve body (Fig. 0051).

10. Install a new o-ring on the plug. Install the plug into the valve body (Fig. 0052).

11. Carefully slide the spool into the valve body (Fig. 0053).
12. Position a gasket over the spool. Install the actuator lever through the hole in the spool and then up to the valve body (Fig. 0054).

13. Install 2 Allen screws to secure the actuator lever to the valve body (Fig. 0055).

14. Install a new o-ring on the plate and slide the plate over the spool up to the valve body (Fig. 0056).

15. Install the detent assembly (Fig. 0057).
16. Slide a gasket over the detent assembly and then position the detent cover over the detent (Fig. 0058).

17. Install 2 Allen cap screws to secure the detent cover to the valve body (Fig. 0059).

100-4163 Hydraulic Cylinder Rebuild

1. Clean away all dirt and other foreign substance from openings, particularly at the head of the hydraulic cylinder.

2. Clamp the tilt cylinder barrel in a vise (Fig. 0060).

Note: If excessive wear due to side-loads or binding is a possibility, mark or note the piston and head relationship to the rod and barrel. This condition will usually show up as a highly polished surface on the piston and head 90° to the pin rotation axis (Fig. 0061).
3. Use a spanner wrench installed in the holes provided. Unscrew the head (counterclockwise from the ram end) (Fig. 0062).

4. Pull out the cylinder rod to remove the piston and head assembly from the barrel (Fig. 0063).

5. Remove the barrel from the vise.

Hydraulic Cylinder Assembly (Fig. 0064):

INSPECT ROD: There should be no scratches or pits deep enough to catch the fingernail. Pits that go to the base metal are unacceptable. Scratches that catch the fingernail but are not to the base metal, 0.5" (1.27 cm) long and primarily in the circumferential direction are acceptable provided they cannot cut the rod seal. Chrome should be present over the entire surface of the rod and the lack thereof is unacceptable. In the event that an unacceptable condition occurs, the cylinder should be replaced.

INSPECT HEAD: Visually inspect the inside bore for scratches or polishing. Deep scratches are unacceptable. Polishing indicates uneven loading and when this occurs, the bore should be checked for out-of-roundness. If out-of-round exceeds 0.007" (.18mm), this is unacceptable. Check the condition of the dynamic seals, looking particularly for metallic particles embedded in the piston seal surface. Remove the seals. Damage to the seal grooves, particularly on the sealing surfaces, is unacceptable. In the event that an unacceptable condition occurs, the cylinder should be replaced.
INSPECT BARREL ASSEMBLY: Visually inspect the inside bore for scratches and pits. There should be no scratches or pits deep enough to catch the fingernail. Scratches that catch the fingernail but are less than 0.5” (1.27cm) and primarily in the circumferential direction are acceptable provided they cannot cut the piston seal. In the event that an unacceptable condition occurs, the cylinder should be replaced.

6. Remove the back-up washer (Fig. 0065).

7. Remove the second back-up washer (Fig. 0066).

8. Remove the o-ring located around the PSP seal (Fig. 0067).
9. Separate the inner seal from the PSP seal and remove the PSP seal (Fig. 0068).

10. Remove the inner seal (Fig. 0069).

11. Remove the piston wear ring (Fig. 0070).

12. Loosen two set screws located on the piston (Fig. 0071).
13. Install the rod end in a bench vise. With a spanner wrench, remove the piston from ram shaft (Fig. 0072).

15. Remove the o-ring dust seal from the head (Fig. 0074).

14. Visually inspect for material defects and contamination. All piston seals and o-rings must be replaced with new parts.

16. Remove the back-up o-ring from the head (Fig. 0075).

Piston Assembly (Fig. 0073):

- A. Wear Ring
- B. Piston
- C. Back-up Washer (2)
- D. Inner PSP Seal
- E. PSP Seal
- F. O-ring
17. Remove the o-ring from the head (Fig. 0076).

Fig. 0076  IMG-0392a

18. Remove the head from the ram shaft (Fig. 0077).

Fig. 0077  IMG-0393a

19. Remove both wear rings from inside the head (Fig. 0078).

Fig. 0078  IMG-0394a

20. From the other side of the head assembly, remove the wiper seal (Fig. 0079).

Fig. 0079  IMG-0395a
ALL UNITS/GENERAL

21. Remove the seal from inside the head assembly (Fig. 0080).

![Fig. 0080](IMG-0396a)

22. Remove the back-up washer from inside the head assembly (Fig. 0081).

![Fig. 0081](IMG-0397a)

23. Thoroughly rinse the inside of the head with a cleaning solvent. Rinse and clean all internal components of any foreign material with a lint-free rag.

![Head Assembly (Inside Seals)](IMG-0399a)

A. Wiper Seal  D. Head
B. Back-up Washer  E. Wear Ring (2)
C. Seal

24. Visually inspect for material defects and contamination. All seals and o-rings must be replaced with new parts (Fig. 0082 and Fig. 0083).

**Note:** Upon assembly lubricate the head and all seals with 10W-30 oil prior to installation.

![Head Assembly (Outside o-rings)](IMG-0401a)

A. Head  C. Back-up o-ring
B. O-ring  D. O-ring dust seal
25. Install the two wear rings inside the head (Fig. 0084).

26. Twist the seal into a “C” shape and allow it to snap into the groove (Fig. 0085).

**Note:** The groove of the seal faces toward the barrel side of the head.

27. Install the back-up washer next to the seal (Fig. 0086).

28. Install the wiper seal in the groove of the head assembly (Fig. 0087).
29. Install the outer o-rings onto the head assembly:
   
   a. Install protective plastic or tape over the threads of the head assembly to protect the o-rings from damage (Fig. 0088).
   
   b. Lubricate and install an o-ring in the groove of the head assembly (Fig. 0089).
   
   c. Remove the protective plastic or tape and install the back-up o-ring onto the head (Fig. 0090).
   
   d. Install the o-ring dust seal next to the back-up o-ring (Fig. 0091).
30. Place the cylinder rod into a vise and install protective plastic or tape over the threads (Fig. 0092).

32. Remove the protective tape/plastic from the threads.

33. Apply a small quantity of thread locking compound (blue) to the cylinder rod threads (Fig. 0094).

34. Loosely install the piston until hand tight or fully seated on the threads (Fig. 0095).
35. Using a spanner wrench, tighten the piston onto the cylinder rod (Fig. 0096).

36. Tighten the 2 set screws on the piston to secure (Fig. 0097).

37. Lubricate and install the wear ring onto the piston (Fig. 0098).

38. Install a back-up washer onto the piston (Fig. 0099).
39. Install the inner PSP seal (Fig. 0100).

41. Install the o-ring over the PSP seal, make sure the o-ring sits flat and is not twisted (Fig. 0102).

40. Install the PSP seal (Fig. 0101).

42. Install the second back-up washer (Fig. 0103).
43. If possible, the piston/seal assembly should sit at least one hour to allow the seals to elastically restore.

44. Install the cylinder rod assembly into the barrel (Fig. 0104).

45. Using a spanner wrench, tighten the head into the barrel (Fig. 0105).

**104-4221 Flow Divider Valve Rebuild**

1. Loosen the set screw securing the handle to the flow divider spool. Remove the handle (Fig. 0106).

2. Remove the plugs located on either side of the flow divider valve (Fig. 0107).
3. Remove the spring and manifold from the flow divider body (Fig. 0108).

4. Remove a snap ring and an o-ring from either end of the flow divider spool. There is one on each side of the valve body (Fig. 0109).

5. Remove the spool from the valve body (Fig. 0110).

6. Remove the o-rings and the back-up o-rings from the flow divider and discard (Fig. 0111):

   A. Spool
   B. Snap ring (2)
   C. Seal (2)
   D. Back-up ring (2)
   E. O-Ring (2)
7. Flush the valve body with a solvent and then compressed air to clean it out. Inspect the manifold and flow divider for any scratches or wear.

8. Install the o-rings and back-up rings onto the spool (Fig. 0112).

9. Lubricate the o-rings and seals. Push the flow diver valve into the valve body (Fig. 0113).

10. Install an o-ring and a snap ring on each side of the flow divider (Fig. 0114).

11. Install a new o-ring on each plug. Install a plug into the side opposite the spool (Fig. 0115).
12. Install the spring and manifold into the valve body (Fig. 0116).

13. Install the second plug into the manifold port (Fig. 0117).

14. Install the handle into the spool and tighten the set screw to secure (Fig. 0118).
105-6246 4-Spool Valve Rebuild (Chain Drive)

1. Remove the 4 return spring covers from the bottom of the 4-spool valve (Fig. 0119).

![Fig. 0119](IMG-0492a)

2. Remove the spool return springs (Fig. 0120).

![Fig. 0120](IMG-0493a)

3. Remove the 4 operator assemblies from the spools (Fig. 0121).

![Fig. 0121](IMG-0494a)

4. Pull the 4-spool out of the valve body (Fig. 0122).

![Fig. 0122](IMG-0495a)
5. Remove the relief valve from the valve body (Fig. 0123).

6. Remove the 3 check valves from the valve body (Fig. 0124).

7. Remove the check valve located on the bottom of the valve body (Fig. 0125).

8. Remove the plug from the valve body (Fig. 0126).
9. Remove and inspect the 8 spool seal o-rings (4 on the top, 4 on the bottom) for cuts or chafing (Fig. 0127).

10. Some 4-spool valves have a pressure relief installed on the back of the valve housing. If a plug is located on the back of the housing, remove it (Fig. 0128).
11. Flush and clean the valve housing with a cleaning solvent and air dry. Inspect the 4-spool for nicks, scratches, wear, or contamination.

4-Spool Valve Assembly (Fig. 0129):

- A. Spool spring cap (4)
- B. Spool spring cap gasket (4)
- C. Spool spring (4)
- D. Spool (4)
- E. Plug
- F. Spool o-ring (8)
- G. Check valve
- H. Check valve o-ring (4, only one shown in photo)
- I. 4-spool valve housing
- J. Check valve (3)
- K. Operator assembly gasket (4)
- L. Operator assembly (4)
- M. Pressure relief valve
12. Lubricate and install new o-rings into the grooves in the top and bottom spool ports (4 ports on top and 4 ports on bottom) (Fig. 0130).

14. Lubricate and install a new o-ring on the pressure relief valve. Install the pressure relief valve in the 4-spool valve (Fig. 0132).

13. Disassemble the relief valve and inspect it for wear or damage. Avoid changing the location of the pressure adjusting screw. Reassembly as shown (Fig. 0131).

15. Make an initial adjustment of the pressure relief valve if the original setting was changed during disassembly, or if the relief valve was replaced. Initial adjustment of the pressure relief valve screw should be 3/8” (9.5 mm) from the shoulder of the relief valve body to the end of the threads (Fig. 0133).

- Pressure relief valve
- 3/8” (9.5mm)
16. Lubricate and install a new o-ring onto the plug. Install the plug into the valve body (Fig. 0134).

17. Lubricate and install a new o-ring onto each of the 3 check valves. Install the 3 check valves into the front face of the valve body (Fig. 0135).

18. Lubricate and install a new o-ring onto the remaining check valve. Install the check valve into the port located on the bottom of the valve body (Fig. 0136).

19. Lubricate the 4-spool ports and carefully insert them into the 4-spool ports in the valve body (Fig. 0137).
20. Apply grease to the ball on all 4 operator assemblies (Fig. 0138).

21. Position a gasket between the 4 operator assemblies and the valve body. Install the 4 operator assemblies to the valve body (Fig. 0139).

22. Lubricate the 4-spool return springs and install them to the 4-spool (Fig. 0140).

23. Position a gasket between the 4 return spring covers and the valve body. Install the 4 return spring covers to the valve body (Fig. 0141).
24. If the 4-spool valve uses an external pressure relief valve: lubricate a new o-ring and install it on the external pressure relief valve. Install the external pressure relief valve in the back of the valve body (Fig. 0142).

105-7867 Hydraulic Cylinder Rebuild

1. Clean away all dirt or other foreign substance from openings, particularly at the head end of the hydraulic cylinder.

2. Clean out any material in the locking slot (Fig. 0143).

3. Clamp the hydraulic cylinder barrel in a vise.

Note: If excessive wear due to side loads or binding is a possibility, mark or note the piston and its relationship to the rod and barrel. This condition will usually show up as a highly polished surface on the piston and head 90° to pin rotation (Fig. 0144).
4. Install a spanner wrench in the holes located on the head. Rotate the head counter-clockwise until the beveled edge of the retaining ring appears in the milled locking slot of the barrel. Insert a flat blade screwdriver between the beveled edge of the retaining ring and the milled locking slot (Fig. 0145).

5. Continue to rotate the head counter-clockwise until the retaining ring is completely removed (Fig. 0146).

6. Pull the cylinder rod assembly out of barrel (Fig. 0147).

7. Remove the barrel from the vise.

Hydraulic Cylinder Assembly (Fig. 0148):

- A. Barrel
- B. Retaining ring
- C. Piston
- D. Head
- E. Cylinder rod
INSPECT ROD: There should be no scratches or pits deep enough to catch the fingernail. Pits that go to the base metal are unacceptable. Scratches that catch the fingernail but are not to the base metal, 0.5” (1.27 cm) long and primarily in the circumferential direction are acceptable provided they cannot cut the rod seal. Chrome should be present over the entire surface of the rod and the lack thereof is unacceptable. In the event that an unacceptable condition occurs, the cylinder should be replaced.

INSPECT HEAD: Visually inspect the inside bore for scratches or polishing. Deep scratches are unacceptable. Polishing indicates uneven loading and when this occurs, the bore should be checked for out-of-roundness. If out-of-round exceeds 0.007” (.18mm), this is unacceptable. Check the condition of the dynamic seals, looking particularly for metallic particles embedded in the piston seal surface. Remove the seals. Damage to the seal grooves, particularly on the sealing surfaces, is unacceptable. In the event that an unacceptable condition occurs, the cylinder should be replaced.

INSPECT BARREL ASSEMBLY: Visually inspect the inside bore for scratches and pits. There should be no scratches or pits deep enough to catch the fingernail. Scratches that catch the fingernail but are less than 0.5” (1.27cm) and primarily in the circumferential direction are acceptable provided they cannot cut the piston seal. In the event that an unacceptable condition occurs, the cylinder should be replaced.

8. Remove the wear ring from the piston assembly (Fig. 0149).

9. Carefully remove the seal from the piston assembly (Fig. 0150).
10. Remove the back-up seal from the piston assembly (Fig. 0151).

11. Remove the nut securing the piston to the cylinder rod (Fig. 0152).

12. Slide the piston off the end of the rod (Fig. 0153).

13. Remove the o-ring from the rod (Fig. 0154).
14. Remove the o-ring from the head (Fig. 0155).

15. Remove the flat back-up ring from the head (Fig. 0156).

16. Slide the head off the end of the ram (Fig. 0157).

17. Remove the wiper seal from inside the head (Fig. 0158).
18. Remove the wear seal from inside the head (Fig. 0159).

19. Thoroughly rinse the inside of the head with a cleaning solvent. Rinse and clean all internal components of foreign material with a lint-free rag.

20. Visually inspect for material defects and contamination. All seals and o-rings must be replaced with new parts.

Note: Lubricate the head, piston and all seals with 10W-30 oil prior to installation.
21. Twist the wear ring into a “C” shape and allow it to snap into the inside groove of the head (Fig. 0162).

**Note:** The groove in the seal faces toward the barrel side of the head.

22. Install the wiper seal so that the lip of the seal is installed in the groove inside the head (Fig. 0163).

23. Install the flat back-up seal into the deepest groove in the head. The flat back-up seal is installed against the ram side of the groove (Fig. 0164).

24. Install the o-ring into the deepest groove in the head next to the back-up seal. The o-ring is installed on the barrel side of the groove (Fig. 0165).

**Note:** If possible, the head/seal assembly should sit for at least one hour to allow the seals to elastically restore.
25. Install the wear ring into the widest groove on the piston (Fig. 0166).

26. Install the back-up ring into the narrowest groove on the piston (Fig. 0167).

27. Install the seal into the narrowest groove of the piston on top of the back-up ring (Fig. 0168).

**Note:** Lubricate all parts during assembly.

28. Secure the cylinder rod into a vise.

29. Apply some tape or plastic cover over the threads of the rod to protect the installation of the o-ring (Fig. 0169).
30. Slide the head onto the cylinder rod (Fig. 0170).

31. Install the o-ring in the groove on the rod. Remove the tape or plastic cover from the threads (Fig. 0171).

32. Slide the piston onto the cylinder rod (Fig. 0172).

33. Install the nut onto the end of the rod (Fig. 0173). Torque the nut to 100-120 ft-lbs. (135.6-162.7 Nm).
34. Remove the rod from the vise and secure the cylinder barrel into the vise.

35. Install the ram assembly into the cylinder barrel by rotating the head assembly while pushing the head into the barrel (Fig. 0174).

36. Continue rotating the head until the ring hole in the ring groove is within the slot on the barrel (Fig. 0175).

37. Insert the tab end of the retaining ring through the notch in the barrel and into the hole in the groove of the head. Place the spanner wrench onto the head assembly (Fig. 0176).

38. Begin rotating the spanner wrench clockwise so that the head pulls the ring inside the barrel. Continue rotating until the ring is completely installed the barrel on the head assembly (Fig. 0177).
108-4710 Hydraulic Tandem Pump Rebuild

Note: Protect all exposed sealing areas and open cavities from damage, foreign material and chemicals.

Note: Remove and discard all seals, o-rings and gaskets and replace with new when reassembling.

1. Remove the key from the keyway in the pump shaft (Fig. 0178).

2. Secure the pump in a vise.

3. Mark the pump housing with a “V” that crosses over all sections of the housing (Fig. 0179).

4. Remove the 4 bolts and washers securing the pump sections (Fig. 0180).
5. Remove the cover of the pump from the pump assembly (Fig. 0181).

6. Remove the cap gasket from the pump housing (Fig. 0182).

7. Mark the rear 5 gpm bushing assembly with a single line that extends onto the pump housing (Fig. 0183).

8. Remove the rear bushing from the pump housing assembly (Fig. 0184).
9. Remove the drive gear (gear with splines) from the pump assembly (Fig. 0185).

![Fig. 0185](IMG-0223a)

10. Remove the driven gear from the pump assembly (Fig. 0186).

![Fig. 0186](IMG-0224a)

11. Using a needle nose pliers grab the center of the inner small bushing and lift it partially out of the pump housing (Fig. 0187).

![Fig. 0187](PICT-2834b)

12. Mark the inner small bushing assembly with a line that extends out onto the pump housing. This line should be on the opposite side as the previous marking (Fig. 0188).

![Fig. 0188](PICT-2835a)
13. Remove the inner small bushing from the pump housing (Fig. 0189).

14. Lift the pump housing off the 11 gpm pump shaft cover (Fig. 0190).

15. Remove the o-ring from the housing (Fig. 0191).

16. Remove the drive link from the drive gear (Fig. 0192).
17. Mark the large pump bushing assembly with a “V” all the way down onto the pump shaft cover (Fig. 0193).

19. Remove the snap ring from the pump cover (Fig. 0195).

18. Remove the large pump bushing assembly from the pump shaft cover (Fig. 0194).

20. With the cover secured so the inside of the cover is facing up, remove the shaft seal from the inside of the pump cover (Fig. 0196).
21. Install a new shaft seal in the pump cover so that the spring side of the seal is facing the housing side of the pump cover (Fig. 0197).

22. Carefully drive the seal into the cover until it is seated (Fig. 0198).

23. Install the snap ring into the pump cover (Fig. 0199).

24. Remove the bushing from the drive gear and driven gear shafts (Fig. 0200).
25. Remove the drive gear from the bushing (Fig. 0201).

26. Remove the driven gear from the bushing (Fig. 0202).

27. Inspect the gear surface of both of the bushings for damage (Fig. 0203).

28. Inspect the drive gear and driven gear surfaces for damage (Fig. 0204).
29. Remove the back-up ring from the top and bottom bushings (Fig. 0205).

31. Install the gear seal with the lip side of the gasket facing away from the groove of the bushing (Fig. 0207).

30. Remove the gear seal from the top and bottom bushings (Fig. 0206).

Note: Lubricate all surfaces on reassembly.

32. Install the back-up ring into the bushing so that it rests in the lip of the gear seal (Fig. 0208).
33. Repeat the previous 2 steps for the second bushing.

34. Making note of the markings on the bushing assembly, install the drive gear into the bushing (Fig. 0209).

35. Install the driven gear into the bushing (Fig. 0210).

36. Install the second bushing onto the 2 gears (Fig. 0211).

37. Making note of the marks on the 11gpm pump, slide the drive gear shaft of the 11gpm pump assembly into the mounting flange (Fig. 0212).
38. Inspect both gear surfaces of both 5 gpm bushings for damage (Fig. 0213).

39. Inspect the drive and driven gears for damage (Fig. 0214).

40. Inspect the drive link for damage (Fig. 0215).

41. Install the drive link onto the drive gear of the 11gpm pump assembly (Fig. 0216).
42. Install an o-ring into the groove in the housing mounting flange face (Fig. 0217).

43. Making note of the markings on the housing and mounting flange, install the pump housing over the 11 gpm pump assembly and onto the mounting flange (Fig. 0218).

44. Making note of the markings, install the 5gpm pump inner bushing (Fig. 0219).

45. Install the 5gpm pump drive gear into the pump assembly (Fig. 0220).
46. Install the 5gpm pump driven gear into the pump assembly (Fig. 0221).

48. Install an o-ring in the cover mounting surface of the housing (Fig. 0223).

47. Making note of the markings on the 5gpm assembly, slide the outer bushing into place over the gears (Fig. 0222).

**Note:** The pump shaft may have to rotate to seat the 5 gpm pump bushing onto the drive link.

49. Install the housing cover onto the housing (Fig. 0224).
50. Install 4 bolts to secure the housing cover to the housing. Torque the 4 bolts 19 – 23 ft-lbs. (25.8 – 31.2 Nm) (Fig. 0225).

98-4732 cross-referenced to 104-7422
4-Spool Valve Rebuild (used on Chain Drive 22304)

1. Remove the 4 return spring covers from the bottom of the 4-spool valve (Fig. 0227).

51. Install the key into the keyway on the pump shaft (Fig. 0226).

2. Remove the spool return springs (Fig. 0228).
3. Remove the operator assemblies from the top side of the 4-spool valve (Fig. 0229).

4. Remove the 4-spool from the valve housing (Fig. 0230).

5. Remove the pressure regulator from the valve. Remove, inspect and then discard the o-ring (Fig. 0231).

6. Disassemble, clean and inspect the pressure regulator for wear of damage. Avoid changing the location of the adjusting screw. Reassemble the regulator (Fig. 0232).

**Note:** The pressure Regulator Assembly comes as a kit, Toro part number 100-8805.
7. Remove, inspect and then discard the 8 spool o-rings (4 on top, 4 on bottom) (Fig. 0233).

8. Remove the 3 check valves (Fig. 0234).

9. Replace the check valve o-ring on all 3 check valves (Fig. 0235).

10. Install the 3 check valves (Fig. 0236).
11. Carefully install 8 new o-ring into the 4-spool ports (4 o-rings on top, 4 o-rings on bottom) (Fig. 0237).

12. Install a new o-ring on the pressure regulator assembly (Fig. 0238).

13. Install the pressure regulator assembly into the valve body (Fig. 0239).

14. The initial adjustment of the pressure regulator screw should be 3/8" (9.5mm) from the shoulder of the regulator body to the end of the screw threads (Fig. 0240).

A. 3/8" (9.5mm)
15. Lubricate the spools and insert them into the valve body (Fig. 0241).

16. Apply grease to the 4 ball/sockets inside the 4 operator assemblies (Fig. 0242).

17. Install the 4 operator assemblies onto the valve body so that the ball in the operator assembly is captured inside the socket (hole) in the spool (Fig. 0243).

18. Install the 4-spool return springs (Fig. 0244).
99-3077 Auxiliary Valve Rebuild

99-3077 Auxiliary Valve Removal

1. Remove the neutral safety switch, if present, from the spring covers (Fig. 0246).

2. Remove the two Allen cap screws and the detent cover, exposing the detent sleeve (Fig. 0247).

19. Install the 4-spool return spring covers (Fig. 0245).
3. Cover the detent assembly with a clean shop towel and remove the detent sleeve.

**CAUTION:** The detent balls are spring-loaded and may become projectiles – wear safety glasses (Fig. 0248).

5. Remove the detent ball housing and return spring (Fig. 0250).

6. Remove the two Allen cap screws and the safety switch mounting-block (Fig. 0251).
7. Remove the neutral safety switch detent (Fig. 0252).

8. Remove the two Allen cap screws and the operator assembly (Fig. 0253).

9. Remove the spool from the body (Fig. 0254).

10. Remove the two O-rings from the valve body (Fig. 0255).

11. Flush and clean the valve housing with a cleaning solvent and air dry. Inspect the valve and valve components. Replace if nicks, scratches, wear, or contamination are present.
99-3077 Auxiliary Valve Assembly

1. Install new o-rings into the grooves in the valve bores (Fig. 0256).

2. Disassemble the relief valve and inspect it for wear or damage. Reassemble as shown (Fig. 0257).

3. Replace the O-rings on the pressure relief valve and install it into the valve housing (Fig. 0258).

4. Make an initial adjustment of the pressure relief valve if the original setting was changed during disassembly, or if the relief valve was replaced. The initial adjustment of the pressure relief valve should be 3/8" (9.5mm) from the shoulder of the relief valve (Fig. 0259).

A. 3/8" (9.5mm)
5. Lubricate the spool and carefully insert it into the valve body (Fig. 0260).

6. Inspect the rubber boot for cracks and damage; replace as needed. Apply grease to the ball end on the operator assembly (Fig. 0261).

7. Install the operator assembly onto the valve body making sure the ball end is inserted into the hole in the spool (Fig. 0262).

8. Install the detent for the neutral safety switch (Fig. 0263).
9. Install a new o-ring onto the switch block and mount to the valve body using two Allen cap screws (Fig. 0264).

10. Lubricate and install the detent ball housing and return spring (Fig. 0265).

11. Place a new o-ring into the flat side of the detent block and slide it over the detent spring (Fig. 0266).

12. Install a new o-ring onto the detent block (Fig. 0267).
13. Place the detent spring and large ball into the detent ball housing (Fig. 0268).

14. Apply lightweight grease to hold the balls in place during assembly. Place the small detent balls into the holder. Use a steel rod to push the center ball down into the holder against the spring pressure until the detent balls retract (Fig. 0269).

15. Then, position the sleeve (large inside diameter first) over the detent balls (Fig. 0270).

16. Install the detent cover with two Allen screws (Fig. 0271).
Drive Chain Replacement

Drive Chain Removal

1. Park CUL on a level surface.
2. Raise the loader arm 6” - 12” (15 - 30cm) off the ground.
3. Turn off the machine and remove the key.
4. Lift the rear of the machine (Fig. 0272).
5. Position jackstands under the rear 2 corners of the machine. Remove the floor jack (Fig. 0273).
6. Raise the front of the machine (Fig. 0274).
7. Position jackstands under the front 2 corners of the machine. Remove the floor jack (Fig. 0275).
8. Lower the loader arm.

9. Using a 1/2” socket, remove the 2 bolts securing the chain cover to the main frame (Fig. 0276).

10. Remove the chain cover for the chain being serviced (Fig. 0277).

11. Rotate the wheels until the master link on the chain is visible (Fig. 0278).

12. Using a 13/16” socket, remove the 5 lug nuts securing the rear wheel to the rear hub (Fig. 0279).
13. Remove the rear wheel from the rear hub (Fig. 0280).

14. Using a 3/4” socket and wrench, loosen the 4 nuts and bolts securing the axle retaining bracket to the main frame (Fig. 0281).

15. Using a 1-1/4” wrench, loosen the jam nut on each of the 2 chain tensioning bolts (Fig. 0282).

16. Using a 1-1/8” socket, loosen the 2 chain tensioning bolts. Continue to loosen the tensioning bolts until there is adequate slack in the chain to release the master link (Fig. 0283).
17. Remove the clip from the master chain link (Fig. 0284).

19. Remove the master chain link from the chain (Fig. 0286).

18. Remove the retainer from the master chain link (Fig. 0285).

20. Remove the chain from the wheel sprockets (Fig. 0287).
21. Inspect the chain assembly. Replace if damaged or worn (Fig. 0288).

Fig. 0288

22. Inspect the front and rear sprockets. Replace if damaged or worn (Fig. 0289).

Fig. 0289
Drive Chain Installation

1. Route one end of the chain around the top of the front wheel sprocket. Route the other end of the chain around the top of the rear wheel sprocket. The two ends should come together on the bottom of the chain routing (Fig. 0290, Fig. 0291 and Fig. 0292).

2. Install the master chain link into one end of the chain (Fig. 0293).
3. Install the other side of the master link through the other end of the chain (Fig. 0294).

4. Install the master link retainer onto the master chain link (Fig. 0295).

5. Install the clip onto master chain link to secure (Fig. 0296).

6. Slide the rear wheel onto the rear hub (Fig. 0297).
7. Using a 13/16” socket, install 5 lug nuts to secure the rear wheel to the rear hub. Torque the lug nuts to 50 ft-lbs. (68 Nm) (Fig. 0298).

8. Position the chain cover to the main frame (Fig. 0299).

9. Using a 1/2” socket, install 2 bolts to secure the chain cover to the main frame (Fig. 0300).

10. Turn the front wheel on one side of the traction unit until the upper span of the drive chain is tight.

11. Using a 1-1/8” wrench, tighten the 2 chain tensioning bolts (Fig. 0301).
12. Continuing tightening, or loosening, the tensioning bolts until there is 1-1/2” to 2-1/2” (3.8 to 6.4cm) between the bottom of the chain guard and the top of the chain on each side of machine (Fig. 0302).

13. With a 1-1/8” socket securing the position of the tensioning bolt, use a 1-1/4” wrench to tighten the jam nut on each of the 2 chain tensioning bolts (Fig. 0303).

14. Use a 1-1/4” crows foot wrench to torque the 2 jam nuts to 30 ft-lbs. (41 Nm) (Fig. 0304).

15. Using a 3/4” socket and wrench, tighten the 4 nuts and bolts securing the axle retaining bracket to the main frame (Fig. 0305).
16. Torque the 4 nuts to 75 ft-lbs. (102 Nm) (Fig. 0306).

17. Apply general purpose oil (10W30) to the upper and lower chain spans.

18. Start the traction unit and slowly move it forward to expose the upper and lower chain spans that have not been lubricated.

19. Stop the engine and remove the key.

20. Apply oil to newly exposed non-lubricated chain spans.

21. Lower the machine to the ground.

Front Axle Replacement

Front Axle Removal

1. Park CUL on a level surface

2. Raise the loader arm 6" - 12" (15 - 30cn) off the ground.

3. Turn off the machine and remove the key.

4. Lift the rear of the machine (Fig. 0307).

5. Position jackstands under the rear 2 corners of the machine. Remove the floor jack (Fig. 0308).
6. Raise the front of the machine (Fig. 0309).

7. Position jackstands under the front 2 corners of the machine. Remove the floor jack (Fig. 0310).

8. Raise the loader arms to the fully raised position.

9. Turn off the engine and remove the key.

10. Remove the loader arm cylinder locks located on the hydraulic auxiliary lines (Fig. 0311).

11. Position a loader arm cylinder lock over each lift cylinder rod (Fig. 0312).
12. Secure each loader arm cylinder lock with a clevis pin and hairpin cotter (Fig. 0313).

13. Lower the loader arm until the loader arm end of the cylinder rods are resting on the cylinder locks.

14. Using a 1/2" socket, remove the 2 bolts securing one of the chain covers to the main frame (Fig. 0314).

15. Remove the chain cover (Fig. 0315).

16. Rotate the wheels until the master chain link is visible (Fig. 0316).
17. Using a 13/16" socket, remove the 5 lug nuts securing the front wheel to the front hub (Fig. 0317).

18. Remove the front wheel from the front hub (Fig. 0318).

19. Remove the clip from the master chain link (Fig. 0319).

20. Remove the retainer from the master chain link (Fig. 0320).
21. Remove the master chain link from the chain (Fig. 0321).

22. Remove the chain from the front wheel sprocket (Fig. 0322).

23. Remove the protective bearing cap (Fig. 0323).

24. Remove the bearing cap (Fig. 0324).
25. Remove the cotter pin (Fig. 0325).

26. Using a 1-1/8" socket, remove the castle nut (Fig. 0326).

27. Remove the washer (Fig. 0327).

28. Remove the bearing (Fig. 0328).
29. Remove the front hub and sprocket assembly from the axle (Fig. 0329).

30. Repeat steps 13 – 28 to remove the front wheel, chain, hub and sprocket from the opposite side of the machine.

31. Using a 3/4" socket and wrench, remove the 4 bolts, washers and nuts securing the 2 axle brackets to the main frame (Fig. 0330).

32. Using a 1-1/4" socket, loosen the jam nuts on the 2 chain tensioning bolts (Fig. 0331).

33. Remove the front axle assembly from the main frame (Fig. 0332).
34. Clean and lubricate the threads of the 2 chain tensioning bolts (Fig. 0333).

35. Using a 1-1/8" socket, remove the chain tensioning bolts, jam nuts and washers from the axle assembly. Remove the jam nut from each of the chain tensioning bolts (Fig. 0334).

36. Remove the 2 axle brackets (Fig. 0335).

Front Axle Assembly (Fig. 0336):

A. Front Axle
B. Chain tensioning bolt (2)
C. Jam nut (2)
D. Washer (4)
E. Axle bracket (2)
Front Axle Installation

1. Thread a jam nut onto each of the chain tensioning bolts approximately 3/4 of the way up the threads (Fig. 0337).

2. Slide 2 washers up to the jam nut on each of the chain tensioning bolts (Fig. 0338).

3. Apply anti-seize compound to the 2 chain tensioning bolts (Fig. 0339).

4. Position an axle bracket to the axle aligning it with the chain tensioning bolt mounting holes. Insert the chain tensioning bolt through the axle bracket and thread it into the axle (Fig. 0340).
5. Repeat step 4 to install the other axle bracket (Fig. 0341).

6. Slide the front axle assembly into the main frame (Fig. 0342).

7. Position the axle brackets so the mounting holes align with the mounting holes in the main frame (Fig. 0343).
8. Loosely install 4 bolts, washers and nuts securing the 2 axle brackets to the main frame (Fig. 0344).

Note: One washer under the bolt head, one washer under the nut (Fig. 0345 and Fig. 0346).
9. Inspect the hub and sprocket. If worn or damaged, replace. Refer to “Sprocket Replacement” on page 4/1-35.

10. Inspect the seals and bearings. If worn or damaged, replace. Refer to “Front Axle Hub Rebuild” on page 4/1-46.

11. Apply grease to the inside of the seal (Fig. 0347).

12. Grease the axle seal surface (Fig. 0348).

13. Slide the front hub and sprocket assembly onto the axle (Fig. 0349).

14. Slide the outer bearing over the axle and into the hub (Fig. 0350).
15. Slide a washer over the axle (Fig. 0351).

16. Thread the castle nut onto the axle (Fig. 0352).

17. Using a 1-1/8" socket, tighten the nut to seat the bearings then back it off. Back off nut so first slot in nut aligns with hole in axle (Fig. 0353).

18. Install a cotter pin in the hole in the axle (Fig. 0354).
19. Install the bearing protector (Fig. 0355).

20. Using general purpose grease, fill the inner cavity of the hub assembly (Fig. 0356).

21. Install the protective bearing cap (Fig. 0357).

22. Repeat steps 9 - 21 to install the sprocket and hub assembly on the opposite side of the machine.

23. Route the chain around the top of the front wheel sprocket (Fig. 0358).
24. Install the master chain link into one end of the chain (Fig. 0359).

25. Install the other end of the master link through the other end of the chain (Fig. 0360).

26. Install the master link retainer onto the master chain link (Fig. 0361).
27. Install the clip onto the master chain link to secure (Fig. 0362 and Fig. 0363).

28. Slide the front wheel onto the wheel hub (Fig. 0364).
29. Using a 13/16” socket, install 5 lug nuts to secure the front wheel to the front hub. Torque the lug nuts to 50 ft-lbs. (68 Nm) (Fig. 0365 and Fig. 0366).

30. Position the chain cover to the main frame (Fig. 0367).

31. Using a 1/2” socket, install 2 bolts to secure the chain cover to the main frame (Fig. 0368).
32. Repeat steps 23 - 31 to install the opposite chain and wheel assembly.

33. Turn the front wheel on one side of the traction unit until the upper span of the drive chain is tight.

34. Using a 1-1/8" wrench, turn the two chain tensioning bolts evenly to tighten the chain (Fig. 0369).

35. Continuing tightening, or loosening, the tensioning bolts until there is 1-1/2" to 2-1/2" (3.8 to 6.4cm) between the bottom of the chain guard and the top of the chain on each side of the machine (Fig. 0370).

36. Use a 1-1/4" crows foot wrench to torque the 2 jam nuts to 30 ft-lbs. (41 Nm) (Fig. 0371).

37. Use a 3/4" socket and wrench to tighten the 4 nuts and bolts securing the axle brackets to the main frame (Fig. 0372).
38. Torque the 4 nuts to 75 ft-lbs. (102 Nm) (Fig. 0373).

39. Apply general purpose oil (10W30) to the upper and lower chain spans.

40. Start the traction unit and slowly move it forward to expose the upper and lower chain spans that have not been lubricated.

41. Stop the engine and remove the key.

42. Apply general purpose oil (10W30) to the newly exposed, non-lubricated chain spans.

43. Lower the machine to the ground.

Sprocket & Wheel Hub

Sprocket & Chain Inspection

Note: It is not necessary to raise the machine and remove wheels to inspect the sprockets or chain.

1. Using a 1/2" socket, remove the 2 bolts securing the chain cover to the main frame (Fig. 0374).

2. Remove the chain cover (Fig. 0375).
3. Inspect the chain assembly. Replace if damaged or worn (Fig. 0376).

4. Inspect the front and rear sprockets. If wear is indicated on the front or rear sprocket, both sprockets and the chain should be replaced (Fig. 0377).

Note: The wheel assembly was removed for photo purposes.

5. Install the chain cover and tighten the bolts (Fig. 0378 and Fig. 0379).
Rear Sprocket & Wheel Hub Removal

1. Raise the machine off the floor. Refer to “Raising the Traction Unit” on page 3/1-1.

2. Using a 1/2” socket, remove the 2 bolts securing the chain cover to the main frame (Fig. 0380).

3. Remove the chain cover (Fig. 0381).

4. Rotate the wheels so the master link on the chain is visible (Fig. 0382).

5. Using a 13/16” socket, remove the 5 lug nuts securing the rear wheel to the rear hub (Fig. 0383).
6. Remove the rear wheel from the rear hub (Fig. 0384).

8. Using a 1-1/4" wrench, loosen the jam nut on each of the 2 chain tensioning bolts (Fig. 0386).

7. Using a 3/4" socket and wrench, loosen the 4 nuts and bolts securing the axle retaining bracket to the main frame (Fig. 0385).

9. Using a 1-1/8" socket, loosen the 2 chain tensioning bolts. Continue to loosen the tensioning bolts until there is adequate slack in the chain to release the master link (Fig. 0387).
10. Remove the clip from the master chain link (Fig. 0388).

11. Remove the retainer from the master chain link (Fig. 0389).

12. Remove the master chain link from the chain (Fig. 0390 and Fig. 0391).
13. Remove the chain from the wheel sprockets (Fig. 0392).

14. Loosen the wheel motor shaft nut with a 1-1/2” socket (Fig. 0393).

15. Place a hub puller (Toro part #TOR6006) onto the hub and secure it with the previously removed lug nuts (tapered end of the lug nuts facing out) (Fig. 0394).

16. Using a 1-1/2” socket, pull the hub off the wheel motor shaft (Fig. 0395).
17. Remove the lug nuts and remove the hub puller (Fig. 0396).

18. Remove the wheel motor shaft nut and discard (Fig. 0397).

19. Remove the rear hub assembly (Fig. 0398).
Sprocket Replacement

Sprocket Removal

1. Place the rear hub assembly in a vise (Fig. 0399).

2. Using a 3/4” socket and wrench, remove the 5 bolts and nuts securing the sprocket to the rear hub (Fig. 0400).

3. Remove the sprocket from the rear hub. Discard the hub (Fig. 0401).

   Note: The hub and wheel motor shaft nut must be discarded and replaced with new.

4. Inspect the sprocket. If worn or damaged, it must be replaced.
Sprocket Installation

1. Install a sprocket onto the new hub (Fig. 0402).

2. Using a 3/4" socket and wrench, install 5 bolts and nuts to secure the sprocket to the rear hub (Fig. 0403).

3. Torque the 5 bolts and nuts to 75 ft-lbs. (102 Nm) (Fig. 0404).
Rear Sprocket & Wheel Hub Installation

1. Ensure the wheel motor shaft key is installed (Fig. 0405).

Note: Prior to installing the drive hub, make sure the wheelmotor shaft and inner drive hub are clean, degreased and free of paint to ensure a proper fit-up and positioning between the drive hub and wheel motor shaft.

Note: The hub and wheel motor shaft nut must be discarded and replaced with new.

2. Slide the new hub assembly onto the wheel motor shaft aligning the hub keyway with the wheel motor shaft key (Fig. 0406).

3. Install the new wheel motor shaft nut and torque to 325 ± 25 ft-lbs. (441 ± 34 Nm) (Fig. 0407).

4. Route the chain around the top of the rear wheel sprocket (Fig. 0408).
5. Install the master chain link into one end of the chain (Fig. 0409).

6. Install the other end of the master link through the other end of the chain (Fig. 0410).

7. Install the master link retainer onto the master chain link (Fig. 0411).

8. Install the clip onto the master chain link to secure (Fig. 0412).
9. Install the wheel and tire assembly (Fig. 0413).

10. Install the lug nuts and torque to 50 ft-lbs. (68 Nm) (Fig. 0414 and Fig. 0415).
11. Position the chain cover to the main frame (Fig. 0416).

12. Using a 1/2” socket, install 2 bolts to secure the chain cover to the main frame (Fig. 0417).

13. Check and adjust drive chain tension. Refer to “Checking Drive Chain Tension” on page 4/1-54.

14. Lower the machine.

Front Sprocket & Wheel Hub Removal

1. Raise the machine off the floor. Refer to “Raising the Traction Unit” on page 3/1-1.

2. Using a 1/2” socket, remove the 2 bolts securing the chain cover to the main frame (Fig. 0418).

3. Remove the chain cover (Fig. 0419).
4. Rotate the wheels until the master chain link is visible (Fig. 0420).

5. Using a 13/16” socket, remove the 5 lug nuts securing the front wheel to the front hub (Fig. 0421).

6. Remove the front wheel from the front hub (Fig. 0422).

7. Remove the clip from the master chain link (Fig. 0423).
8. Remove the retainer from the master chain link (Fig. 0424).

9. Remove the master chain link from the chain (Fig. 0425 and Fig. 0426).
10. Remove the chain from the front wheel sprocket (Fig. 0427).

11. Remove the bearing protector cap (Fig. 0428).

12. Remove the bearing protector (Fig. 0429).

13. Remove the cotter pin (Fig. 0430).
14. Using a 1-1/8” socket, remove the castle nut (Fig. 0431).

15. Remove the washer (Fig. 0432).

16. Remove the bearing (Fig. 0433).

17. Remove the front hub and sprocket assembly from the axle shaft (Fig. 0434).
18. Place the front hub assembly in a vise and ensure that debris does not get into the opening by placing a rag in it (Fig. 0435).

19. Using a 3/4” socket and wrench, remove the 5 bolts and nuts securing the sprocket to the front hub (Fig. 0436).

20. Remove the sprocket from the front hub (Fig. 0437).

21. Inspect the sprocket. If worn or damaged, it must be replaced.

22. Rebuild the bug if seals or bearings need replacement.
Front Axle Hub Rebuild

Front Axle Hub Assembly (Fig. 0438):

1. Remove the wheel bearing seal (Fig. 0439).

2. Remove the wheel bearings and inspect them for pitting, galling, or overheating. (Fig. 0440).

3. Inspect the cup bearing race for pitting, galling, or overheating (Fig. 0441).
4. If a cup bearing race needs replacing, remove it by tapping it out of the hub with a punch (Fig. 0442).

5. When installing a cup bearing race use a brass punch or soft metal punch to drive it in. Make sure it is seated completely (Fig. 0443).

6. Pack the inner bearing with grease and install to the seal side of the hub (Fig. 0444).

7. Install the seal with the cupped side facing out (Fig. 0445).
8. Install the seal into the hub until it is square and flush with the top of the bore (Fig. 0446).

Front Sprocket & Wheel Hub Installation

1. Install a sprocket onto the hub (Fig. 0447).

2. Install 5 bolts and nuts to secure the sprocket to the front hub (Fig. 0448).

9. Pack the other bearing with grease and install to the nut side of the hub.
3. Using a 3/4" socket and wrench, torque the 5 bolts and nuts to 75 ft-lbs. (102 Nm) (Fig. 0449).

5. Grease the axle seal surface (Fig. 0451).

4. Grease the inside of the seal (Fig. 0450).

6. Install the front hub and sprocket assembly onto the axle (Fig. 0452).
7. Install the outer bearing (Fig. 0453).

8. Install the washer (Fig. 0454).

9. Install the castle nut (Fig. 0455).

10. Using a 1-1/8” socket, tighten the nut to seat the bearings then back it off. Back off nut so first slot in nut aligns with hole in axle (Fig. 0456).
11. Install a cotter pin (Fig. 0457).

12. Install the bearing protector (Fig. 0458).

13. Using general purpose grease, fill the inner cavity of the hub assembly (Fig. 0459).

14. Install the bearing protector cap (Fig. 0460).
15. Route the chain around the top of the front wheel sprocket (Fig. 0461).

16. Install the master chain link into one end of the chain (Fig. 0462).

17. Install the other end of the master link through the other end of the chain (Fig. 0463).

18. Install the master link retainer onto the master chain link (Fig. 0464).
19. Install the clip onto the master chain link to secure (Fig. 0465).

20. Slide the front wheel onto the wheel hub (Fig. 0466).

21. Using a 13/16” socket, install 5 lug nuts to secure the rear wheel to the rear hub. Torque the lug nuts to 50 ft-lbs. (68 Nm) (Fig. 0467).

22. Position the chain cover to the main frame (Fig. 0468).
23. Using a 1/2" socket, install 2 bolts to secure the chain cover to the main frame (Fig. 0469).

24. Check and adjust the drive chain tension. Refer to “Checking the Drive Chain Tension” on page 4/1-54.

25. Lower the machine.

Checking the Drive Chain Tension

1. With the bucket installed, lower it until it raises the front tires off of the ground.

2. Stop the engine and remove the key.

3. Turn the front wheel forward on one side of the traction unit until the top span of the drive chain is tight.

4. Measure the distance between the bottom of the chain guard and the lower chain span (Fig. 0470).

5. If the slack in the chain is not within 1-1/2 to 2-1/2 inches (3.8 to 6.35cm), adjust the tension. Refer to “Adjusting the Drive Chain Tension” on page 4/1-55.

6. Repeat steps 3 through 5 for the other drive chain.

7. Start the engine and raise the bucket to return the front wheels to the ground.
Adjusting the Drive Chain Tension

1. With the bucket installed, lower it until it raises the front tires off of the ground.

2. Stop the engine and remove the key.

3. Loosen the nuts securing the axle retaining bracket to the frame (Fig. 0471).

4. Loosen the nut on the chain tensioning bolt and loosen the bolt (Fig. 0472).

5. Turn the front wheel on one side of the traction unit until the upper span of the drive chain is tight.

6. Adjust the chain tensioning bolt until the distance between the bottom of the chain guard and the lower chain span is within 1-1/2” to 2-1/2” (3.8 to 6.35cm) (Fig. 0473).

7. Position the axle retaining bracket tight against the axle and the frame. Tighten the nut on the bolt to secure it in place (Fig. 0474) and torque the nut to 30 ft-lbs. (41 Nm).
8. Tighten the nuts securing the axle retaining bracket to the frame. Torque them to 75 ft-lbs. (102 Nm) (Fig. 0475).

9. Repeat steps 3 through 8 for the other drive chain.

10. Start the engine and raise the bucket to return the front wheels to the ground.

Wheel Motor Replacement

Wheel Motor Removal

Note: Upon removal, all seals, o-rings and gaskets should be replace. During installation, lightly lubricate all seals, o-rings and gaskets with clean petroleum jelly prior to assembly.

Note: The following procedures show removal of the left wheel motor. To remove the right wheel motor remove the battery and then follow the same procedures. Refer to “Battery Removal” on page 4/5-6.

1. Raise the machine off the floor. Refer to “Raising the Traction Unit” on page 3/1-1.

Note: The bottom of the frame under the wheel motor must be 12” (30cm) off the ground.

2. Using a 1/2” socket, remove the 2 bolts securing the chain cover to the main frame (Fig. 0476).
3. Remove the chain cover (Fig. 0477).

4. Rotate the wheels until the master link on the chain is visible (Fig. 0478).

5. Using a 13/16” socket, remove the 5 lug nuts that secure the rear wheel to the rear hub (Fig. 0479).

6. Remove the rear wheel from the rear hub (Fig. 0480).
7. Remove the clip from the master chain link (Fig. 0481).

8. Remove the retainer from the master chain link (Fig. 0482).

9. Remove the master chain link from the chain (Fig. 0483).

10. Remove the chain from the rear wheel sprocket (Fig. 0484).
11. Using a 1-1/2” socket, loosen the lock nut from the wheel motor shaft (Fig. 0485).

12. Slide a wheel hub puller (Toro part no. TOR6006) onto the wheel hub studs (Fig. 0486).

13. Install the 5 lugs nuts backward (taper side facing out) onto the studs (Fig. 0487).

14. Using a 1-1/2” socket, break the hub assembly free of the wheel motor shaft (Fig. 0488).
15. Remove the puller from the hub.

16. Remove the lock nut from the wheel motor shaft and discard (Fig. 0489).

17. Remove the hub and sprocket assembly from the wheel motor shaft (Fig. 0490).

18. Position a drain pan under the wheel motor.

19. Mark the hydraulic line nut on the front port of the counterbalance valve with a “C” (Fig. 0491).

20. Using a 1-1/8” offset wrench, remove the hydraulic line (marked with a “C”) from the counterbalance valve (Fig. 0492).
21. Using a 1-1/8" offset wrench, remove the hydraulic line from the front wheel motor fitting (Fig. 0493).

22. Remove the hydraulic line (Fig. 0494).

23. Using a 1-1/8" offset wrench, loosen the hydraulic line nut from the rear counterbalance valve fitting (Fig. 0495).

24. Using a 1-1/8" offset wrench, remove the hydraulic line from the rear wheel motor fitting (Fig. 0496).
25. Using a 1-1/16” socket, remove both fittings from the wheel motor ports (Fig. 0497).

26. Cap the hydraulic line, counterbalance valve fitting and wheel motor ports to prevent debris from contaminating the system (Fig. 0498).

27. Support the wheel motor with a floor jack (Fig. 0499).

28. Using a 3/4” socket, remove the 4 bolts securing the wheel motor housing to the main frame (Fig. 0500).
29. With the wheel motor resting on the floor jack, slide the floor jack toward the opposite side of the machine to remove the wheel motor from the main frame (Fig. 0501). Lower the floor jack and slide it out from under the machine to remove the wheel motor (Fig. 0502).

![Fig. 0501](DSC-0404a)

![Fig. 0502](DSC-0405a)

30. To service the existing wheel motor, refer to the Parker Hydraulics Service Manual (Toro Form No. 492-4753).
Wheel Motor Installation

1. Set the wheel motor onto a floor jack with the ports facing up (Fig. 0503).

Fig. 0503  DSC-0405a

2. Slide the floor jack under the machine. Raise the floor jack and angle the wheel motor shaft up (Fig. 0504).

Fig. 0504  DSC-0407a

3. Position the wheel motor shaft through the opening in the frame (Fig. 0505).

Fig. 0505  DSC-0409a

4. Continue raising the floor jack and sliding the wheel motor into the frame aligning the mounting holes in the wheel motor with the mounting holes in the frame (Fig. 0506).

Fig. 0506  DSC-0410a
5. Loosely install 4 wheel motor mounting bolts (Fig. 0507).

6. Remove the floor jack.

7. Remove plugs from ports and fittings. Using a 1-1/16” socket, install 2 fittings into the wheel motor ports (Fig. 0508).

8. Position the previously removed hydraulic line (marked “C”) to the counterbalance valve and front wheel motor fitting (Fig. 0509).

9. Loosely install the hydraulic line nut to the front wheel motor fitting (Fig. 0510).
10. Position the other hydraulic line to the rear wheel motor fitting and loosely install the hydraulic line nut to the rear wheel motor fitting (Fig. 0511).

11. Using a 1-1/8” offset wrench, tighten the hydraulic line nut to the rear counterbalance valve fitting (Fig. 0512).

12. Using a 1-1/8” offset wrench, loosely install the hydraulic line nut marked with a “C” to the front counterbalance valve fitting (Fig. 0513).

13. Using a 3/4” socket, torque the 4 wheel motor mounting bolts to 75 ± 8 ft-lbs. (102 ± 11 Nm) (Fig. 0514).
14. Using a 1-1/8" offset wrench, tighten the hydraulic line nut to the front counterbalance valve fitting (Fig. 0515).

15. Using a 1-1/8" offset wrench, tighten both hydraulic line nuts to the wheel motor fittings (Fig. 0516).

16. Start the engine. Operate the machine slowly in forward and reverse motion to purge the air from the hydraulic drive circuit.

17. Check for leaks at the hydraulic connections.

18. Turn off the engine and remove the key.

19. Place the rear hub assembly in a vise (Fig. 0517).

20. Using a 3/4" socket and wrench, remove the 5 bolts and nuts that secure the sprocket to the rear hub (Fig. 0518).
21. Remove the sprocket from the rear hub. Discard the hub (Fig. 0519).

22. Place a new hub in a vise.

23. Position the sprocket onto the new hub (Fig. 0520).

24. Install 5 bolts and nuts to secure the sprocket to the hub (Fig. 0521).

25. Using a 3/4" socket and wrench, torque the 5 bolts and nuts to 75 ft-lbs. (102 Nm) (Fig. 0522).
26. Ensure the wheel motor shaft key is installed (Fig. 0523).

28. Install a new nut onto the wheel motor shaft (Fig. 0525).

Note: Prior to installing the drive hub, make sure the wheel motor shaft and inner drive hub are clean, degreased and free of paint to ensure a proper fit-up and positioning between the drive hub and wheel motor shaft.

27. Slide the hub assembly onto the wheel motor shaft aligning the slot in the hub with the wheel motor shaft key (Fig. 0524).

29. Using a 1-1/2" socket, torque the wheel motor nut to 323 ± 25 ft-lbs. (441 ± 34 Nm) (Fig. 0526).
30. Route the chain around the top of the rear wheel sprocket (Fig. 0527).

31. Install the master link into the ends of the chain (Fig. 0528).

32. Install the master link retainer onto the master chain link (Fig. 0529).
33. Install the clip onto the master chain link to secure (Fig. 0530 and Fig. 0531).

34. Slide the wheel and tire assembly onto the wheel hub studs (Fig. 0532).

35. Install the 5 lug nuts (Fig. 0533).
36. Using a 3/4" socket, torque the 5 lug nuts to 50 ft-lbs. (68 Nm) (Fig. 0534).

38. Using a 1/2" socket, install 2 bolts to secure the chain cover to the main frame (Fig. 0536).

37. Position the chain cover to the main frame (Fig. 0535).

39. Check and adjust the drive chain tension. Refer to “Checking the Drive Chain Tension” on page 4/1-54.

40. If the right wheel motor was installed, reinstall the battery. Refer to “Battery Installation” on page 4/5-7.

40. Lower the machine.

41. Start the engine and operate the wheel motor. Check for leaks and purge air.

42. Check hydraulic fluid for proper level and add if required.
Counterbalance Valve Replacement

Counterbalance Valve Removal

Note: Upon removal, all seals, o-rings and gaskets should be replace. During installation, lightly lubricate all seals, o-rings and gaskets with clean petroleum jelly prior to assembly.

1. Raise the loader arms to the fully raised position.
2. Turn off the engine and remove the key.
3. Remove the loader arm cylinder locks located on the hydraulic auxiliary lines (Fig. 0537).
4. Position a loader arm cylinder lock over each lift cylinder rod (Fig. 0538).
5. Secure each loader arm cylinder lock with a clevis pin and hairpin cotter (Fig. 0539).
6. Lower the loader arm until the loader arm end of the cylinder rods are resting on the cylinder locks.
7. Disconnect the negative and then the positive battery cable. Remove the wing nut, washer and carriage bolt securing the battery clamp to the frame. Remove the battery clamp (Fig. 0540).

A. Negative battery cable
B. Positive battery cable
C. Wing nut, washer, carriage bolt
D. Battery clamp
8. Remove the battery from the frame (Fig. 0541).

9. Using a 1/2" wrench and socket, remove the nut from the fuel tank mounting bolt (Fig. 0542).

10. Remove the fuel tank mounting bolt (Fig. 0543).

11. Remove the fuel tank mounting plate (Fig. 0544).
12. Remove the fuel tank and set it on the operator’s stand (Fig. 0545).

13. Using a 1-1/8” offset wrench, remove the hydraulic line nut from the rear upper counterbalance valve fitting (Fig. 0546).

14. Using a 1-1/8” offset wrench, remove the hydraulic line nut from the front upper counterbalance valve fitting (Fig. 0547).

15. Using a 1-1/8” offset wrench, remove the hydraulic line nut from the lower front counterbalance valve fitting (Fig. 0548).
16. Using a 1-1/8" offset wrench, loosen the hydraulic line nut from the front wheel motor fitting. Swing the hydraulic line away from the counterbalance valve so the lower rear counterbalance valve nut can be accessed (Fig. 0549).

![Fig. 0549](DSC-0479a)

17. Using a 1-1/8" offset wrench, remove the hydraulic line nut from the lower rear counterbalance valve fitting (Fig. 0550).

![Fig. 0550](DSC-0480a)

18. Using a 7/16" wrench and socket, remove the nut from the bolt securing the counterbalance valve to the frame (Fig. 0551).

![Fig. 0551](DSC-0482a)
19. Remove the counterbalance valve mounting bolt, washer and spacer (Fig. 0552).

![Image](DSC-0488a)

**Fig. 0552**

20. Remove the counterbalance valve from the machine (Fig. 0554).

![Image](DSC-0490a)

**Fig. 0554**

**Note:** The spacer is located between the counterbalance valve and the frame (Fig. 0553).

![Image](DSC-0487a)

**Fig. 0553**

21. Transfer the hydraulic fittings from the old counterbalance valve and the frame to the new counterbalance valve (Fig. 0555).

![Image](DSC-0491a)

**Fig. 0555**
Counterbalance Valve Installation

1. Position the counterbalance valve into the machine aligning the valve fittings with the existing hydraulic lines (Fig. 0556).

2. Loosely install the hydraulic line nut to the lower rear counterbalance valve fitting (Fig. 0557).

3. Loosely install the hydraulic line nut to the rear upper counterbalance valve fitting (Fig. 0558).

4. Loosely install the hydraulic line nut to the front upper counterbalance valve fitting (Fig. 0559).
5. Using a 1-1/8” offset wrench, tighten the hydraulic line nut securing the hydraulic line to the lower rear counterbalance valve fitting (Fig. 0560).

6. Swing the hydraulic line (coming from the wheel motor) into position so it aligns with the lower front counterbalance valve fitting. Loosely install the hydraulic line nut to the lower front counterbalance valve fitting (Fig. 0561).

7. Insert the spacer between the counterbalance valve and frame (Fig. 0562).

8. Insert the bolt, with washer, through the counterbalance valve, spacer and the frame (Fig. 0563).
9. Using a 7/16” wrench and socket, install a nut onto the counterbalance valve mounting bolt (Fig. 0564).

10. Using a 1-1/8” offset wrench, tighten the 3 remaining hydraulic line nuts to the counterbalance valve fittings and the hydraulic line nut to the front wheel motor fitting.

11. Position the fuel tank on the fuel tank mounting bracket (Fig. 0565).

12. Position the fuel tank mount plate (Fig. 0566).

13. Install the fuel tank mount bolt (Fig. 0567).
14. Using a 1/2" wrench and socket, install a nut onto the fuel tank mount bolt (Fig. 0568).

15. Position the battery into the frame (Fig. 0569).

16. Position the battery clamp onto the battery and against the frame. Install a wing nut, washer and carriage bolt securing the battery clamp to the frame. Connect the positive and then the negative battery cable to the battery (Fig. 0570).

17. Raise the loader arm all the way up to remove pressure from the loader arm cylinder locks.

18. Remove the clevis pin and cotter pin from the loader arm cylinder locks (Fig. 0571).
19. Remove the loader arm cylinder locks from the cylinder rods (Fig. 0572).

20. Reinstall the loader arm cylinder locks onto the hydraulic auxiliary lines (for storage) (Fig. 0573).

21. Lower the loader arms.

22. Check the hydraulic fluid level. Fill the hydraulic tank per specifications.

23. Turn the machine on and run it to purge air from the system. Check for leaks.

24. Turn the engine off.

25. Check and add hydraulic fluid to the hydraulic tank as required.
4-Spool Valve Replacement

4-Spool Valve Removal

Note: Upon removal, all seals, o-rings and gaskets should be replace. During installation, lightly lubricate all seals, o-rings and gaskets with clean petroleum jelly prior to assembly.

1. Remove the 4 screws retaining the cover plate around the 4-Spool Valve (Fig. 0574).

2. Remove the cover plate (Fig. 0575).

3. Remove the bolt and lock washer securing the left control arm to the 4-spool valve. Remove the left control arm (Fig. 0576).

4. Loosen both the hydraulic line nuts on the hydraulic line with the test port fitting (Fig. 0577).
5. Place and absorbent towel under the 4-spool valve.

6. Remove the hydraulic line from the machine (Fig. 0578).

7. Remove the hydraulic line nut from the fitting located on the right hand side of the 4-spool valve (Fig. 0579).

8. Remove both left hand counterbalance valve hydraulic line nuts from the 4-spool valve (Fig. 0580).

9. Remove the 2 hydraulic cylinder line T-fittings from the fittings on the 4-spool valve (Fig. 0581).
10. Remove both right hand counterbalance valve hydraulic line nuts from the 4-spool valve (Fig. 0582).

11. Remove the 2 hydraulic tilt cylinder lines from the 4-spool valve (Fig. 0583).

12. Remove the auxiliary valve hydraulic line nut and the auxiliary relief hydraulic line nut from the 4-spool valve T-fitting (Fig. 0584).

13. Remove the 2 bolts securing the manual tube r-clamps to the control panel (Fig. 0585). Note there are 2 washers on each bolt: one in front of the r-clamp and one on the back of the r-clamp.
14. Remove the manual tube assembly.

15. Remove the third bolt and 2 washers securing the 4-spool valve assembly to the control panel (Fig. 0586).

16. Lower the 4-spool valve and loosen the hydraulic line nut from the auxiliary relief fitting (Fig. 0587).

17. Remove the auxiliary relief hydraulic line (Fig. 0588).

18. Remove the 4-spool valve from the machine (Fig. 0589).
19. Loosen the jam nut and set screw on the 3 remaining handles (Fig. 0590).

20. Remove the 3 remaining handles from the 4-spool valve (Fig. 0591).

21. Remove the 2 bolts and spacer blocks from one end of the 4-spool valve (Fig. 0592).

22. Remove the bolt and spacer block from the other end of the 4-spool valve (Fig. 0593).
23. Remove the relief valve from the 4-spool valve (Fig. 0594).

![Fig. 0594](image)

24. Remove the relief valve o-ring from the 4-spool valve (Fig. 0595).

![Fig. 0595](image)

25. If the 4-spool valve is being serviced, remove all the fittings before servicing (Fig. 0596). To service the 4-spool valve, refer to "105-6246 4-Spool Valve Rebuild (Chain Drive)" on page 3/1-33.

![Fig. 0596](image)
26. If the 4-Spool valve is being replaced, transfer all the fittings and markings to the new 4-Spool valve.

4-Spool Valve (Fig. 0597):

A. Hydraulic fluid return fitting
B. Auxiliary valve and relief fitting
C. Tilt cylinder fittings (2)
D. Lift cylinder fittings (2)
E. Right hand counterbalance valve fittings (2)
F. Left hand counterbalance valve fittings (2)
G. Hydraulic test port fitting

4-Spool Valve Installation

1. Before installing the 4-Spool valve back in the frame, leave the two 90° fittings loose (Fig. 0598).

2. Install the o-ring on the relief valve (Fig. 0599).
3. Install the relief valve assembly on the 4-spool valve housing (Fig. 0600).

4. Loosely install the 3 spacers and bolts to the valve body (Fig. 0601).

   **Note:** The different size spacer is located at the top.

5. Install the 4 handles. Adjust the 2 drive handles so they are at the same height and adjust the 2 lift handles so they are at equal heights (Fig. 0602).

6. Tighten the jam nuts on the three levers (Fig. 0603).
7. Remove the left control lever assembly that routes under the drive lever controls (Fig. 0604).

**Note:** This will be reinstalled after the 4-spool valve is installed and the hydraulic lines are connected.

8. Tighten the 3 set screws securing the control lever rods (Fig. 0605).

9. Insert the 4-spool Valve through the front opening of the frame up into the upper frame assembly and rest on top of air cleaner assembly (Fig. 0606).

10. Route the auxiliary relief valve metal line around the choke cable (Fig. 0607).
11. Loosely install the relief valve hydraulic line nut on the longer end of the hydraulic line to the relief valve (Fig. 0608).

12. Thread the nut on the other end of the auxiliary relief valve line to the T-fitting on the 4-spool valve (Fig. 0609). Tighten both nuts on the auxiliary relief valve hydraulic line.

13. Loosely install a bolt and washer through the upper frame into the spool valve (Fig. 0610).

14. Install 2 bolts and 4 washers through the manual tube r-clamps and the upper frame into the 4-spool valve (Fig. 0611).
15. Install the auxiliary valve hydraulic line nut to the 4-spool valve t-fitting (Fig. 0612).

16. Install the 2 hydraulic tilt cylinder lines to the 4-spool valve (Fig. 0613).

**Note:** The hydraulic line on the rod end of the tilt cylinder connects to the top fitting on the 4-spool valve.

17. Install all 4 counterbalance valve hydraulic lines to the 4-spool valve fittings (Fig. 0614).

18. Install the two hydraulic lift cylinder t-fittings to the 4-spool valve fittings (Fig. 0615).
19. Tighten the 3 bolts securing the 4-spool valve to the spacer blocks and the 3 bolts securing the 3 spacer blocks to the control panel (Fig. 0616).

20. Install the filter return line to the fitting on the right hand side of the 4-spool valve (fitting was previously left loose. After the hydraulic line is installed, tighten the fitting (Fig. 0617).

21. Position the test port hydraulic line to the selector valve fitting and the fitting on the left side of the 4-spool valve. Install the two hydraulic line nuts to secure (Fig. 0618 and Fig. 0619).

Note: The fitting on the selector valve may need to be loosened to position the hydraulic hard line. If loosened, tighten it and the fitting on the left hand end of the 4-spool valve that was previously left loose.
22. Position the lift arm lever to the 4-spool valve. Install a bolt and lock washer to secure (Fig. 0620).

23. Position the control panel plate on the control panel (Fig. 0621).

24. Install 4 screws to secure the plate to the control panel (Fig. 0622).

25. Check the hydraulic fluid level and add if necessary.

26. Start the machine and check for leaks.

27. Purge air from the system.

28. Check the hydraulic fluid level and add if necessary.
Hydraulic Filter Head Replacement

Hydraulic Filter Head Removal

1. Start the unit, raise the lift arm all the way up and install the cylinder locks (Fig. 0623). Lower the lift arm cylinder onto the locks.

2. Loosen the hose clamp securing the hydraulic fluid return hose to the fitting on the top of the filter head assembly (Fig. 0624).

3. Remove the hydraulic fluid return hose from the fitting (Fig. 0625).

4. Remove the hydraulic fluid filter from the filter head assembly (Fig. 0626).
5. Loosen the straight fitting (Fig. 0627).

6. Remove the filter head assembly from the hydraulic tank return port (Fig. 0628).

7. Remove the straight fitting and the 45° elbow fitting from the filter head assembly (Fig. 0629).
Hydraulic Filter Head Installation

1. Install the straight fitting and the 45° elbow fitting (leave loose, do not tighten) on the filter head assembly (Fig. 0630).

Note: The body of the filter head assembly has arrows on it. The arrows should be pointing toward the straight fitting.

2. Install the filter head assembly into the hydraulic tank return port (Fig. 0631).

3. Tighten the straight fitting with a wrench (Fig. 0632).

4. With the hose clamp on the hydraulic fluid return hose, slide the hydraulic fluid return hose on the 45° elbow fitting. Tighten the 45° elbow fitting (Fig. 0633).
5. Position and tighten the hose clamp securing the hydraulic fluid return hose to the 45° elbow fitting (Fig. 0634).

8. Clean up any spilled fluid.

9. Start the engine and let it run for about two minutes to purge air from the system.

10. Stop the engine and check for leaks.

11. Check the fluid level in the hydraulic tank. If necessary, add hydraulic fluid to raise the level to between the marks on dipstick.

12. Do not over-fill the tank.

13. Start the unit and raise the lift arm.

14. Remove and store the cylinder locks.

15. Lower the loader arms.

6. Apply a thin coat of hydraulic fluid to the rubber gasket on the replacement filter.

7. Install the replacement hydraulic filter onto the filter adapter. Tighten it clockwise until the rubber gasket contacts the filter adapter, then tighten the filter an additional 1/2 turn (Fig. 0635).

Fig. 0634

Fig. 0635

A. Hydraulic filter
B. Gasket
C. Adapter
Auxiliary Valve & Selector Valve Replacement

Auxiliary Valve & Selector Valve Removal

Note: The auxiliary valve and selector valve are removed as an assembly (Fig. 0636).

A. Auxiliary Valve  B. Selector Valve

1. Unplug the auxiliary valve safety switch from the harness (Fig. 0637).

A. Switch  B. Harness Plug

2. Tag or mark the 2 selector valve hydraulic lines and the 2 auxiliary valve hydraulic lines (Fig. 0638).

A. Selector valve hydraulic line  B. Selector valve hydraulic line  C. Auxiliary valve hydraulic line  D. Auxiliary valve hydraulic line

3. Remove the hydraulic lines from the pump selector valve fittings. Cap the fittings and hose ends to prevent contamination (Fig. 0639).
4. Remove the tie strap that holds the two hydraulic hoses to the fitting between the two valves (Fig. 0640).

5. Remove the hydraulic hard line connected to the 90° fitting located on the left side of the selector valve (Fig. 0641).

6. Remove the hydraulic hard line connected to the 90° fitting located on the right side of the auxiliary valve (Fig. 0642).

7. Remove the four bolts, spacers, washers, and nuts securing the valves to the upper frame (Fig. 0643).
8. Remove the auxiliary valve and selector valve assembly from the upper frame (Fig. 0644).

9. Loosen the jam nut on the straight fitting located between the valves (Fig. 0645).

10. Separate the valves from the straight fitting (Fig. 0646).

11. Remove the Auxiliary bracket from the auxiliary valve (Fig. 0647).
12. Remove the two screws and washer securing the auxiliary lever and mount to the valve (Fig. 0648).

**Auxiliary Valve & Selector Valve Installation**

1. Loosely install the auxiliary lever and mount to the auxiliary valve with a bolt and washer.

**Note:** The washer is located between the auxiliary mount and the auxiliary valve (Fig. 0649).

2. Loosely install a second bolt through the auxiliary mount and into the valve spool (Fig. 0650).
3. Position the auxiliary bracket over the handle and onto the auxiliary valve (Fig. 0651).

4. Install the straight fitting into the auxiliary valve (Fig. 0652).

5. Loosely install the selector valve onto the straight fitting (Fig. 0653).

   **Note:** Do not tighten at this point. You may need to adjust the spacing between the two valves to match the mounting holes on the machine.

6. Before installing the valves to the upper frame, notice the two different size spacers used on the valves. The two short spacers are used on the auxiliary valve (A) and the two longer spacers are used on the selector valve (B) (Fig. 0654).
7. Position two short spacers between the auxiliary valve and the auxiliary bracket. Insert two bolts through the auxiliary valve, spacers and bracket (Fig. 0655).

8. Position the valve assembly to the upper frame (Fig. 0656). Position two long spacers between the selector valve and the frame. Loosely install two bolts, washers and nuts.

9. Install and tighten the hydraulic metal lines to the fittings on the auxiliary and selector valve (Fig. 0657 and Fig. 0658). Tighten the straight fitting between the two valves.
10. Tighten the 4 bolts, spacers, washers, nuts securing the valve assembly to the upper frame (Fig. 0659).

11. Install the hydraulic lines to the auxiliary valve (Fig. 0660).

12. Install the hydraulic lines to the selector valve Fig. 0661).

13. Install a tie strap around the two tilt cylinder hydraulic lines and the straight fitting between the auxiliary and selector valves. Tighten and trim the excess (Fig. 0662). This will ensure the hydraulic lines do not come in contact with the muffler.
14. Plug the auxiliary valve safety switch into the harness connector (Fig. 0663).

15. Check the hydraulic fluid level. Add fluid if necessary.

16. Start and run the machine to purge air from the system.

17. Check for leaks.

18. Check the hydraulic fluid level. Add fluid if necessary.

**Lift Cylinder Replacement**

**Lift Cylinder Removal**

1. Start the unit and raise the lift arm all the way up. Install a cylinder lock on the cylinder that you are not removing (Fig. 0664).

2. Turn the machine off and remove the key.

3. Mark the upper hydraulic hose and cylinder fitting (Fig. 0665).
4. Remove the hydraulic hose from the upper fitting on the hydraulic cylinder (Fig. 0666).

5. Remove the hydraulic hose from the lower fitting on the hydraulic cylinder (Fig. 0668).

Note: Install a plug and cap on the hose and cylinder fittings to help stop any oil leakage and prevent debris from entering the system (Fig. 0667).

6. Remove the shoulder bolt securing the upper pivot pin to the cylinder (Fig. 0669).
7. Remove the pivot pin from the cylinder/loader arm pivot point (Fig. 0670).

8. Remove the shoulder bolt securing the lower pivot pin to the cylinder (Fig. 0671).

9. Remove the pivot pin from the main frame/cylinder pivot point (Fig. 0672).

10. Remove the hydraulic cylinder from the machine (Fig. 0673).
11. Remove the two 90º fittings from the lift cylinder (Fig. 0674 and Fig. 0675).

12. To service the lift cylinder, refer to “100-4163 Hydraulic Cylinder Rebuild” (Old Style) for 2004 and older units, on page 3/1-17 or “105-7867 Hydraulic Cylinder Rebuild” (New Style) for 2005 and newer units, on page 3/1-40.

**Lift Cylinder Installation**

1. Install the 2 hydraulic fittings in the lift cylinder. Position the fittings so they are facing each other (Fig. 0676).

   **Note:** The marked fitting goes into the port on the ram end of the cylinder barrel.

2. Position the lift cylinder in the machine with the ram end facing up (Fig. 0677).
3. Align the barrel end of the cylinder with the main-frame pivot point. Insert the pivot pin (Fig. 0678).

4. Install a shoulder bolt to secure the pivot pin. Torque the shoulder bolt to 150 - 179 in-lbs (17 - 20 Nm) (Fig. 0679).

5. Install both hydraulic lines to the lift cylinder fittings. Ensure the marked hydraulic line is attached to the marked fitting (Fig. 0680).

Note: Use double wrenches to prevent the fittings from spinning.
6. Align the ram end of the cylinder with the loader arm pivot point. Insert the pivot pin into the pivot point (Fig. 0681).

**Note:** If the holes on the ram end of the cylinder and the lift arm pivot point are not aligned, start the unit and raise the lift arm. Remove the cylinder lock and carefully align the holes so that the pivot pin can be installed. Replace the cylinder lock after the pivot pin has been installed.

7. Install a shoulder bolt to secure the pivot pin. Torque the shoulder bolt to 150 - 179 in-lbs (17 - 20 Nm) (Fig. 0682).

8. Grease the top and bottom pivot pins and bushing assemblies (Fig. 0683).

9. Start the unit and raise the lift arm. Remove the cylinder lock.

10. Purge the system and check for any leaks.

11. Check the hydraulic fluid and add if necessary.
Tilt Cylinder Replacement (New Style)

2. Support the attach plate. Remove the pivot pin from the tilt cylinder/attach plate pivot (Fig. 0686).

A. New style tilt cylinder  B. Old style tilt cylinder

Fig. 0684  DSC-3929a

Tilt Cylinder Removal

1. Remove the shoulder bolt from the lower pivot pin (Fig. 0685).

Fig. 0685  DSC-2854a

3. Remove the cable tie securing the hydraulic lines to the tilt cylinder barrel (Fig. 0687).

Fig. 0687  DSC-2856a
6. Remove the pivot pin and the tilt cylinder from the machine (Fig. 0690).

4. Position a drain pan under the front of the machine. Remove the hydraulic lines from the tilt cylinder fittings (Fig. 0688). Allow the hydraulic fluid to drain into the drain pan.

5. Remove the shoulder bolt from the upper pivot pin (Fig. 0689).
7. Remove the two 90° fittings from the tilt cylinder (Fig. 0691 and Fig. 0692).

8. To service the tilt cylinder, refer to “100-4163 Hydraulic Cylinder Rebuild” (Old Style) for 2004 and older units, on page 3/1-17 or “105-7867 Hydraulic Cylinder Rebuild” (New Style) for 2005 and newer units, on page 3/1-40.

Tilt Cylinder Installation

1. Install the 2 hydraulic fittings in the tilt cylinder. Orientate the fittings so they face away from the ram end of the cylinder (Fig. 0693).

2. Position the barrel end of the tilt cylinder to the loader arm. Install a pivot pin (Fig. 0694).
3. Install a shoulder bolt to secure the pivot pin. Torque the shoulder bolt to 150 – 170 in-lbs. (17 - 20 Nm) (Fig. 0695).

5. Lift the attach plate and align the cylinder ram to the attach plate. Install a pivot pin (Fig. 0697).

4. Install the hydraulic lines to the tilt cylinder fittings (Fig. 0696).

   **Note:** Use double wrenches to prevent the fittings from spinning and twisting the hose.

6. Install a shoulder bolt to secure the pivot pin. Torque the shoulder bolt to 150 – 170 in-lbs. (17 – 20 Nm) (Fig. 0698).
7. Install a cable tie around the cylinder barrel and hydraulic lines to secure (Fig. 0699).

10. Check the hydraulic fluid and add as necessary.

11. Start the machine and purge the air from the system.
    Check for leaks.

12. Check the hydraulic fluid and add as necessary.

8. Remove the drain pan.

9. Grease the upper and lower pivot pin and bushing assemblies (Fig. 0700).
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Loader Arm Replacement

Loader Arm Removal

1. Raise the loader arm 6” - 8” (15 - 20cm) away from frame and position attach plate flat (horizontally) (Fig. 0701).

2. 4-Paw machines: Remove the hood.

3. Support the attach plate with a floor jack (Fig. 0702).

4. Using a 1/2” socket, remove the 3 bolts retaining the 3 pivot pins to the attach plate (Fig. 0703).

5. Remove the center pivot pin (Fig. 0704).
6. Remove the RH and LH pivot pins (Fig. 0705 and Fig. 0706).

7. Remove the attach plate (Fig. 0707).

8. Using a 1/2” socket, remove the bolt securing the upper tilt cylinder pivot pin to the tilt cylinder (Fig. 0708).
9. Remove the upper pivot pin (Fig. 0709).

Note: Support the cylinder with one hand as you remove the upper pivot pin.

10. Lay the tilt cylinder alongside the unit (Fig. 0710).

11. Mark the hydraulic lines to the flush face couplers with an M for male and F for female relating to the couplers (Fig. 0711).

12. Place an oil pan underneath the couplers to catch drainage.

13. Using a 1-1/8" wrench remove the hydraulic line to the male (M) flush face coupler (Fig. 0712).

Note: Use a plug to protect the line from contamination.
14. Using a 1-18” wrench remove the hydraulic line to the female (F) flush face coupler (Fig. 0713).

**Note:** Use a plug to protect the line from contamination.

15. Using a 1-1/4” wrench and 1-5/16” wrench remove the nut from the male flush face coupler (Fig. 0714) and remove the male flush face coupler (Fig. 0715).
16. Using a 1-5/16” wrench remove the nut from the female flush face coupler (Fig. 0716) and remove the female flush face coupler (Fig. 0717).

17. Remove the drain pan.

18. Using a properly rated strap or chain and hoist, support the cross-member of the loader arm (Fig. 0718).

19. Using a 1/2” socket remove the 2 bolts securing the lift cylinder pin to the loader arm and the loader arm pivot pin to the frame (2 per side, left side shown) (Fig. 0719).
20. Remove the left and right lift cylinder pin from the loader arm (Fig. 0720).

21. Remove the left and right loader arm pivot pin from the frame (Fig. 0721).

22. Remove the loader arm from the machine (Fig. 0722).
Loader Arm Installation

1. Inspect the loader arm and pivot pins for wear or damage. Replace as necessary (Fig. 0723).

![Fig. 0723 DSC-1448a]

2. Inspect the hydraulic cylinder yolks for wear or damage. Replace as necessary (Fig. 0724).

![Fig. 0724 DSC-1453a]

3. Inspect the attach plate for wear or damage. Replace as necessary (Fig. 0725).

![Fig. 0725 DSC-1458a]

4. Install the loader arm onto the unit, aligning the pivot points on the loader arm with the pivot points on the upper frame (Fig. 0726).

![Fig. 0726 DSC-1459a]
5. Install a pivot pin through the frame and loader arm pivot point (Fig. 0727).

6. Repeat for the opposite side.

7. Install a pivot pin through the lift cylinder and loader arm pivot point (Fig. 0728).

8. Repeat for the opposite side.

9. Using a 1/2" socket, install 4 bolts to secure the pivot pins to the upper frame and lift cylinders on both sides of the machine. Torque the bolts to 19 ft-lbs. (26 Nm) (Fig. 0729 and Fig. 0730).
10. Remove the support from the loader arm.

11. Position the female flush face coupler into the outside hole of the coupler bracket on the loader arm (Fig. 0731).

12. Using a 1-5/16" wrench install the nut to the female flush face coupler (Fig. 0732).

**Note:** Upon removal, all seals, o-rings and gaskets should be replaced. During installation, lightly lubricate all seals, o-rings and gaskets with clean petroleum jelly prior to assembly.

13. Position the male flush face coupler into the coupler bracket on the loader arm (Fig. 0733).

14. Using a 1-1/4" wrench and 1-5/16" wrench install the nut to the male flush face coupler (Fig. 0734).
15. Using a 1-1/8" wrench install the hydraulic line (F) to the female flush face coupler (Fig. 0735).

16. Using a 1-1/8" wrench install the hydraulic line (M) to the male flush face coupler (Fig. 0736).

17. With the fittings facing up toward the engine, position the tilt cylinder in the center of the loader arm (Fig. 0737).

18. Install the upper pivot pin through the tilt cylinder yoke and loader arm bracket (Fig. 0738).
19. Install a bolt to secure the pivot pin to the cylinder yoke. Torque the bolt to 19 ft-lbs. (26 Nm) (Fig. 0739).

20. Position the attach plate to the loader arm pivot points (Fig. 0740).

21. Install the right and left side pivot pins into the pivot points (Fig. 0741).

22. Align the tilt cylinder ram with the attach plate center pivot point. Install the center pivot pin securing the tilt cylinder to the attach plate (Fig. 0742).
23. Using a 1/2" socket, install 3 bolts securing each of the pivot pins to the attach plate (2) and the tilt cylinder ram (1) (Fig. 0743).

24. Torque the 3 pivot pin bolts to 19 ft-lbs. (26 Nm) (Fig. 0744).

25. Remove the floor jack.

26. 4-Paw machines: Install the hood.

27. Start the machine. Raise and lower the loader arm.

28. Check the hydraulic fluid level and add if necessary.

29. Grease the pivot points (using #2 general purpose lithium grease):
   - Left side (Fig. 0745)
Attach plate (Fig. 0746)

Right side (Fig. 0747)
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Gas Engine Replacement

Gas Engine Removal

1. Start the engine and let it run for five minutes to warm the engine oil.

2. Park the traction unit so that the drain side (rear left corner) is slightly lower than the opposite side to ensure that the oil drains completely.

3. Raise the loader arms to the fully raised position.

4. Turn off the engine and remove the key.

5. Remove the loader arm cylinder locks located on the hydraulic auxiliary lines (Fig. 0748).

6. Position a loader arm cylinder lock over each lift cylinder rod (Fig. 0749).

7. Secure each loader arm cylinder lock with a clevis pin and hairpin cotter (Fig. 0750).
8. Lower the loader arm until the loader arm end of the cylinder rods are resting on the cylinder locks.

9. Place a drain pan under the rear left corner of the machine to drain the engine oil into.

10. Uncap the engine oil drain valve (Fig. 0751).

11. Place one end of a hose on the drain valve and the other end in the drain pan (Fig. 0752).

12. Open the drain valve by turning it counterclockwise pulling out as you turn (Fig. 0753).

13. When the oil has drained completely, close the drain valve, remove the hose and replace the dust cap.

14. Disconnect the negative and then the positive battery cable. Remove the wing nut, washer and carriage bolt securing the battery clamp to the frame. Remove the battery clamp (Fig. 0754).
15. Remove the battery from the frame (Fig. 0755).

16. Turn the fuel shut off valve to the OFF position (Fig. 0756).

17. Mark the hydraulic pump lines and port locations F and R (Fig. 0757):

F: Front hydraulic line    R: Rear hydraulic line

18. Place an absorbent towel under the hydraulic pump.

19. Using a 15/16” wrench, remove the front hydraulic line from the pump fitting (Fig. 0758).
20. Using a 15/16” wrench, remove the rear hydraulic line from the pump fitting (Fig. 0759).

21. Cap the lines and fittings so debris does not enter the system (Fig. 0760).

22. Loosen the hose clamps on the front suction hose (Fig. 0761).

23. Slide the front suction hose off the hydraulic pump suction fitting (Fig. 0762).
24. Loosen the hose clamps on the rear suction hose (Fig. 0763).

25. Slide the rear suction hose off the hydraulic pump suction fitting (Fig. 0764).

26. Cap all hydraulic lines, hoses and fittings to prevent debris from entering the system.

27. Using a 1/2” socket, remove the 4 nuts and lock washers securing the muffler to the engine manifold (Fig. 0765 and Fig. 0766).
28. Using a 1/2” socket, remove the 2 bolts securing the muffler bracket to the engine (Fig. 0767).

29. Remove the muffler (Fig. 0768).

30. Using an 8mm socket, loosen the throttle cable clamp (Fig. 0769).

31. Remove the throttle cable from the clamp and unhook it from the engine throttle lever (Fig. 0770).
32. Loosen the air cleaner cover knob from the air cleaner cover (Fig. 0771).

34. Using an 8mm socket, loosen the choke cable clamp (Fig. 0773).

33. Remove the air cleaner cover from the engine (Fig. 0772).

35. Remove the choke cable from the clamp and unhook it from the engine choke lever (Fig. 0774).
36. Using a 1/2" socket, remove the 2 front bolts securing the engine mount to the main frame and discard them (Fig. 0775).

37. Slide the fuel line hose clamp away from the fuel filter (Fig. 0776).

38. Slide the fuel line off the fuel filter. Allow the fuel to drain into an approved container (Fig. 0777).

39. Unplug the wire harness connector from the engine (Fig. 0778).
40. Using a 13mm socket, remove the bolt securing the ground wire to the engine (Fig. 0779).

41. Using a 13mm socket, remove the nut securing the positive battery cable and the red harness wire to the starter solenoid (Fig. 0780).

42. Remove the positive battery cable from the starter solenoid (Fig. 0781).

43. Remove the red harness wire from the starter solenoid (Fig. 0782).
44. Using a 1/2" socket, remove the 2 rear bolts securing the engine mount to the main frame and discard the bolts (Fig. 0783).

45. Place suitable lumber on the operator’s stand to receive the engine. Slide the engine out toward the rear. Rest the back of the engine on the lumber (Fig. 0784).

46. Hook chains to the engine lift points (Fig. 0785). Attach a properly rated hoist to the chains. Raise the hoist to apply tension to the chains.

47. Carefully raise the engine out of the frame (Fig. 0786).
48. Slide the hose clamp away from the fuel filter (Fig. 0787).

49. Remove the fuel filter from the fuel line (Fig. 0788).

50. Rotate the engine until the 2 hydraulic pump coupler set screws are accessible through the opening in the pump mount (Fig. 0789).

51. Using an 8 point 1/4” socket, loosen the 2 hydraulic pump coupler set screws (Fig. 0790).
52. Using a 5/8" socket, remove the 4 bolts securing the pump mount to the engine (Fig. 0791).

53. Remove the hydraulic pump and mount assembly from the crankshaft (Fig. 0792).

54. Remove the key from the crankshaft keyway (Fig. 0793).
55. Using a 9/16" socket and wrench, remove the 4 bolts and nuts securing the engine to the engine mount (Fig. 0794 and Fig. 0795).

56. Separate the engine mount from the engine (Fig. 0796).

57. Remove the dust cap from the oil drain valve (Fig. 0797).
58. Using a 15/16” wrench, remove the oil drain valve from the engine (Fig. 0798 and Fig. 0799).

Gas Engine Installation

1. Apply pipe sealant to the threads of the oil drain valve (Fig. 0800).

59. For engine service, refer to applicable Kohler service manual.
2. Install the engine oil drain valve finger tight. Use a 15/16” wrench to tighten the drain valve an additional 2-1/2 turns past finger tight (Fig. 0801 and Fig. 0802).

3. Position the engine mount to the engine (Fig. 0803).

4. Using a 9/16” socket and wrench, install 4 bolts and nuts securing the engine to the engine mount (Fig. 0804).
5. Torque the engine mount bolts to 30 ± 3 ft-lbs. (40.67 ± 4 Nm) (Fig. 0805).

7. Install the key into the crankshaft keyway (Fig. 0807).

6. Install the dust cap onto the oil drain valve (Fig. 0806).

8. Apply anti-seize to the engine crankshaft (Fig. 0808).
9. Align the coupler with the crankshaft keyway. Position the hydraulic pump and mount assembly onto the crankshaft (Fig. 0809).

10. Install 4 bolts securing the pump mount to the engine (Fig. 0810).

11. Use a 5/8” socket to tighten the 4 bolts securing the pump mount to the engine. Torque the 4 bolts to 216 ± 25 in-lbs. (24.4 ± 2.8 Nm) (Fig. 0811).

12. Using an 8 point 1/4” socket, tighten the 2 hydraulic pump coupler set screws. Torque them to 100 ± 10 in-lbs. (11.3 ± 1 Nm) (Fig. 0812).
13. Hook chains to the engine lift points (Fig. 0813). Attach a properly rated hoist to the chains. Raise the hoist to apply tension to the chains.

14. Place suitable lumber on the operator’s stand.

15. Raise the hoist and position the engine partially into the main frame and resting on the lumber (Fig. 0814).

16. Remove the chains and hoist (Fig. 0815).

17. Slide the engine into position in the main frame so the engine mount plate mounting holes align with the mounting holes in the main frame (Fig. 0816).
18. Using a 1/2" socket, loosely install 4 new engine mounting bolts to secure the engine to the main frame (Fig. 0817 and Fig. 0818).

19. Torque the 4 engine mounting bolts to 350 ± 50 in-lbs. (39.5 ± 5.6 Nm) (Fig. 0819).

20. Slide the black battery cable onto the ground bolt (Fig. 0820).
21. Slide the black harness ground wire onto the ground bolt (Fig. 0821).

23. Using a 13mm socket, install the ground bolt assembly into the engine block (Fig. 0823).

22. Slide the star washer onto the ground bolt (Fig. 0822).

24. Torque the ground bolt to 200 ± 25 in-lbs. (22.6 ± 2.8 Nm) (Fig. 0824).
25. Plug the harness connector into the engine connector (Fig. 0825).

26. Slide the fuel line onto the fuel filter (Fig. 0826).

27. Slide the hose clamp into place to secure the fuel filter (Fig. 0827).

28. Turn the fuel shut-off valve to the ON position (Fig. 0828).
29. Slide the red harness wire onto the starter solenoid (Fig. 0829).

30. Slide the red battery cable onto the starter solenoid (Fig. 0830).

31. Using a 1/2" socket, install a nut to secure the red battery cable and red harness wire to the starter solenoid (Fig. 0831).

32. Remove the air cleaner cover (Fig. 0832).
33. Hook the choke cable z-bend into the choke linkage on the engine (Fig. 0833).

34. Slide the choke cable into the cable clamp aligning the previous indention on the cable with the choke cable clamp (Fig. 0834).

35. Push the throttle linkage over and hook the throttle cable z-bend into the throttle linkage (Fig. 0835).

36. Slide the throttle cable into the cable clamp aligning the previous indention on the cable with the throttle cable clamp (Fig. 0836).
37. Position the air cleaner cover onto the engine (Fig. 0837).

38. Install the air cleaner cover knob to secure (Fig. 0838).

39. Install the 2 manifold gaskets (Fig. 0839 and Fig. 0840).
40. Position the muffler onto the engine manifold studs aligning the muffler bracket mounting holes with the mounting holes on the engine (Fig. 0841).

41. Loosely install 2 bolts securing the muffler bracket to the engine (Fig. 0842).

42. Loosely install 4 lock washers and nuts securing the muffler to the engine manifold studs (Fig. 0843).

43. Use a 1/2" socket to tighten the 4 muffler manifold nuts (Fig. 0844).
44. Use a 1/2" socket to torque the 2 bolts securing the muffler bracket to the engine to 200 ± 25 in-lbs. (23 ± 3 Nm) (Fig. 0845).

45. Slide one of the hydraulic suction hoses onto the hydraulic pump suction fitting (Fig. 0846).

46. Position the hose clamp and tighten to secure the suction hose to the fitting (Fig. 0847).

47. Slide the second hydraulic suction hose onto the other hydraulic pump suction fitting (Fig. 0848).
48. Position the hose clamp and tighten to secure the suction hose to the fitting (Fig. 0849).

49. Position the battery into the main frame (Fig. 0850).

50. Connect the positive and then the negative battery cable to the battery. Position the battery clamp on the battery up against the frame. Install the carriage bolt, washer and wing nut securing the battery clamp to the frame (Fig. 0851).

51. Install the hydraulic line (marked with an R) to the rear hydraulic pump fitting (also marked with an R) (Fig. 0852).
52. Use a 15/16” wrench to tighten the hydraulic line nut to the fitting (Fig. 0853).

53. Install the hydraulic line (marked with and F) to the front hydraulic pump fitting (also marked with an F) (Fig. 0854).

54. Use a 15/16” wrench to tighten the hydraulic line nut to the fitting (Fig. 0855).

55. Fill the engine with oil.

56. Check the hydraulic fluid level:

Hydraulic Tank Capacity: 17.25 US gallons (67 liters)

a. Use 10W-30 or 15W-40 detergent, diesel engine oil (API service CH-4 or higher).

b. Clean the area around the filler neck of the hydraulic tank.

c. Remove the cap from the filler neck and check the fluid level on the dipstick.

d. The fluid level should be between the marks on the dipstick.

e. If the level is low, add enough fluid to raise it to the proper level.

f. Install the cap on the filler neck.
57. Turn the machine on and run it to purge air from the system. Check for leaks.
58. Raise the loader arm to remove pressure from the loader arm cylinder locks.
59. Remove the clevis pin and cotter pin from the loader arm cylinder locks (Fig. 0856).

61. Reinstall the loader arm cylinder locks onto the hydraulic auxiliary lines (for storage) (Fig. 0858).

62. Lower the loader arms.
63. Turn the engine off.
64. Check and add hydraulic fluid to the hydraulic tank as required.
65. Verify/adjust engine RPM to the following:
   • Maximum engine speed (full throttle) to 3600 ± 75 RPM.
   • Minimum engine speed (idle) to 1400 ± 200 RPM.
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Ignition Switch

Purpose

This component provides the proper switching for the starter, ignition, accessories, and safety circuits.

Location

The ignition switch is mounted on the right hand side of the upper frame assembly (Fig. 0859).

How It Works

Detents inside the ignition switch give it 3 positions: OFF, RUN, and START. The START position is spring loaded so the cylinder automatically returns to RUN once the key is released.

Testing

1. Disconnect the switch from the wiring harness.

2. Verify continuity exists between the terminals listed for the START and RUN switch positions. Verify that there is continuity between the terminals G and M in the OFF switch position only (Fig. 0860).

<table>
<thead>
<tr>
<th>Position</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>OFF</td>
<td>G + M</td>
</tr>
<tr>
<td>RUN</td>
<td>B + R (L)</td>
</tr>
<tr>
<td>START</td>
<td>B + S</td>
</tr>
</tbody>
</table>
Relay

Purpose

The chain drive wheeled traction unit uses one relay to direct current flow to the start circuit of the unit.

Location

The relay is located on the right hand side, bolted to the lower frame assembly, next to the engine (Fig. 0861).

How It Works

A relay is an electrically actuated switch.

1. **Coil:** Terminals 85 and 86 are connected to a coil. Applying 12 volts to these terminals energizes the coil turning it into an electromagnet.

2. **Switch:** Terminals 30, 87 and 87a are actually part of a single pole, double throw (SPDT) switch. Terminal 30 is the common lead. The switch is spring loaded so that 30 and 87a are not connected when the coil is not energized. When the coil is energized the switch is “thrown” and 30 and 87 are connected (Fig. 0937).

Testing

1. Disconnect the relay from the harness.

2. Verify the coil resistance between terminals 85 and 86 with a multimeter (ohms setting). Resistance should be from 70 to 90 ohms. There should be continuity between terminals 87a and 30 (Fig. 0862).

3. Connect the multimeter (ohms setting) leads to relay terminals 30 and 87. Ground terminal 86 and apply +12 VDC to terminal 85. The relay should make and break continuity between terminals 30 and 87 as 12 VDC is applied and removed from terminal 85 (Fig. 0862).

4. Connect the multimeter (ohms setting) leads to relay terminals 30 and 87a. Apply +12VDC to terminals 85. With terminal 86 still grounded, the relay should break and make continuity between terminals 30 and 87a as 12 VDC is applied and removed from the terminal (Fig. 0862).

5. Disconnect voltage and multimeter leads from relay terminals.
Fuses

Purpose

Fuses are used in the circuits to limit damage in the event of excessive current flow. If a fuse fails, look for a short circuit, a corroded/poor connection, or any component that appears to have been overheated. A failed fuse is a sign of a problem in that circuit.

Location

The fuses are located on the right hand side of the lower frame assembly, above the relay, next to the engine (Fig. 0863).

How It Works

The fuse block is where the wires that carry 12 volts meet the wires that need 12 volts to operate a component or function. The fuse makes the connection between the 12 volt wire carrying the current and the 12 volt wire that needs the current.

Testing

A failed fuse will often be discolored or melted. Please note that not all fuse failures are easy to see. A fuse can be checked with a continuity tester if there is doubt. If there is no continuity between the fuse terminals, replace the fuse, even if it appears good.

A. 25 amp fuse = Charge and fuel solenoid
B. 30 amp fuse = Start circuit
Auxiliary Neutral Switch

**Purpose**

The normally closed ball type switch is used on the auxiliary hydraulic valve. This is a safety switch to make sure the auxiliary hydraulic valve is in the neutral detent (Fig. 0864).

**How It Works**

The switch has a spring loaded ball. When the auxiliary hydraulic valve is in the neutral position, the ball moves into a machined notch located in the spool. The normally closed switch then provides a ground to the start circuit. When the auxiliary lever is moved out of neutral, the spool pushes against the ball end of the switch and opens the ground circuit which prevents the engine from starting.

**Testing**

1. Disconnect the switch from the wiring harness. The ball end of the switch should remain installed in the auxiliary hydraulic valve.

2. Connect the VOM multimeter (ohms setting) leads to the two wire terminals. Move the auxiliary hydraulic valve handle to either the reverse flow or forward flow position; there should be NO continuity.

**Location**

A neutral switch is threaded into the lower portion of the auxiliary hydraulic valve, located on the right side of the upper frame assembly (Fig. 0865).
Hour Meter

Purpose

The digital hour meter displays engine run time and is a service reminder. When the engine is off, the hour meter displays the number of operation hours that have been logged on the traction unit.

After 50 hours and then every 100 hours thereafter (that is 150, 250, 350, etc.) the screen displays CHG OIL to remind you to change the engine oil. After every 100 hours, the screen displays SVC to remind you to perform the other maintenance procedures based on a 100, 200 or 400 hour schedule. These reminders come on starting three hours prior to the service interval time and flash at regular intervals for six hours.

Location

The hour meter is mounted below the ignition switch on the upper frame assembly (Fig. 0866).

How It Works

The digital hour meter is an electronic clock. It is not repairable or resettable (Fig. 0867).

Testing

The digital hour meter should be replaced if any of the functions do not work properly. Prior to replacing the hour meter, verify that 12 volts DC is present across the two terminals when the engine is running and the ignition key is in the RUN position. If 12 volts DC is present, and the meter is not running, replace the meter. If 12 volts is not present, check the connections.
Battery Replacement

Battery Removal

1. Raise the loader arms to the fully raised position.
2. Turn off the engine and remove the key.
3. Remove the loader arm cylinder locks located on the hydraulic auxiliary lines (Fig. 0868).
4. Position a loader arm cylinder lock over each lift cylinder rod (Fig. 0869).
5. Secure each loader arm cylinder lock with a clevis pin and hairpin cotter (Fig. 0870).
6. Lower the loader arm down until the loader arm end of the cylinder rods are resting on the cylinder locks.

7. Disconnect the negative and then the positive battery cable. Remove the wing nut, washer and carriage bolt securing the battery clamp to the frame. Remove the battery clamp (Fig. 0871).

Battery Installation

1. Position the battery into the frame (Fig. 0873).

2. Position the battery clamp onto the battery, up against the frame. Install a carriage bolt washer and wing nut to secure the battery clamp to the frame. Connect the positive and then the negative battery cable (Fig. 0874).

8. Remove the battery from the frame (Fig. 0872).
3. Turn on the machine and raise the loader arm up to relieve pressure from the cylinder locks.

4. Turn off the engine and remove the key.

5. Remove the clevis pin and cotter pin securing each loader arm cylinder lock to the cylinder rod (Fig. 0875).

6. Remove the cylinder locks from the lift cylinder rods (Fig. 0876).

7. Store the loader arm cylinder locks by installing them on the hydraulic auxiliary lines (Fig. 0877).

8. Lower the loader arms.
Electrical Schematic

22311 / 22317

Fig. 0878  3326-607 22311-22317
Front Wheel Motor Replacement

Front Wheel Motor Removal

1. Park CUL on a level surface.
2. Raise the loader arm 6” - 12” (15 - 30cm) off the ground.
3. Turn off the machine and remove the key.
4. Lift the rear of the machine (Fig. 0879).
5. Position jackstands under the rear 2 corners of the machine. Remove the floor jack (Fig. 0880).
6. Raise the front of the machine (Fig. 0881).
7. Position jackstands under the front corners of the machine. Remove the floor jack (Fig. 0882).
8. Lower the loader arm.

9. Using a 13/16” socket, remove 5 lug nuts securing the rear wheel to the wheel hub (Fig. 0883).

10. Remove the wheel from the wheel hub (Fig. 0884).

11. Using a 13/16” socket, remove 5 lug nuts securing the front wheel to the wheel hub (Fig. 0885).

12. Remove the wheel from the wheel hub (Fig. 0886).
13. Using a 1/2" socket, remove the 4 bolts securing the hose cover to the main frame (Fig. 0887).

14. Remove the hose cover (Fig. 0888).

15. Using a 1-1/2" socket, loosen, do not remove, the patch lock nut on the front wheel motor shaft (Fig. 0889).

**Note:** In 2004 there was a running change from the castle nut and cotter pin (22312 serial #240000200 and lower) to a patch lock nut (22312 serial #240000201 and higher) for retaining the wheel motors.

16. Install a wheel hub puller (TOR4096) onto the front wheel hub (Fig. 0890).
17. Install 5 lug nuts (reversed) to secure the hub puller to the wheel hub (Fig. 0891).

18. Using a 1-1/2" socket, rotate the center puller bolt to break the hub free of the wheel motor shaft (Fig. 0892).

19. Remove the 5 lug nuts and the puller from the hub (Fig. 0893).

20. Remove the patch lock nut from the wheel motor shaft and discard (Fig. 0894).
21. Remove the hub from the wheel motor shaft and discard (Fig. 0895).

22. Place a drain pan under the front wheel motor.

23. Using a 1-1/8” wrench, remove the upper hydraulic line from the upper wheel motor fitting (Fig. 0896).

24. Using a 1-1/8” wrench, loosen the left hand upper hydraulic line from the bulkhead fitting in the main frame (Fig. 0897).

25. Rotate the upper hydraulic line out and allow the fluid to drain in the drain pan (Fig. 0898).
26. Using a 1/1/8" wrench, remove the lower hydraulic line from the lower wheel motor fitting (Fig. 0899).

27. Allow the fluid to drain into the pan (Fig. 0900).

28. Using a 1-1/16" socket, remove the 2 wheel motor fittings (Fig. 0901).

29. Cap the lines, fittings and ports to prevent debris from contaminating the system.

30. Support the wheel motor with a floor jack (Fig. 0902).
31. Using a 3/4” socket, remove the 4 bolts securing the wheel motor to the mainframe (Fig. 0903).

32. Using the floor jack, lower the wheel motor out of the frame (Fig. 0904).

33. To service the existing wheel motor, refer to "Parker / Ross Wheel Motor Service Manual" (Toro Form No. 492-4753).

Front Wheel Motor Installation

Note: Upon removal, all seals, o-rings and gaskets should be replaced. During installation, lightly lubricate all seals, o-rings and gaskets with clean petroleum jelly prior to assembly.

1. Place the wheel motor onto a floor jack with the fittings facing to the side. Position the wheel motor under the main frame (Fig. 0905).

2. Raise the floor jack and position the wheel motor into the opening in the main frame so the mounting holes in the wheel motor align with the mounting holes in the main frame (Fig. 0906).
3. Loosely install 4 wheel motor mounting bolts (Fig. 0907).

4. Using a 3/4” socket, tighten and torque the 4 mounting bolts to 75 ± 8 ft-lbs. (102 ± 11 Nm) (Fig. 0908).

5. Remove the floor jack.

6. Using a 1-1/16” socket, install the 2 wheel motor fittings (Fig. 0909).

7. Using a 1-1/8” wrench, install the lower hydraulic line to the lower wheel motor fitting (Fig. 0910).
8. Rotate the upper hydraulic line into position aligning it with the upper wheel motor fitting. Use a 1-1/8" wrench to install the upper hydraulic line to the upper wheel motor fitting (Fig. 0911 and Fig. 0912).

9. Use a 1-1/8" wrench to tighten the front upper hydraulic line to the bulkhead fitting in the main frame (Fig. 0913).

10. Start the machine. Operate the machine slowly in forward and reverse motion to purge the air from the hydraulic drive circuit.

11. Turn the machine off and remove the key.
Note: Prior to installing the drive hub, make sure the wheel motor shaft and inner drive hub are clean, degreased and free of paint to ensure a proper fit between the drive hub and wheel motor shaft.

12. With the key installed in the wheel motor shaft (Fig. 0914), slide a new hub onto the wheel motor shaft (Fig. 0915).

13. Install a new patch lock nut onto the wheel motor shaft. Torque the patch lock nut to 325 ± 25 ft-lbs. (441 ± 34 Nm) (Fig. 0916).

Note: In 2004 there was a running change from the castle nut and cotter pin (22312 serial #240000200 and lower) to a patch lock nut (22312 serial #240000201 and higher) for retaining the wheel motors.

14. Position the hose cover to the main frame (Fig. 0917).
15. Loosely install 4 bolts to secure the hose cover to the main frame (Fig. 0918).

16. Using a 1/2" socket, tighten the 4 bolts, securing the hose cover to the main frame (Fig. 0919).

17. Slide the front wheel onto the wheel hub (Fig. 0920).

18. Loosely install 5 lug nuts (tapered side in) (Fig. 0921).
19. Torque all 5 lug nuts to 50 ± 5ft-lbs. (68 ± 7 Nm) (Fig. 0922).

20. Slide the rear wheel onto the wheel hub (Fig. 0923).

21. Loosely install 5 lug nuts (tapered side in) (Fig. 0924).

22. Torque all 5 lug nuts to 50 ± 5ft-lbs. (68 ± 7 Nm) (Fig. 0925).

23. Check the hydraulic fluid level and add fluid if necessary.

24. Remove from jackstands and test operate unit.
Rear Wheel Motor Replacement

Rear Wheel Motor Removal

1. Park CUL on a level surface.
2. Raise the loader arm 6” - 12” (15 - 30cm) off the ground.
3. Turn off the machine and remove the key.
4. Lift the rear of the machine (Fig. 0926).
5. Position jackstands under the rear 2 corners of the machine. Remove the floor jack (Fig. 0927).
6. Raise the front of the machine (Fig. 0928).
7. Position jackstands under the front 2 corners of the machine. Remove the floor jack (Fig. 0929).
8. Lower the loader arm.

9. Using a 13/16” socket, remove 5 lug nuts securing the rear wheel to the wheel hub (Fig. 0930).

10. Remove the wheel from the wheel hub (Fig. 0931).

11. Using a 13/16” socket, remove 5 lug nuts securing the front wheel to the wheel hub (Fig. 0932).

12. Remove the wheel from the wheel hub (Fig. 0933).
13. Using a 1/2” socket, remove the 4 bolts securing the hose cover to the main frame (Fig. 0934).

15. Using a 1-1/2” socket, loosen, do not remove, the patch lock nut on the rear wheel motor shaft (Fig. 0936).

Note: In 2004 there was a running change from the castle nut and cotter pin (22312 serial #240000200 and lower) to a patch lock nut (22312 serial #240000201 and higher) for retaining the wheel motors.

14. Remove the hose cover (Fig. 0935).

16. Install a wheel hub puller (TOR4096) onto the rear wheel hub (Fig. 0937).
17. Install 5 lug nuts (reversed) to secure the hub puller to the wheel hub (Fig. 0938).

18. Using a 1-1/2" socket, rotate the center puller bolt to break the hub free of the wheel motor shaft (Fig. 0939).

19. Remove the 5 lug nuts and the puller from the hub (Fig. 0940).

20. Remove the patch lock nut from the wheel motor shaft and discard (Fig. 0941).
21. Remove the hub from the wheel motor shaft and discard (Fig. 0942).

22. Place a drain pan under the rear wheel motor.

23. Using a 1-1/8” wrench, remove the upper hydraulic line from the upper wheel motor fitting (Fig. 0943).

24. Using a 1-1/8” wrench, loosen the rear upper hydraulic line from the bulkhead fitting in the main frame (Fig. 0944).

25. Rotate the upper hydraulic line out and allow the fluid to drain in the drain pan (Fig. 0945).
26. Using a 1/1/8" wrench, remove the lower hydraulic line from the lower wheel motor fitting (Fig. 0946).

27. Allow the fluid to drain into the drain pan (Fig. 0947).

28. Using a 1-1/16" socket, loosen the 2 wheel motor fittings (Fig. 0948).

29. Cap the hydraulic lines and fittings to prevent debris from contaminating the system.

30. Support the wheel motor with a floor jack (Fig. 0949).
31. Using a 3/4” socket, remove the 4 bolts securing the wheel motor to the main frame (Fig. 0950).

32. Using the floor jack, lower the wheel motor out of the frame (Fig. 0951).

33. To service the existing wheel motor, refer to “Parker / Ross Wheel Motor Service Manual” (Toro Form No. 492-4753).

34. If a new wheel motor is being installed, remove the 2 wheel motor fittings and transfer them to the new wheel motor (Fig. 0952).
Rear Wheel Motor Installation

Note: Upon removal, all seals, o-rings and gaskets should be replaced. During installation, lightly lubricate all seals, o-rings and gaskets with clean petroleum jelly prior to assembly.

1. Place the wheel motor onto a floor jack with the fittings facing to the side. Position the wheel motor under the main frame (Fig. 0953).

2. Raise the floor jack and position the wheel motor into the opening in the main frame so the mounting holes in the wheel motor align with the mounting holes in the mainframe (Fig. 0954).

3. Loosely install 4 wheel motor mounting bolts (Fig. 0955).

4. Using a 3/4” socket, tighten and torque the 4 mounting bolts to 75 ± 8 ft-lbs. (102 ± 11 Nm) (Fig. 0956).
5. Remove the floor jack.

6. Using a 1-1/16" socket, tighten the 2 wheel motor fittings (Fig. 0957).

7. Using a 1/18" wrench, install the lower hydraulic line to the lower wheel motor fitting (Fig. 0958).

8. Rotate the upper hydraulic line into position aligning it with the upper wheel motor fitting. Use a 1-1/8" wrench to install the upper hydraulic line to the upper wheel motor fitting (Fig. 0959).

9. Use a 1-1/8" wrench to tighten the rear upper hydraulic line to the bulkhead fitting in the main frame (Fig. 0960).
10. Start the machine. Allow the air to purge from the hydraulic system. Check the wheel motor, hydraulic lines and fittings for leaks.

11. Turn the machine off and remove the key.

**Note:** Prior to installing the drive hub, make sure the wheel motor shaft and inner drive hub are clean, degreased and free of paint to ensure a proper fit between the drive hub and wheel motor shaft.

12. With the key installed in the wheel motor shaft (Fig. 0961), slide a new wheel hub onto the wheel motor shaft (Fig. 0962).

13. Install a new patch lock nut onto the wheel motor shaft. Torque the patch lock nut to 325 ± 25 ft-lbs. (441 ± 34 Nm) (Fig. 0963).

**Note:** In 2004 there was a running change from the castle nut and cotter pin (22312 serial #240000200 and lower) to a patch lock nut (22312 serial #240000201 and higher) for retaining the wheel motors.

14. Position the hose cover to the mainframe (Fig. 0964).
15. Loosely install 4 bolts to secure the hose cover to the main frame (Fig. 0965).

16. Using a 1/2” socket, tighten the 4 bolts securing the hose cover to the mainframe (Fig. 0966).

17. Slide the front wheel onto the wheel hub (Fig. 0967).

18. Loosely install 5 lug nuts (tapered side in) (Fig. 0968).
19. Torque all 5 lug nuts to 50 ± 5 ft-lbs. (68 ± 7 Nm) (Fig. 0969).

21. Loosely install 5 lug nuts (tapered side in) (Fig. 0971).

20. Slide the rear wheel onto the wheel hub (Fig. 0970).

22. Torque all 5 lug nuts to 50 ± 5 ft-lbs. (68 ± 7 Nm) (Fig. 0972).

23. Check the hydraulic fluid level and add fluid if necessary.

24. Remove from jackstands and test operate unit.
Left Hand Counterbalance Valve Replacement

Left Hand Counterbalance Valve Removal

1. Park CUL on a level surface.
2. Raise the loader arms to the fully raised position.
3. Turn off the engine and remove the key.
4. Remove the loader arm cylinder locks located on the hydraulic auxiliary lines (Fig. 0973).

5. Position a loader arm cylinder lock over each lift cylinder rod (Fig. 0974).

6. Secure each loader arm cylinder lock with a clevis pin and hairpin cotter (Fig. 0975).
7. Lower the loader arm until the loader arm end of the cylinder rods are resting on the cylinder locks.

8. Loosen the 4 swell latches securing the hood to the main frame (Fig. 0976).

9. Remove the hood (Fig. 0977).

10. Lift the rear of the machine (Fig. 0978).

11. Position jackstands under the rear 2 corners of the machine. Remove the floor jack (Fig. 0979).
Note: **Lower the loader arms.**

12. Raise the front of the machine (Fig. 0980).

13. Position jackstands under the front corners of the machine. Remove the floor jack (Fig. 0981).

14. Using a 13/16” socket, remove 5 lug nuts securing the left rear wheel to the wheel hub (Fig. 0982).

15. Remove the wheel from the wheel hub (Fig. 0983).
16. Place a drain pan under the location of the left counterbalance valve.

17. Mark the hydraulic lines on the counterbalance valve with an F and an R (Fig. 0984).

18. Mark the hydraulic lines on the bulkhead with an F and an R (Fig. 0985).

19. Using a 1-1/8” offset wrench, remove the hydraulic line nut from the front upper counterbalance valve fitting (Fig. 0986).

20. Using a 1-1/8” offset wrench, remove the hydraulic line nut marked with an F from the bulkhead fitting (Fig. 0987).
21. Set hydraulic line fitting marked F to the side.

22. Using a 1-1/8" offset wrench, remove the hydraulic line nut from the front lower counterbalance valve fitting (Fig. 0988).

23. Using a 1-1/8" offset wrench, remove the hydraulic line nut from the bottom fitting on the counterbalance valve (Fig. 0989).

24. Using a 1-1/8" offset wrench, remove the hydraulic line nut from the top fitting on the counterbalance valve (Fig. 0990).

25. Using a 7/16" socket and wrench, remove the nut from the bolt securing the counterbalance valve to the frame (Fig. 0991).
26. Remove the washer from the counterbalance valve mounting bolt (Fig. 0992).

27. Remove the counterbalance valve assembly, mounting bolt, washer and spacer from the frame (Fig. 0993).

28. Remove the mounting bolt, washer and spacer from the counterbalance valve (Fig. 0994).

29. Transfer 4 of the 6 hydraulic fittings from the old counterbalance valve to the new counterbalance valve (Fig. 0995).

Note: The 2 spool fittings do not get transferred. They come with the new counterbalance valve.
Left Hand Counterbalance Valve Installation

Note: Upon removal, all seals, o-rings and gaskets should be replaced. During installation, lightly lubricate all seals, o-rings and gaskets with clean petroleum jelly prior to assembly.

1. Position the counterbalance valve inside the frame.

2. Loosely install the bottom hydraulic hard line nut (Fig. 0997).

3. Loosely install the top hydraulic hard line nut (Fig. 0998).

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A. Nut  
B. Washer (2)  
C. Spacer  
D. Counterbalance Valve  
E. Bolt
4. Loosely install the hydraulic hard line nut marked R to the lower fitting on the front of the counterbalance valve (Fig. 0999).

5. Install the mounting bolt and washer through the counterbalance valve (Fig. 1000).

6. Position the spacer in between the counterbalance valve and the frame. Slide the bolt through the spacer and frame (Fig. 1001).

7. Install a washer onto the mounting bolt (Fig. 1002).
8. Using a 7/16” socket and wrench, install a nut onto the counterbalance valve mounting bolt (Fig. 1003).

9. Using a 1-1/8” offset wrench, tighten the 3 hydraulic hard lines to the counterbalance valve fittings (Fig. 1004).

10. Position the hydraulic hard line marked F to the counterbalance valve and bulkhead fitting. Using a 1-1/8” offset wrench, install the hydraulic line nut to the bulkhead fitting (Fig. 1005).

11. Using a 1-1/8” offset wrench, install the other end of the hydraulic hard line marked F to the counterbalance valve fitting (Fig. 1006).
12. Start the machine. Allow the air to purge from the hydraulic system. Check the hydraulic lines and fittings for leaks. Remove the drain pan.

13. Turn the machine off and remove the key.

14. Slide the rear wheel onto the wheel hub (Fig. 1007).

15. Loosely install 5 lug nuts (tapered side in) (Fig. 1008).

16. Torque all 5 lug nuts to 50 ± 5 ft-lbs. (68 ± 7 Nm) (Fig. 1009).

17. Check the hydraulic fluid level and add fluid if necessary.

18. Remove the unit from the jackstands.

19. Raise the loader arms; remove and re-stow the loader arm cylinder locks.

20. Test operate the machine.
Right Hand Counterbalance Valve Replacement

Right Hand Counterbalance Valve Removal

1. Park CUL on a level surface.
2. Raise the loader arms to the fully raised position.
3. Turn off the engine and remove the key.
4. Position a loader arm cylinder lock over each lift cylinder rod (Fig. 1011).
5. Secure each loader arm cylinder lock with a clevis pin and hairpin cotter (Fig. 1012).
6. Lower the loader arm until the loader arm end of the cylinder rods are resting on the cylinder locks.

7. Loosen the 4 swell latches securing the hood to the main frame (Fig. 1013).

8. Remove the hood (Fig. 1014).

9. Lift the rear of the machine (Fig. 1015).

10. Position jackstands under the rear 2 corners of the machine. Remove the floor jack (Fig. 1016).
Note: Lower the loader arms.

11. Raise the front of the machine (Fig. 1017).

12. Position jackstands under the front corners of the machine. Remove the floor jack (Fig. 1018).

13. Using a 13/16" socket, remove 5 lug nuts securing the right rear wheel to the wheel hub (Fig. 1019).

14. Remove the wheel from the wheel hub (Fig. 1020).
15. Disconnect the negative and then the positive battery cable from the battery (Fig. 1021).

16. Remove the battery hold-down and retainer (Fig. 1022).

17. Remove the battery (Fig. 1023).

18. Using a 1/2" wrench and socket, remove the 2 bolts and nuts securing the battery tray to the frame. Remove the bolt securing the inside of the tray to the frame (Fig. 1024).
19. Remove the battery tray (Fig. 1025).

22. Mark the hydraulic lines connected to the bulkhead with an F and an R (Fig. 1027).

20. Place a drain pan under the location of the left counterbalance valve.

21. Mark the hydraulic lines on the counterbalance valve with an F and an R (Fig. 1026).

23. Using a 1-1/8” offset wrench, remove the hydraulic line nut marked with an F from the bulkhead fitting (Fig. 1028).

F: Front hydraulic line  R: Rear hydraulic line
24. Using a 1-1/8" offset wrench, remove the hydraulic line nut from the front counterbalance valve fitting (Fig. 1029).

25. Set the hydraulic line marked F to the side.

26. Using a 1-1/8" offset wrench, remove the hydraulic line nut from the rear counterbalance valve fitting (Fig. 1030).

27. Using a 1-1/8" offset wrench, remove the hydraulic line nut from the bottom fitting on the counterbalance valve (Fig. 1031).

28. Using a 1-1/8" offset wrench, remove the hydraulic line nut from the top fitting on the counterbalance valve (Fig. 1032).
29. Using a 7/16” socket and wrench, remove the nut from the bolt securing the counterbalance valve to the main frame (Fig. 1033).

30. Remove the washer from the counterbalance valve mounting bolt (Fig. 1034).

31. Remove the counterbalance valve assembly, mounting bolt, washer and spacer from the frame (Fig. 1035).

32. Remove the mounting bolt, washer and spacer from the counterbalance valve (Fig. 1036).
33. Transfer 4 of the 6 hydraulic fittings from the old counterbalance valve to the new counterbalance valve (Fig. 1037).

**Note:** The 2 spool fittings do not get transferred. They come with the new counterbalance valve.

### Right Hand Counterbalance Valve Installation

**Note:** Upon removal, all seals, o-rings and gaskets should be replaced. During installation, lightly lubricate all seals, o-rings and gaskets with clean petroleum jelly prior to assembly.

1. Position the counterbalance valve inside the frame.

2. Loosely install the bottom hydraulic hard line nut (Fig. 1039).

3. Loosely install the top hydraulic hard line nut (Fig. 1040).

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**Fig. 1037**

Counterbalance Valve (Fig. 1038).

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**Fig. 1038**

A. Bolt  
B. Washer (2)  
C. Counterbalance valve  
D. Spacer  
E. Nut

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**Fig. 1039**

**Fig. 1040**
4. Loosely install the hydraulic hard line nut marked R to the counterbalance valve fitting (Fig. 1041).

5. Position the spacer in between the counterbalance valve and the frame. Install the mounting bolt and washer through the counterbalance valve, spacer and frame (Fig. 1042).

6. Install a washer onto the mounting bolt (Fig. 1043).

7. Using a 7/16” socket and wrench, install a nut onto the counterbalance valve mounting bolt (Fig. 1044).
8. Using a 1-1/8” offset wrench, tighten the 3 hydraulic hard lines to the counterbalance valve fittings (Fig. 1045).

Fig. 1045 DSC-1081a

10. Using a 1-1/8” offset wrench, install the other end of the hydraulic hard line marked F to the counterbalance valve fitting (Fig. 1047).

Fig. 1047 DSC-1083a

9. Position the hydraulic hard line marked F to the counterbalance valve and bulkhead fitting. Using a 1-1/8” offset wrench, install the hydraulic line nut to the bulkhead fitting (Fig. 1046).

Fig. 1046 DSC-1084a

11. Position the battery tray in the main frame (Fig. 1048).

Fig. 1048 DSC-1043a
12. Install the side of the battery tray to the side of the frame with 2 bolts and 2 nuts. Install the bottom of the battery tray to the bottom of the frame with a bolt (Fig. 1049).

13. Position the battery in the battery tray (Fig. 1050).

14. Install the battery hold-down and battery straps to secure the battery by inserting the ends of the battery straps in the slots located in the battery tray (Fig. 1051).

15. Connect the positive and then the negative battery cable to the battery (Fig. 1052).
16. Start the machine. Allow the air to purge from the hydraulic system. Check the hydraulic lines and fittings for leaks. Remove the drain pan.

17. Turn the machine off and remove the key.

18. Slide the rear wheel onto the wheel hub (Fig. 1053).

19. Loosely install 5 lug nuts (tapered side in) (Fig. 1054).

20. Torque all 5 lug nuts to 50 + 5 ft-lbs. (68 + 7 Nm) (Fig. 1055).

21. Remove the unit from the jackstands.

22. Raise the loader arms; remove and re-stow the loader arm cylinder locks.

23. Test operate the machine.

24. Check the hydraulic fluid and add fluid if necessary.
### Loader Arm Replacement

#### Loader Arm Removal

1. Raise the loader arm 6” - 8” (15 - 20cm) away from frame and position attach plate flat (horizontally) (Fig. 1056).

2. 4-Paw machines: Remove the hood.

3. Support the attach plate with a floor jack (Fig. 1057).

4. Using a 1/2” socket, remove the 3 bolts retaining the 3 pivot pins to the attach plate (Fig. 1058).

5. Remove the center pivot pin (Fig. 1059).
6. Remove the RH and LH pivot pins (Fig. 1060 and Fig. 1061).

7. Remove the attach plate (Fig. 1062).

8. Using a 1/2" socket, remove the bolt securing the upper tilt cylinder pivot pin to the tilt cylinder (Fig. 1063).
9. Remove the upper pivot pin (Fig. 1064).

Note: Support the cylinder with one hand as you remove the upper pivot pin.

10. Lay the tilt cylinder alongside the unit (Fig. 1065).

11. Mark the hydraulic lines to the flush face couplers with an M for male and F for female relating to the couplers (Fig. 1066).

12. Place an oil pan underneath the couplers to catch drainage.

13. Using a 1-1/8” wrench remove the hydraulic line to the male (M) flush face coupler (Fig. 1067).

Note: Use a plug to protect the line from contamination.
14. Using a 1-18” wrench remove the hydraulic line to the female (F) flush face coupler (Fig. 1068).

**Note:** Use a plug to protect the line from contamination.

15. Using a 1-1/4” wrench and 1-5/16” wrench remove the nut from the male flush face coupler (Fig. 1069) and remove the male flush face coupler (Fig. 1070).
16. Using a 1-5/16” wrench remove the nut from the female flush face coupler (Fig. 1071) and remove the female flush face coupler (Fig. 1072).

17. Remove the drain pan.

18. Using a properly rated strap or chain and hoist, support the cross-member of the loader arm (Fig. 1073).

19. Using a 1/2” socket remove the 2 bolts securing the lift cylinder pin to the loader arm and the loader arm pivot pin to the frame (2 per side, left side shown) (Fig. 1074).
20. Remove the left and right lift cylinder pin from the loader arm (Fig. 1075).

21. Remove the left and right loader arm pivot pin from the frame (Fig. 1076).

22. Remove the loader arm from the machine (Fig. 1077).
Loader Arm Installation

1. Inspect the loader arm and pivot pins for wear or damage. Replace as necessary (Fig. 1078).

![Fig. 1078](DSC-1448a)

2. Inspect the hydraulic cylinder yolks for wear or damage. Replace as necessary (Fig. 1079).

![Fig. 1079](DSC-1453)

3. Inspect the attach plate for wear or damage. Replace as necessary (Fig. 1080).

![Fig. 1080](DSC-1458a)

4. Install the loader arm onto the unit, aligning the pivot points on the loader arm with the pivot points on the upper frame (Fig. 1081).

![Fig. 1081](DSC-1459a)
5. Install a pivot pin through the frame and loader arm pivot point (Fig. 1082).

6. Repeat for the opposite side.

7. Install a pivot pin through the lift cylinder and loader arm pivot point (Fig. 1083).

8. Repeat for the opposite side.

9. Using a 1/2" socket, install 4 bolts to secure the pivot pins to the upper frame and lift cylinders on both sides of the machine. Torque the bolts to 19 ft-lbs. (26 Nm) (Fig. 1084 and Fig. 1085).
10. Remove the support from the loader arm.
11. Position the female flush face coupler into the outside hole of the coupler bracket on the loader arm (Fig. 1086).

Note: Upon removal, all seals, o-rings and gaskets should be replaced. During installation, lightly lubricate all seals, o-rings and gaskets with clean petroleum jelly prior to assembly.

12. Using a 1-5/16” wrench install the nut to the female flush face coupler (Fig. 1087).

13. Position the male flush face coupler into the coupler bracket on the loader arm (Fig. 1088).

14. Using a 1-1/4” wrench and 1-5/16” wrench install the nut to the male flush face coupler (Fig. 1089).
15. Using a 1-1/8” wrench install the hydraulic line (F) to the female flush face coupler (Fig. 1090).

16. Using a 1-1/8” wrench install the hydraulic line (M) to the male flush face coupler (Fig. 1091).

17. With the fittings facing up toward the engine, position the tilt cylinder in the center of the loader arm (Fig. 1092).

18. Install the upper pivot pin through the tilt cylinder yoke and loader arm bracket (Fig. 1093).
19. Install a bolt to secure the pivot pin to the cylinder yoke. Torque the bolt to 19 ft-lbs. (26 Nm) (Fig. 1094).

20. Position the attach plate to the loader arm pivot points (Fig. 1095).

21. Install the right and left side pivot pins into the pivot points (Fig. 1096).

22. Align the tilt cylinder ram with the attach plate center pivot point. Install the center pivot pin securing the tilt cylinder to the attach plate (Fig. 1097).
23. Using a 1/2" socket, install 3 bolts securing each of the pivot pins to the attach plate (2) and the tilt cylinder ram (1) (Fig. 1098).

24. Torque the 3 pivot pin bolts to 19 ft-lbs. (26 Nm) (Fig. 1099).

25. Remove the floor jack.

26. 4-Paw machines: Install the hood.

27. Start the machine. Raise and lower the loader arm.

28. Check the hydraulic fluid level and add if necessary.

29. Grease the pivot points (using #2 general purpose lithium grease):
    Left side (Fig. 1100)
Attach plate (Fig. 1101)

Right side (Fig. 1102)
4-PAW GAS/LOADER ARM

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Engine Replacement

Engine Removal

1. Park the CUL on a level surface.
2. Raise the loader arms to the fully raised position.
3. Turn off the engine and remove the key.
4. Remove the loader arm cylinder locks located on the hydraulic auxiliary lines (Fig. 1103).
5. Position a loader arm cylinder lock over each lift cylinder rod (Fig. 1104).
6. Secure each loader arm cylinder lock with a clevis pin and hairpin cotter (Fig. 1105).
7. Lower the loader arm until the loader arm end of the cylinder rods are resting on the cylinder locks.

8. Place a drain pan under the rear left corner of the machine to drain the engine oil.

9. Uncap the engine oil drain valve (Fig. 1106).

10. Place one end of a hose on the drain valve and the other end in the drain pan (Fig. 1107).

11. Open the drain valve (push in, turn counterclockwise and pull out) (Fig. 1108).

12. When the oil has drained completely, close the drain valve and remove the hose. Replace the dust cap.

13. Disconnect the negative and then the positive battery cable (Fig. 1109).

A. Negative battery cable  B. Positive battery cable
14. Turn both fuel shut off valves to the OFF position (Fig. 1110).

15. Using a 1/2" socket, remove the 4 exhaust manifold mounting nuts and lock washers (Fig. 1111 and Fig. 1112).

16. Using a 13mm socket, remove the 2 mounting bolts securing the muffler to the engine (Fig. 1113).
17. Remove the muffler assembly from the machine (Fig. 1114).

20. Using a 15/16” wrench, remove the hydraulic line marked F from the front hydraulic pump fitting (Fig. 1116).

**Note:** Use a plug to protect the line from contamination.

18. Place an absorbent towel under the hydraulic pump area.

19. Slide the 2 thermal sleeves up away from the hydraulic pump fittings. Mark the 2 hydraulic lines F and R (Fig. 1115):

21. Using a 15/16” wrench, remove the hydraulic line marked R from the rear hydraulic pump fitting (Fig. 1117).

**Note:** Use a plug to protect the line from contamination.

F: Front hydraulic line  R: Rear hydraulic line
22. Using a 5/16” socket, loosen the hose clamp securing the front suction hose to the hydraulic pump fitting (Fig. 1118).

23. Slide the suction hose off the pump fitting (Fig. 1119).

   **Note:** Use a plug to protect the line from contamination.

24. Using a 5/16” socket, loosen the hose clamp securing the rear suction hose to the hydraulic pump fitting (Fig. 1120).

25. Slide the suction hose off the pump fitting (Fig. 1121).

   **Note:** Use a plug to protect the line from contamination.
26. Using an 8mm socket, loosen the throttle cable clamp (Fig. 1122).

28. Using an 8mm socket, loosen the choke cable clamp (Fig. 1124).

27. Remove the throttle cable from the clamp and unhook the z-bend from the throttle linkage (Fig. 1123).

29. Remove the choke cable from the clamp and unhook the z-bend from the choke linkage (Fig. 1125).
30. Slide the boot off the starter solenoid terminal. Using a 13mm socket, remove the nut from the starter solenoid terminal (Fig. 1126).

31. Remove the red battery cable from the solenoid terminal (Fig. 1127).

32. Remove the harness wire from the solenoid terminal (Fig. 1128).

33. Using a 15mm socket, remove the bolt and star washer securing the ground wires to the engine block (Fig. 1129).
34. Remove the cable tie securing the hour meter wire winding to the spark plug wire (Fig. 1130).

35. Unwind the hour meter wire from the spark plug wire (Fig. 1131).

36. Disconnect the wire harness connector from the engine (Fig. 1132).

37. Using a 5/16" socket, loosen the hose clamp on the air cleaner intake hose (Fig. 1133).
38. Slide the air cleaner intake hose off the air cleaner adapter (Fig. 1134).

39. Slide the fuel line hose clamp away from the fuel filter (Fig. 1135).

40. Slide the fuel line off the fuel filter. Allow excess fuel to drain into a proper receptacle (Fig. 1136).

41. Using a 1/2” socket, remove the 4 mounting bolts securing the engine plate to the main frame. Discard the 4 mounting bolts (Fig. 1137).
42. Place suitable lumber on the operator stand to receive the engine (Fig. 1138).

43. Slide the engine back onto the lumber on the operator stand (Fig. 1139).

44. Using a properly rated hoist and chains, lift the engine out of the frame (Fig. 1140).

45. Rotate the engine crankshaft until the 2 hydraulic pump coupler set screws are accessible through the opening in the pump mount (Fig. 1141).
46. Using a 1/4” 8-point socket, loosen the 2 hydraulic pump coupler set screws (Fig. 1142).

47. Using a 5/8” socket, remove the 4 bolts securing the pump mount to the engine (Fig. 1143).

48. Remove the hydraulic pump and mount assembly from the crankshaft (Fig. 1144).

49. Remove the key from the crankshaft keyway (Fig. 1145).
50. Using a 9/16” socket and wrench, remove the 4 bolts and nuts securing the engine to the engine mount plate (Fig. 1146 and Fig. 1147).

51. Separate and remove the engine mount from the engine (Fig. 1148).

52. Remove the dust cap from the oil drain valve (Fig. 1149).
53. Using a 15/16" wrench, remove the oil drain valve from the engine (Fig. 1150).

54. For engine service, refer to the proper Kohler engine service manual.

**Engine Installation**

1. Apply pipe sealant to the threads of the oil drain valve. Install the engine oil drain valve finger tight (Fig. 1151).

2. Use a 15/16" wrench to tighten the drain valve an additional 2-1/2 turns past finger tight (Fig. 1152).
3. Install the dust cap onto the oil drain valve (Fig. 1153).

4. Hook chains to the engine lift points (Fig. 1154). Attach a properly rated hoist to the chains. Raise the hoist to apply tension to the chains.

5. Position the engine mount to the engine (Fig. 1155).
6. Using a 9/16" socket and wrench, install 4 bolts and nuts securing the engine to the engine mount (Fig. 1156).

![Fig. 1156](DSC-1230a)

7. Torque the engine mount bolts to 30 ± 3 ft-lbs. (41 ± 4 Nm) (Fig. 1158).

![Fig. 1158](DSC-1231a)

Note: One of the bolts and nuts is installed from the bottom, the other 3 from the top (Fig. 1157).

![Fig. 1157](DSC-1196a)

8. Install the key into the crankshaft keyway (Fig. 1159).

![Fig. 1159](DSC-1236a)
9. Apply anti-seize to the engine crankshaft (Fig. 1160).

10. Position the hydraulic pump and mount assembly onto the crankshaft, aligning the keyway in the pump coupler with the key in the crankshaft keyway (Fig. 1161).

11. Install 4 bolts securing the pump mount to the engine. Use a 5/8” socket to tighten the 4 bolts securing the pump mount to the engine. Torque the 4 bolts to 216 ± 25 in-lbs. (24 ± 3 Nm) (Fig. 1162).

12. Using a 1/4" 8-point socket, tighten the 2 hydraulic pump coupler set screws. Torque them to 100 ± 10 in-lbs. (11 ± 1 Nm) (Fig. 1163).
13. Place suitable lumber on the operator’s stand.

14. Raise the hoist and position the engine onto the lumber. Remove the chains and hoist from the engine (Fig. 1164).

15. Slide the engine into position in the main frame so the engine mount plate mounting holes align with the mounting holes in the main frame (Fig. 1165).

16. Using a 1/2" socket, loosely install 4 new mounting bolts securing the engine plate to the main frame (Fig. 1166).

17. Torque the 4 engine plate mounting bolts to 20 - 26 ft-lbs. (27 - 35 Nm) (Fig. 1167).
18. Slide the fuel line onto the fuel filter (Fig. 1168).

19. Slide the fuel line hose clamp into position to secure the fuel line to the filter (Fig. 1169).

20. Slide the air cleaner intake hose onto the air cleaner adapter (Fig. 1170).

21. Position the hose clamp and use a 5/16” socket to tighten the hose clamp securing the air cleaner intake hose to the adapter (Fig. 1171).
22. Connect the wire harness connector to the engine (Fig. 1172).

23. Wind the hour meter wire around the spark plug wire (Fig. 1173).

24. Install a cable tie securing the hour meter wire winding to the spark plug wire (Fig. 1174).

25. Install the star washer, negative battery cable, and wire harness ground cable onto the ground bolt (Fig. 1175).
26. Using a 15mm socket, install the ground bolt and star washer securing the negative battery cable, and wire harness ground wire to the engine block (Fig. 1176).

27. Open the 2 fuel shut-offs (Fig. 1177).

28. Install the harness wire and red battery cable to the solenoid terminal. (Fig. 1178).

29. Using a 13mm socket, install the nut to the starter solenoid (Fig. 1179).
30. Slide the boot onto the starter solenoid terminal (Fig. 1180).

31. Install the choke cable z-bend into the choke linkage (Fig. 1181).

32. Position the choke cable under the cable clamp (Fig. 1182).

33. Position the choke lever in the open position. Push the choke cable toward the linkage (Fig. 1183).
34. Using an 5/16” socket, tighten the choke cable clamp (Fig. 1184).

35. Install the throttle cable z-bend into the throttle linkage clamp (Fig. 1185).

36. Position the throttle cable under the throttle cable clamp (Fig. 1186).

37. Position the throttle lever in the slow position. Push the throttle cable toward the linkage (Fig. 1187).
38. Using an 5/16” socket, tighten the throttle cable clamp (Fig. 1188).

39. Install 2 new manifold gaskets, placing the flat side of the gasket against the engine (Fig. 1189).

40. Position the muffler onto the engine manifold studs aligning the muffler bracket mounting holes with the mounting holes on the engine (Fig. 1190).

41. Loosely install 2 bolts securing the muffler bracket to the engine (Fig. 1191).
42. Loosely install 4 lock washers and 4 nuts securing the muffler to the engine manifold studs (Fig. 1192).

Fig. 1192  DSC-1355a

43. Use a 13mm socket to tighten the 4 muffler manifold nuts. Torque the 2 bolts securing the muffler bracket to the engine to 200 ± 25 in-lbs. (23 ± 3 Nm) (Fig. 1193).

Fig. 1193  DSC-1357a

44. Install the rear suction hose onto the rear pump fitting (Fig. 1194).

Fig. 1194  DSC-1359a

45. Position the hose clamp and use a 5/16” socket to tighten the hose clamp securing the rear suction hose to the rear pump fitting (Fig. 1195).

Fig. 1195  DSC-1360a
46. Slide the front suction hose onto the front pump fitting (Fig. 1196).

47. Position the hose clamp and use a 5/16” socket to tighten the hose clamp securing the front suction hose to the front pump fitting (Fig. 1197).

**Note:** Upon removal, all seals, o-rings and gaskets should be replaced. During installation, lightly lubricate all seals, o-rings and gaskets with clean petroleum jelly prior to assembly.

48. Install the hydraulic line (marked with an R) to the rear hydraulic pump fitting (Fig. 1198).

49. Use a 15/16” wrench to tighten the hydraulic line nut to the fitting (Fig. 1199).
50. Install the hydraulic line (marked with and F) to the front hydraulic pump fitting (Fig. 1200).

![Fig. 1200](DSC-1366a)

51. Use a 15/16” wrench to tighten the hydraulic line nut to the fitting (Fig. 1201).

![Fig. 1201](DSC-1368a)

52. Connect the positive and then the negative battery cable to the battery. Position the battery clamp on the battery up against the frame (Fig. 1202).

![Fig. 1202](DSC-1369a)

A. Negative battery cable  B. Positive battery cable

53. Remove the absorbent towels.
54. Fill the engine with oil:
   a. Remove the oil fill cap and slowly pour approximately 80% of the specified amount of oil in through the valve cover.
   b. Clean around the oil dipstick (Fig. 1203).
   c. Pull out the dipstick and wipe the metal end clean (Fig. 1203).
   d. Slide the dipstick fully into the dipstick tube (Fig. 1203).
   e. Pull the dipstick out and look at the metal end.
   f. If the oil level is low, clean around the oil filler cap and remove the cap (Fig. 1203).
   g. Slowly pour only enough oil into the valve cover to raise the level to the F (full) mark.

Important: Overfilling the crankcase could damage the engine.
   h. Replace the filler cap and dipstick.

55. Check the hydraulic fluid level:

Hydraulic Tank Capacity: 17.25 US gallons (67 l)
   a. Use 10W-30 or 15W-40 detergent, diesel engine oil (API service CH-4 or higher).
   b. Clean the area around the filler neck of the hydraulic tank (Fig. 1204).
   c. Remove the cap from the filler neck and check the fluid level on the dipstick (Fig. 1204).
   d. The fluid level should be between the marks on the dipstick.
   e. If the level is low, add enough fluid to raise it to the proper level.
   f. Install the cap on the filler neck.
56. Verify/adjust engine RPM to the following (refer to Kohler engine service manual):

Maximum engine speed (full throttle) to 3600 ± 75 RPM.
Minimum engine speed (idle) to 1400 ± 200 RPM.

57. Install the hood.

58. Raise the loader arm all the way up to remove pressure from the loader arm cylinder locks.

59. Remove the clevis pin and cotter pin from the loader arm cylinder locks (Fig. 1205).

60. Remove the loader arm cylinder locks from the cylinder rods (Fig. 1206).

61. Reinstall the loader arm cylinder locks onto the hydraulic auxiliary lines (for storage) (Fig. 1207).

62. Lower the loader arms.

63. Test operate machine and operate all hydraulics to purge air from the system. Check for leaks.

64. Turn the engine off.
Ignition Switch (P/N 103990)

Purpose

This component provides the proper switching for the starter, ignition, accessories, and safety circuits.

Location

The ignition switch is mounted on the right hand side of the upper frame assembly (Fig. 1208).

How It Works

Detents inside the ignition switch give it 3 positions: OFF, RUN, and START. The START position is spring loaded so the cylinder automatically returns to RUN once the key is released.

Testing

1. Disconnect the switch from the wiring harness.

2. Verify that continuity exists between the terminals listed for the START and RUN switch positions. Verify that there is NO continuity between the terminals in the OFF switch position (Fig. 1209).

<table>
<thead>
<tr>
<th>Position</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>OFF</td>
<td>No continuity</td>
</tr>
<tr>
<td>RUN</td>
<td>B + R + I + A</td>
</tr>
<tr>
<td>START</td>
<td>B + R + I + S</td>
</tr>
</tbody>
</table>
Relay

Purpose

The 4-Paw Gas Wheeled Compact Utility Loader uses two relays: a start relay and a kill relay.

Start Relay

If all conditions of the safety system are met, the start relay will activate allowing current to flow to the engine starter when the ignition switch is in the “start” position.

Kill Relay

If any of the conditions of the safety circuit are not met during operation the kill relay is de-energized which will ground the ignition coil. Also, when the ignition switch is placed in the “off” position, it will de-energize the kill relay and will ground the ignition coil.

Location

The relays are located on the right hand side, bolted to the inside of the lower frame assembly, next to the engine (Fig. 1210).

How It Works

A relay is an electrically actuated switch.

1. Coil: Terminals 85 and 86 are connected to a coil. Applying 12 volts to these terminals energizes the coil turning it into an electromagnet.

2. Switch: Terminals 30, 87 and 87a are actually part of a single pole, double throw (SPDT) switch. Terminal 30 is the common lead. The switch is spring loaded so that 30 and 87a are connecting when the coil is not energized. When the coil is energized the switch is “thrown” and 30 and 87 are connected (Fig. 1211).
Testing

1. Disconnect the relay from the harness.

2. Verify the coil resistance between terminals 85 and 86 with a multimeter (ohms setting). Resistance should be 70 to 90 ohms. There should be continuity between terminals 87a and 30 (Fig. 1212).

3. Connect the multimeter (ohms setting) leads to relay terminals 30 and 87. Ground terminal 86 and apply +12 VDC to terminal 85. The relay should make and break continuity between terminals 30 and 87 as 12 VDC is applied and removed from terminal 85 (Fig. 1212).

4. Connect the multimeter (ohms setting) leads to relay terminals 30 and 87a. Apply +12VDC to terminals 85. With terminal 86 still grounded, the relay should break and make continuity between terminals 30 and 87a as 12 VDC is applied and removed from the terminal (Fig. 1212).

5. Disconnect voltage and multimeter leads from relay terminals.

Fuses

Purpose

Fuses are used in the circuits to limit damage in the event of excessive current flow. If a fuse fails, look for a short circuit, a corroded/poor connection, or any component that appears to have been overheated. A failed fuse is a sign of a problem in that circuit.

Location

The fuses are located on the right hand side of the inside of the lower frame assembly, above the relays, next to the engine (Fig. 1213).

A. 30 amp fuse = Start Circuit
B. 25 amp fuse = Charge Circuit
C. 10 amp fuse = Accessories & Safety Circuit
How It Works

The fuse block is where the wires that carry 12 volts meet the wires that need 12 volts to operate a component or function. The fuse makes the connection between the 12 volt wire that needs the current.

Testing

A failed fuse will often be discolored or melted. Please note that not all fuse failures are easy to see. A fuse can be checked with a continuity tester if there is doubt. If there is no continuity between the fuse terminals, replace the fuse, even if it appears good.

Neutral Safety Switch

Purpose

The normally closed ball type switch is used on the 4-spool hydraulic valve. This is a safety switch to make sure the control levers are in the neutral detent (Fig. 1214).

How It Works

The switch has a spring loaded ball. When the hydraulic 4-spool valve forward and reverse control handles are in the neutral position, the ball moves into a machined notch located in the spool. The normally closed switch then provides a ground to the start circuit. When the 4-spool valve forward and reverse control handles are moved out of neutral, the spool pushes against the ball end of the switch and opens the ground circuit which prevents the engine from starting.

Testing

1. Disconnect the switch from the wire harness. The ball end of the switch should remain installed in the hydraulic 4-spool valve.
2. Set the VOM multimeter to the ohms setting. Connect the leads to the two wire terminals. Move the hydraulic 4-spool valve lever to either the forward or reverse position. There should be NO continuity.
Auxiliary Neutral Switch

Purpose

The normally closed ball type switch is used on the hydraulic auxiliary valve. This is a safety switch to make sure the hydraulic auxiliary valve is in the neutral detent (Fig. 1216).

How It Works

The switch has a spring loaded ball. When the hydraulic auxiliary valve is in neutral position, the ball moves into a machined notch located in the spool. The normally closed switch then provides a ground to the start circuit. When the auxiliary lever is moved out of neutral, the spool pushes against the ball end of the switch and opens the ground circuit which prevents the engine from starting.

Testing

1. Disconnect the switch from the wire harness. The ball end of the switch should remain installed in the hydraulic auxiliary valve.

2. Set the VOM multimeter to the ohms setting. Connect the leads to the two wire terminals. Move the hydraulic auxiliary valve handle to either the reverse flow or forward flow position. There should be NO continuity.

Location

The neutral switch is threaded into the lower portion of the hydraulic auxiliary valve. This valve is located on the right side of the upper frame assembly (Fig. 1217).
Hour Meter/Tachometer

Purpose

The hour meter displays engine run time and is a service reminder. When the engine is running, it also displays the speed of the engine in revolutions per minute (rpm).

After 50 hours and then every 100 hours thereafter (that is at 150, 250, 350, etc.) the screen displays CHG OIL to remind you to change the oil. After every 100 hours, the screen displays SVC to remind you to perform the other maintenance procedures based on a 100, 200, or 400 hour schedule. These reminders come on starting three hours prior to the service interval time and flash at regular intervals for six hours.

Location

The hour meter is mounted below the ignition switch on the upper frame assembly (Fig. 1218).

How It Works

The digital inductive hour meter is an electronic clock and RPM gauge. It is not repairable or resettable (Fig. 1219).

Testing

The hour meter uses inductive current flow from the spark plug wire. Prior to replacing the hour meter, do a continuity check on the wire that is wrapped around the spark plug wire to the hour meter. If you have continuity, replace the hour meter.
Front Wheel Motor Replacement

Front Wheel Motor Removal

1. Park CUL on a level surface.

2. Raise the loader arm 6” - 12” (15 - 30cm) off the ground.

3. Turn off the machine and remove the key.

4. Lift the rear of the machine (Fig. 1224).

5. Position jackstands under the rear 2 corners of the machine. Remove the floor jack (Fig. 1225).

6. Raise the front of the machine (Fig. 1226).

7. Position jackstands under the front corners of the machine. Remove the floor jack (Fig. 1227).
8. Lower the loader arm.

9. Using a 13/16” socket, remove 5 lug nuts securing the rear wheel to the wheel hub (Fig. 1228).

10. Remove the wheel from the wheel hub (Fig. 1229).

11. Using a 13/16” socket, remove 5 lug nuts securing the front wheel to the wheel hub (Fig. 1230).

12. Remove the wheel from the wheel hub (Fig. 1231).
13. Using a 1/2" socket, remove the 4 bolts securing the hose cover to the main frame (Fig. 1232).

14. Remove the hose cover (Fig. 1233).

15. Using a 1-1/2" socket, loosen, do not remove, the patch lock nut on the front wheel motor shaft (Fig. 1234).

Note: In 2004 there was a running change from the castle nut and cotter pin (22312 serial #240000200 and lower) to a patch lock nut (22312 serial #240000201 and higher) for retaining the wheel motors.

16. Install a wheel hub puller (TOR4096) onto the front wheel hub (Fig. 1235).
17. Install 5 lug nuts (reversed) to secure the hub puller to the wheel hub (Fig. 1236).

18. Using a 1-1/2” socket, rotate the center puller bolt to break the hub free of the wheel motor shaft (Fig. 1237).

19. Remove the 5 lug nuts and the puller from the hub (Fig. 1238).

20. Remove the patch lock nut from the wheel motor shaft and discard (Fig. 1239).
21. Remove the hub from the wheel motor shaft and discard (Fig. 1240).

22. Place a drain pan under the front wheel motor.

23. Using a 1-1/8" wrench, remove the upper hydraulic line from the upper wheel motor fitting (Fig. 1241).

24. Using a 1-1/8" wrench, loosen the left hand upper hydraulic line from the bulkhead fitting in the main frame (Fig. 1242).

25. Rotate the upper hydraulic line out and allow the fluid to drain in the drain pan (Fig. 1243).
26. Using a 1/1/8” wrench, remove the lower hydraulic line from the lower wheel motor fitting (Fig. 1244).

28. Using a 1-1/16” socket, remove the 2 wheel motor fittings (Fig. 1246).

27. Allow the fluid to drain into the pan (Fig. 1245).

29. Cap the lines, fittings and ports to prevent debris from contaminating the system.

30. Support the wheel motor with a floor jack (Fig. 1247).
31. Using a 3/4” socket, remove the 4 bolts securing the wheel motor to the mainframe (Fig. 1248).

32. Using the floor jack, lower the wheel motor out of the frame (Fig. 1249).

33. To service the existing wheel motor, refer to “Parker / Ross Wheel Motor Service Manual” (Toro Form No. 492-4753).

Front Wheel Motor Installation

Note: Upon removal, all seals, o-rings and gaskets should be replaced. During installation, lightly lubricate all seals, o-rings and gaskets with clean petroleum jelly prior to assembly.

1. Place the wheel motor onto a floor jack with the fittings facing to the side. Position the wheel motor under the main frame (Fig. 1250).

2. Raise the floor jack and position the wheel motor into the opening in the main frame so the mounting holes in the wheel motor align with the mounting holes in the main frame (Fig. 1251).
3. Loosely install 4 wheel motor mounting bolts (Fig. 1252).

4. Using a 3/4" socket, tighten and torque the 4 mounting bolts to 75 ± 8 ft-lbs. (102 ± 11 Nm) (Fig. 1253).

5. Remove the floor jack.

6. Using a 1-1/16" socket, install the 2 wheel motor fittings (Fig. 1254).

7. Using a 1-1/8" wrench, install the lower hydraulic line to the lower wheel motor fitting (Fig. 1255).
8. Rotate the upper hydraulic line into position aligning it with the upper wheel motor fitting. Use a 1-1/8" wrench to install the upper hydraulic line to the upper wheel motor fitting (Fig. 1256 and Fig. 1257).

9. Use a 1-1/8" wrench to tighten the front upper hydraulic line to the bulkhead fitting in the main frame (Fig. 1258).

10. Start the machine. Allow the air to purge from the hydraulic system. Check the wheel motor, hydraulic lines and fittings for leaks.

11. Turn the machine off and remove the key.
Note: Prior to installing the drive hub, make sure the wheel motor shaft and inner drive hub are clean, degreased and free of paint to ensure a proper fit between the drive hub and wheel motor shaft.

12. With the key installed in the wheel motor shaft (Fig. 1259), slide a new hub onto the wheel motor shaft (Fig. 1260).

13. Install a new patch lock nut onto the wheel motor shaft. Torque the patch lock nut to 325 ± 25 ft-lbs. (441 ± 34 Nm) (Fig. 1261).

Note: In 2004 there was a running change from the castle nut and cotter pin (22312 serial #240000200 and lower) to a patch lock nut (22312 serial #240000201 and higher) for retaining the wheel motors.

14. Position the hose cover to the main frame (Fig. 1262).
15. Loosely install 4 bolts to secure the hose cover to the main frame (Fig. 1263).

16. Using a 1/2” socket, tighten the 4 bolts, securing the hose cover to the main frame (Fig. 1264).

17. Slide the front wheel onto the wheel hub (Fig. 1265).

18. Loosely install 5 lug nuts (tapered side in) (Fig. 1266).
19. Torque all 5 lug nuts to $50 \pm 5$ ft-lbs. ($68 \pm 7$ Nm) (Fig. 1267).

20. Slide the rear wheel onto the wheel hub (Fig. 1268).

21. Loosely install 5 lug nuts (tapered side in) (Fig. 1269).

22. Torque all 5 lug nuts to $50 \pm 5$ ft-lbs. ($68 \pm 7$ Nm) (Fig. 1270).

23. Check the hydraulic fluid level and add fluid if necessary.

24. Remove from jackstands and test operate unit.
Rear Wheel Motor Replacement

Rear Wheel Motor Removal

1. Park CUL on a level surface.

2. Raise the loader arm 6” - 12” (15 - 30cm) off the ground.

3. Turn off the machine and remove the key.

4. Lift the rear of the machine (Fig. 1271).

5. Position jackstands under the rear 2 corners of the machine. Remove the floor jack (Fig. 1272).

6. Raise the front of the machine (Fig. 1273).

7. Position jackstands under the front 2 corners of the machine. Remove the floor jack (Fig. 1274).
8. Lower the loader arm.

9. Using a 13/16” socket, remove 5 lug nuts securing the rear wheel to the wheel hub (Fig. 1275).

10. Remove the wheel from the wheel hub (Fig. 1276).

11. Using a 13/16” socket, remove 5 lug nuts securing the front wheel to the wheel hub (Fig. 1277).

12. Remove the wheel from the wheel hub (Fig. 1278).
13. Using a 1/2" socket, remove the 4 bolts securing the hose cover to the main frame (Fig. 1279).

14. Remove the hose cover (Fig. 1280).

15. Using a 1-1/2" socket, loosen, do not remove, the patch lock nut on the rear wheel motor shaft (Fig. 1281).

Note: In 2004 there was a running change from the castle nut and cotter pin (22312 serial #240000200 and lower) to a patch lock nut (22312 serial #240000201 and higher) for retaining the wheel motors.

16. Install a wheel hub puller (TOR4096) onto the rear wheel hub (Fig. 1282).
17. Install 5 lug nuts (reversed) to secure the hub puller to the wheel hub (Fig. 1283).

18. Using a 1-1/2” socket, rotate the center puller bolt to break the hub free of the wheel motor shaft (Fig. 1284).

19. Remove the 5 lug nuts and the puller from the hub (Fig. 1285).

20. Remove the patch lock nut from the wheel motor shaft and discard (Fig. 1286).
21. Remove the hub from the wheel motor shaft and discard (Fig. 1287).

22. Place a drain pan under the rear wheel motor.

23. Using a 1-1/8” wrench, remove the upper hydraulic line from the upper wheel motor fitting (Fig. 1288).

24. Using a 1-1/8” wrench, loosen the rear upper hydraulic line from the bulkhead fitting in the main frame (Fig. 1289).

25. Rotate the upper hydraulic line out and allow the fluid to drain in the drain pan (Fig. 1290).
26. Using a 1/18" wrench, remove the lower hydraulic line from the lower wheel motor fitting (Fig. 1291).

27. Allow the fluid to drain into the drain pan (Fig. 1292).

28. Using a 1-1/16" socket, loosen the 2 wheel motor fittings (Fig. 1293).

29. Cap the hydraulic lines and fittings to prevent debris from contaminating the system.

30. Support the wheel motor with a floor jack (Fig. 1294).
31. Using a 3/4” socket, remove the 4 bolts securing the wheel motor to the main frame (Fig. 1295).

32. Using the floor jack, lower the wheel motor out of the frame (Fig. 1296).

33. To service the existing wheel motor, refer to “Parker / Ross Wheel Motor Service Manual” (Toro Form No. 492-4753).

34. If a new wheel motor is being installed, remove the 2 wheel motor fittings and transfer them to the new wheel motor (Fig. 1297).
Rear Wheel Motor Installation

Note: Upon removal, all seals, o-rings and gaskets should be replaced. During installation, lightly lubricate all seals, o-rings and gaskets with clean petroleum jelly prior to assembly.

1. Place the wheel motor onto a floor jack with the fittings facing to the side. Position the wheel motor under the main frame (Fig. 1298).

2. Raise the floor jack and position the wheel motor into the opening in the main frame so the mounting holes in the wheel motor align with the mounting holes in the mainframe (Fig. 1299).

3. Loosely install 4 wheel motor mounting bolts (Fig. 1300).

4. Using a 3/4” socket, tighten and torque the 4 mounting bolts to 75 ± 8 ft-lbs. (102 ± 11 Nm) (Fig. 1301).
5. Remove the floor jack.

6. Using a 1-1/16" socket, tighten the 2 wheel motor fittings (Fig. 1302).

7. Using a 1/18" wrench, install the lower hydraulic line to the lower wheel motor fitting (Fig. 1303).

8. Rotate the upper hydraulic line into position aligning it with the upper wheel motor fitting. Use a 1-1/8" wrench to install the upper hydraulic line to the upper wheel motor fitting (Fig. 1304).

9. Use a 1-1/8" wrench to tighten the rear upper hydraulic line to the bulkhead fitting in the main frame (Fig. 1305).
10. Start the machine. Allow the air to purge from the hydraulic system. Check the wheel motor, hydraulic lines and fittings for leaks.

11. Turn the machine off and remove the key.

**Note:** Prior to installing the drive hub, make sure the wheel motor shaft and inner drive hub are clean, degreased and free of paint to ensure a proper fit between the drive hub and wheel motor shaft.

12. With the key installed in the wheel motor shaft (Fig. 1306), slide a new wheel hub onto the wheel motor shaft (Fig. 1307).

13. Install a new patch lock nut onto the wheel motor shaft. Torque the patch lock nut to 325 ± 25 ft-lbs. (441 ± 34 Nm) (Fig. 1308).

**Note:** In 2004 there was a running change from the castle nut and cotter pin (22312 serial #240000200 and lower) to a patch lock nut (22312 serial #240000201 and higher) for retaining the wheel motors.

14. Position the hose cover to the mainframe (Fig. 1309).
15. Loosely install 4 bolts to secure the hose cover to the main frame (Fig. 1310).

16. Using a 1/2" socket, tighten the 4 bolts securing the hose cover to the mainframe (Fig. 1311).

17. Slide the front wheel onto the wheel hub (Fig. 1312).

18. Loosely install 5 lug nuts (tapered side in) (Fig. 1313).
19. Torque all 5 lug nuts to 50 ± 5 ft-lbs. (68 ± 7 Nm) (Fig. 1314).

20. Slide the rear wheel onto the wheel hub (Fig. 1315).

21. Loosely install 5 lug nuts (tapered side in) (Fig. 1316).

22. Torque all 5 lug nuts to 50 ± 5 ft-lbs. (68 ± 7 Nm) (Fig. 1317).

23. Check the hydraulic fluid level and add fluid if necessary.

24. Remove from jackstands and test operate unit.
4-Spool Valve Replacement (Diesel)

4-Spool Valve Removal

Note: Upon removal, all seals, o-rings and gaskets should be replace. During installation, lightly lubricate all seals, o-rings and gaskets with clean petroleum jelly prior to assembly.

1. Park the machine on a level surface.

2. Turn the machine off and remove the key.

3. Unlatch and open the engine rear cover.

4. Loosen the hose clamp securing the air cleaner hose to the engine. Remove the air cleaner hose from the engine (Fig. 1318).

5. Remove the two bolts and nuts securing the air cleaner assembly to the mounting bracket (Fig. 1319).

6. Remove the air cleaner assembly from the machine (Fig. 1320).
7. Remove the 3 bolts and nuts securing the indicator lamp mounting bracket to the upper frame assembly (Fig. 1321).

8. Mark the wiring plugs and indicator lights to aid reassembly (Fig. 1322). Remove the lamp mount from the upper frame assembly.

9. Remove the bottom jam nut from each of the 4 control levers on the 4-spool valve and then remove the 4 control levers (Fig. 1323).

10. Remove the 2 bolts and nuts securing the throttle control assembly (Fig. 1324).
11. Remove the throttle control assembly from the control panel (Fig. 1325).

12. Remove the metal hydraulic test port line from the fitting located on the left side of the 4-spool valve (Fig. 1326).

13. Remove the inlet hydraulic line assembly from the top of the flow control valve and the 4-spool valve (Fig. 1327).

14. Remove the two hydraulic lift cylinder lines from the 4-spool valve (Fig. 1328).
15. Remove the return hydraulic line nut from the fitting on the right side of the 4-spool valve (Fig. 1329).

17. Loosen the auxiliary hydraulic line nut from the fitting on the 4-spool valve (Fig. 1331).

16. Loosen the auxiliary return hydraulic line nut from the fitting located on the right side of the auxiliary valve (Fig. 1330).

18. Remove the hydraulic line from the machine (Fig. 1332).
19. Mark one of the tilt cylinder hydraulic lines and fittings located on the 4-spool valve (Fig. 1333).

20. Remove the 2 tilt cylinder hydraulic lines from the fittings on the 4-spool valve (Fig. 1334).

21. Remove the 2 hydraulic lines coming from the right side counterbalance valve (Fig. 1335).

22. Remove the 2 hydraulic lines coming from the left side counterbalance valve (Fig. 1336).
23. Loosen the 3 bolts and remove the nuts securing the 4-spool valve to the upper frame assembly (Fig. 1337).

24. Remove the top bolt, washer and spacer securing the 4-spool valve to the frame (Fig. 1338).

25. Remove the remaining two bolts, washers, spacers, and the mount bracket from the upper frame assembly (Fig. 1339).

26. Carefully lower the 4-spool valve onto the top of the engine (Fig. 1340).
27. Cut the plastic ties securing the lift cylinder hydraulic line and the wiring harness with the two wire plugs for the neutral safety switches (Fig. 1341).

Fig. 1341  DSC-3110a

28. Unplug the two neutral safety switch plugs (Fig. 1342).

Fig. 1342  DSC-3123a

29. Remove the 4-spool valve from the machine (Fig. 1343).

Fig. 1343  DSC-3124a

Note: Place protective caps and plugs on the valve fittings and hydraulic lines to protect them from any contamination.
4-Spool Valve (Fig. 1344).

A. Attachment Tilt Lever
B. Traction Control Lever (2)
C. Loader Arm Lever
D. Hydraulic Return Line
E. Auxiliary Valve Line
F. Tilt Cylinder Line
G. Right Side Counter-balance Valve
H. Left Side Counter-balance Valve
I. Lift Cylinder Line
J. Flow Control Line
K. Test Port Line
L. Neural Safety Switch (2)

4-Spool Valve Installation

1. Position the 4-spool valve on top of the engine (Fig. 1345).

2. Plug the two neutral safety switch plugs into the harness (Fig. 1346).
3. Install 3 cable ties to secure the neutral switches to the harness and the harness wires to the right hand lift cylinder hydraulic line (Fig. 1347).

4. Position the valve up into the control panel. Install a bolt into the upper right hand mounting hole. Position the longest spacer between the valve and control panel. Install a nut onto the bolt to secure (Fig. 1348).

5. Position the mount bracket into the control panel between the 4-spool valve and the frame. Align the bracket holes with the mounting holes (Fig. 1349).

6. Install 2 bolts and washers into the mounting holes. Position a spacer onto each bolt between the valve and the support bracket. Install a nut onto each of the bolts to secure (Fig. 1350).
7. Install the 4 hydraulic counterbalance valve lines to the 4-spool valve fittings (Fig. 1351).

8. Install 2 hydraulic tilt cylinder lines to the 4-spool valve.

Note: The top line and fitting were previously marked (Fig. 1352).

9. Position the auxiliary valve return hydraulic line to the auxiliary valve and 4-spool valve and loosely install the line nuts (Fig. 1353).

10. Tighten the auxiliary valve hydraulic line nuts to the auxiliary valve fitting and the 4-spool valve fitting (Fig. 1354).
11. Install the hydraulic return line to the straight fitting on the end of the 4-spool valve (Fig. 1355).

12. Install the 2 lift cylinder hydraulic line T-fittings to the 4-spool valve (Fig. 1356).

13. Position the inlet hydraulic flow control line to the top of the flow control valve and the 4-spool valve fitting (Fig. 1357).

14. Install the hydraulic test port line to the 90 degree fitting located on the left hand end of the 4-spool valve (Fig. 1358).
15. Position the throttle control lever assembly into the control panel (Fig. 1359).

16. Install two bolts and nuts to secure the throttle control lever assembly to the control panel (Fig. 1360).

17. Thread the 4 control levers into the 4-spool valve (Fig. 1361).

18. Install a jam nut on each lever to secure the lever to the 4-spool valve (Fig. 1362).
19. Connect the harness plugs to the indicator lights (previously marked) (Fig. 1363).

20. Position the indicator lamp mount to the control panel. Install 3 bolts and nuts to secure the lamp mount to the control panel (Fig. 1364).

21. Position the air cleaner assembly into the chassis in the position located above and to the left of the engine (Fig. 1365).

22. Install two bolts and nuts securing the air cleaner assembly to the mounting bracket (Fig. 1366).
23. Slide the air cleaner hose onto the engine intake. Position the hose clamp and tighten to secure (Fig. 1367).

Hydraulic Auxiliary, Selector & Flow Divider Valves

Hydraulic Auxiliary, Selector & Flow Divider Valves Removal

Note: Upon removal, all seals, o-rings and gaskets should be replace. During installation, lightly lubricate all seals, o-rings and gaskets with clean petroleum jelly prior to assembly.

1. Mark the hydraulic line and fitting on the flow divider valve (A) (Fig. 1368).

24. Start the machine. Allow the air to purge from the hydraulic system. Check the hydraulic lines and fittings for leaks.

25. Turn the machine off and remove the key.

26. Add hydraulic fluid if necessary.

27. Close the engine rear cover and latch.
2. Mark the two hydraulic lines and fittings on the selector valve (B & C) (Fig. 1369).

3. Mark the two hydraulic lines and fittings on the auxiliary valve (D & E) (Fig. 1370).

4. Remove the hydraulic line from the flow divider valve fitting (marked ‘A’) (Fig. 1371).

5. Remove the hydraulic line nut from the fitting located on top of the flow divider valve (Fig. 1372).
6. Remove the two hydraulic selector valve lines from the fittings marked ‘B’ & ‘C’ (Fig. 1373).

8. Remove the hydraulic return line nut from the fitting located on the side of the auxiliary valve (Fig. 1375).

7. Remove the two hydraulic auxiliary valve lines marked ‘D’ & ‘E’ (Fig. 1374).

9. Place plugs and caps on the hydraulic lines and fittings to protect the system from contamination (Fig. 1376).
10. Unplug the auxiliary safety switch from the harness located under the auxiliary valve (Fig. 1377).

12. Remove the auxiliary, selector, and flow divider valves from the upper frame assembly (Fig. 1379).

11. Remove the 6 bolts, spacers, washers, and nuts securing the valves to the upper frame assembly (Fig. 1378).

13. Mark the hydraulic line nut and t-fitting located between the auxiliary and the selector valves (F) (Fig. 1380).
14. Remove the hydraulic line (F) from the t-fitting located between the auxiliary and the selector valves (Fig. 1381).

15. Loosen the jam nut on the flow divider valve fitting (Fig. 1382).

16. Remove the flow divider valve from the fitting (Fig. 1383).

17. Loosen the jam nut on the t-fitting between the selector and auxiliary valves (Fig. 1384).
18. Remove the selector valve from the t-fitting (Fig. 1385).

19. Valve assembly separated (Fig. 1386):

A. Auxiliary Valve  
B. Selector Valve  
C. Flow Divider Valve

20. Remove the bolt and nut securing the handle to the auxiliary valve (Fig. 1387).

Note: For auxiliary valve rebuild instructions, refer to “99-3077 Auxiliary Valve Rebuild” on page 3/1-67.
Hydraulic Auxiliary, Selector & Flow Divider Valves Installation

1. Position the handle to the auxiliary valve. Loosely install a bolt and nut to secure the handle to the auxiliary valve (Fig. 1388).

2. Install the selector valve to the t-fitting on the auxiliary valve, leave the jam nut loose (Fig. 1389).

3. Install the flow divider valve to the fitting on the selector valve; leave the jam nut loose (Fig. 1390).

4. Position the auxiliary, selector, and the flow divider valve assembly to the upper frame (Fig. 1391).
5. Position a spacer between the frame and the auxiliary valve. Install a bolt through the valve and the spacer (Fig. 1392).

6. Install and tighten the remaining 5 bolts, spacers, washers, and 6 nuts through the valves and the upper frame assembly (Fig. 1393).

7. Tighten the two jam nuts: one located between the flow divider valve and the selector valve (Fig. 1394) and the other on the t-fitting between the selector valve and auxiliary valve (Fig. 1395).
8. Install the hydraulic line nut to the fitting located on the side of the auxiliary valve (Fig. 1396).

9. Install the two hydraulic lines (D & E) from the bulkhead coupler assemblies to the auxiliary valve (Fig. 1397).

10. Install the hydraulic line (F) to the t-fitting between the auxiliary and selector valve (Fig. 1398).

11. Route the hydraulic line (F) between the two tilt cylinder hydraulic lines (Fig. 1399).
12. Connect the hydraulic line (F) to the bottom of the flow divider valve (Fig. 1400).

13. Install the hydraulic line nut to the fitting on top of the flow divider valve (Fig. 1401).

14. Install the (B & C) hydraulic lines to the selector valve. Make sure the two hydraulic lines are routed to the inside of the hydraulic line going from the t-fitting to the flow divider valve (Fig. 1402).

15. Connect the auxiliary safety switch plug (located under the auxiliary valve) to the wire harness plug (Fig. 1403).
16. Adjust the auxiliary valve lever by pulling it back to the handle and tighten the bolt and nut (Fig. 1404).

17. Start the unit and check for any oil leaks.

18. Allow the machine to run and purge air from the system.

19. Turn the machine off and remove the key.

20. Check the hydraulic fluid level and add as necessary.

Hydraulic Lift Cylinder Replacement (Old Style)

Note: The front grill was removed for photo purposes.

Note: Upon removal, all seals, o-rings and gaskets should be replace. During installation, lightly lubricate all seals, o-rings and gaskets with clean petroleum jelly prior to assembly.

Hydraulic Lift Cylinder Removal

1. Start the unit and raise the lift arm all the way. Install a cylinder lock on the cylinder that is not being removed (Fig. 1405).
2. Mark the upper hydraulic hose and cylinder fitting (A) (Fig. 1406).

3. Remove the hydraulic hose from the upper cylinder fitting (Fig. 1407).

4. Install a plug and cap on the hydraulic hose and cylinder fitting to prevent contamination and assist in stopping oil leakage (Fig. 1408).

5. Remove the hydraulic hose from the lower cylinder fitting (Fig. 1409).
6. Install a plug and cap on the hydraulic hose and cylinder fitting to prevent contamination and assist in stopping oil leakage (Fig. 1410).

7. Remove the shoulder bolt securing the upper pivot pin to the cylinder ram (Fig. 1411).

8. Remove the pivot pin from the ram end of the cylinder (Fig. 1412).

9. Remove the shoulder bolt securing the lower pivot pin to the barrel end of the cylinder (Fig. 1413).
10. Support the cylinder and remove the pivot pin from the barrel end of the cylinder (Fig. 1414).

11. Remove the lift cylinder from the machine (Fig. 1415).

12. Remove the two 90 degree fittings from the lift cylinder (Fig. 1416).

13. To service the lift cylinder, refer to “100-4163 Hydraulic Cylinder Rebuild” (Old Style) for 2004 and older units on page 3/1-17 or “105-7867 Hydraulic Cylinder Rebuild” (New Style) for 2005 and newer units on page 3/1-40.
Hydraulic Lift Cylinder Installation

1. Install 2 hydraulic fittings into the lift cylinder. Position the fittings so they face each other (Fig. 1417).

2. Position the lift cylinder in the machine with the ram end facing up, aligning the pivot points on the cylinder with the pivot points on the frame and loader arm (Fig. 1418).

3. Install a pivot pin through the barrel end pivot point and frame (Fig. 1419).

4. Align the pivot pin through hole with the mounting hole in the cylinder. Install a shoulder bolt to secure the pivot pin. Torque the shoulder bolt to 150 to 170 in-lbs. (17 – 19 Nm) (Fig. 1420).

Fig. 1417  IMG-0102a

Fig. 1418  IMG-0105a

Fig. 1419  IMG-0098a

Fig. 1420  IMG-0106a
5. Install the hydraulic lines to the lift cylinder fittings, with the hydraulic line (A) installed to the upper cylinder fitting (Fig. 1421).

Note: Use double wrenches to prevent the hose from twisting while tightening.

6. Install the pivot pin through the ram end pivot point and loader arm (Fig. 1422).

Note: If there is a misalignment in the pivot points, start the machine and activate the hydraulic lift lever to raise the lift arm. Remove the cylinder lock from the other lift cylinder and carefully align the pivot points to install the pivot pin.

7. Align the pivot pin through hole with the mounting hole in the cylinder. Install a shoulder bolt to secure the pivot pin. Torque the shoulder bolt to 150 to 179 in-lbs. (17 – 19 Nm) (Fig. 1423).

8. Grease the top and bottom pivot pins and bushing assemblies using general purpose grease (Fig. 1424).

9. Start the machine and raise the lift arm. Remove the cylinder lock.

10. Purge the system and check for leaks.

11. Turn the machine off and remove the key.

12. Check the hydraulic oil and add as necessary.
Hydraulic Tilt Cylinder Replacement (Old Style)

Note: The front grill was removed for photo purposes.

1. Park the machine on a level surface, turn it off and remove the key.

2. Remove the shoulder bolt securing the lower pivot pin to the ram end of the tilt cylinder (Fig. 1426).

3. Support the attach plate. Remove the pivot pin from the tilt cylinder/attach plate pivot (Fig. 1427).

A. New style tilt cylinder  B. Old style tilt cylinder
4. Remove the cable tie securing the hydraulic hoses to the tilt cylinder barrel (Fig. 1428).

5. Remove the cable tie securing the hydraulic hoses together (Fig. 1429).

6. Place a drain pan under the front end of the machine to catch the hydraulic fluid from the hydraulic hoses.

7. Remove the hydraulic hoses from the tilt cylinder fittings. Allow the hydraulic fluid to drain into the drain pan (Fig. 1430).

8. Install plugs in the hoses and fittings to prevent contamination and oil leakage.

9. Remove the shoulder bolt securing the upper pivot pin to the barrel end of the tilt cylinder (Fig. 1431).
10. Support the tilt cylinder and remove the upper pivot pin. Remove the tilt cylinder from the machine (Fig. 1432).

11. Remove the two 90 degree fittings from the tilt cylinder (Fig. 1433).

12. To service the tilt cylinder, refer to “100-4163 Hydraulic Cylinder Rebuild” (Old Style) for 2004 and older units on page 3/1-17 or “105-7867 Hydraulic Cylinder Rebuild” (New Style) for 2005 and newer units on page 3/1-40.

Hydraulic Tilt Cylinder Installation

1. Install 2 hydraulic fittings in the tilt cylinder. Orient the fittings so they face away from the rod end of the cylinder (Fig. 1434).

2. Position the barrel end of the tilt cylinder to the loader arm pivot point. Install a pivot pin through the cylinder barrel and loader arm pivot point (Fig. 1435).
3. Align the pivot pin through hole with the mounting hole in the cylinder. Install a shoulder bolt to secure the pivot pin. Torque the shoulder bolt to 150 to 170 in-lbs. (17 – 19 Nm) (Fig. 1436).

5. Lift the attach plate and align the cylinder ram to the attach plate pivot point. Install a pivot pin (Fig. 1438).

4. Install the hydraulic lines to the tilt cylinder fittings (Fig. 1437).

Note: Use double wrenches to prevent the hose from twisting.

6. Align the pivot pin through hole with the mounting hole in the cylinder ram. Install a shoulder bolt to secure the pivot pin. Torque the shoulder bolt to 150 to 170 in-lbs. (17 to 19 Nm) (Fig. 1439).
7. Install a cable tie around the tilt cylinder hydraulic hoses (Fig. 1440).

8. Install a cable tie around the cylinder barrel and hydraulic hose (Fig. 1441).

9. Grease the pivot pins and bushings using general purpose grease (Fig. 1442 and Fig. 1443).

10. Check the hydraulic fluid level and add as necessary.

11. Start the machine and check for leaks.

12. Purge air from the system.

13. Check the hydraulic fluid level again and add as necessary.
Left Hand Counterbalance Valve Replacement

Left Hand Counterbalance Valve Removal

Note: Upon removal, all seals, o-rings and gaskets should be replaced. During installation, lightly lubricate all seals, o-rings and gaskets with clean petroleum jelly prior to assembly.


2. Using a 7/16” socket, remove the 4 bolts and lock washers securing the fan to the fan adapter (Fig. 1444).

3. Remove the fan assembly (Fig. 1445).

4. Mark the hydraulic lines on the bulkhead F and R (Fig. 1446).

5. Mark the hydraulic lines on the counterbalance valve F and R (Fig. 1447).

F: Front hydraulic line  R: Rear hydraulic line
6. Place absorbent towel inside the chassis under the left hand counterbalance valve.

7. Using a 1-1/8" offset wrench, remove the hydraulic line nut marked F from the bulkhead fitting (Fig. 1448).

8. Using a 1-1/8" offset wrench, remove the hydraulic line nut from the front, top counterbalance valve fitting (Fig. 1449).

9. Lay the (F) hydraulic line to the side in the chassis.

10. Using a 1-1/8" offset wrench, remove the hydraulic line nut marked R from the front, bottom counterbalance valve fitting (Fig. 1450).

11. Using a 1-1/8" offset wrench, remove the hydraulic line nut marked R from the bulkhead fitting (Fig. 1451).
12. Using an 11/16” wrench, remove the lift cylinder t-fitting from the lower fitting on the 4-spool valve (Fig. 1452).

13. Using a 1-1/8” crowfoot wrench, remove the left hand counterbalance valve line nut from the lower fitting on the 4-spool valve (Fig. 1453).

14. Using a 1-1/8” crowfoot wrench, loosen the hydraulic line nut on the 90 degree fitting on the bottom of the counterbalance valve (Fig. 1454).

15. Using a 1-1/8” wrench, remove the hydraulic line nut from the top counterbalance valve fitting (Fig. 1455).
16. Using a 7/16” socket and nut, remove the bolt, washer, spacer, washer and nut securing the left hand counterbalance valve to the frame (Fig. 1456).

17. Slide counterbalance valve out. Remove the hydraulic line from the bottom counterbalance valve fitting (Fig. 1457).

18. Transfer 4 of the 7 fittings from the old counterbalance valve to the new counterbalance valve (Fig. 1458).

Note: The 2 spool fittings and the tow valve do not get transferred. They come with the new counterbalance valve.

Left Hand Counterbalance Valve Assembly (Fig. 1459).
**Left Hand Counterbalance Valve Installation**

1. Position the counterbalance valve near the frame. Snug fit the hydraulic line nut to the bottom counterbalance valve fitting (Fig. 1460).

2. Position the counterbalance valve into the frame. Align the other end of the snug-fit hydraulic line to the 4-spool valve fitting. Loosely install the hydraulic line nut to the 4-spool valve fitting (Fig. 1461).

3. Loosely install the hydraulic hard line nut (R) to the fitting located on the front, bottom of the counterbalance valve (Fig. 1462).

4. Loosely install the hydraulic hard line nut (R) to the bulkhead fitting (R) (Fig. 1463).
5. Using a 1-1/8" crowfoot wrench, tighten the hydraulic line nut to the 90 degree fitting located on the bottom of the counterbalance valve (Fig. 1464).

6. Install a washer and spacer onto the counterbalance valve mounting bolt (Fig. 1465).

7. Install the bolt assembly into the slot on the counterbalance valve (Fig. 1466).

   Note: Position the spacer between the counterbalance valve and the frame.

8. Install a washer onto the mounting bolt (Fig. 1467).
9. Using a 7/16” socket and wrench, install a nut onto the mounting bolt (Fig. 1468).

10. Position the hydraulic line marked F to the counter-balance valve fitting marked F (front, top) and loosely install the nut to the fitting (Fig. 1469).

11. Position the other end of the hydraulic line marked F to the bulkhead fitting marked F. Using a 1-1/8” wrench, install the hydraulic line nut to the bulkhead fitting (Fig. 1470).

12. Using a 1-1/8” crowfoot wrench, tighten the hydraulic line nut to the 4-spool valve fitting (Fig. 1471).
13. Using an 11/16" wrench, install the lift cylinder t-fitting onto the 4-spool valve fitting (Fig. 1472).

14. Tighten the hydraulic line nuts as follows:
   a. Top fitting on counterbalance valve using a 1-1/8" wrench
   b. Counterbalance valve line nut marked F using a 1-1/8" wrench
   c. Bulkhead fitting line nut marked R using a 1-1/8" wrench
   d. Bulkhead fitting line nut marked F using a 1-1/8" wrench

15. Remove the absorbent towel.

16. Slide the fan onto the fan adapter (Fig. 1473).

17. Using a 7/16" socket, install 4 bolts and lock washers securing the fan to the fan adapter. Torque the 4 bolts to 100 ± 10 ft-lbs. (136 ± 14 Nm) (Fig. 1474).

18. Install the radiator. Refer to "Radiator Installation" on page 6/4-97.

19. Start the machine. Allow the air to purge from the hydraulic system. Check the hydraulic lines and fittings for leaks.

20. Turn the machine off and remove the key.

21. Check the hydraulic fluid level. Add if necessary.
Right Hand Counterbalance Valve Replacement

Right Hand Counterbalance Valve Removal

Note: Upon removal, all seals, o-rings and gaskets should be replaced. During installation, lightly lubricate all seals, o-rings and gaskets with clean petroleum jelly prior to assembly.


2. Using a 7/16” socket, remove the 4 bolts and lock washers securing the fan to the fan adapter (Fig. 1475).

3. Remove the fan (Fig. 1476).

4. Mark the rear wheel motor hydraulic line nut and fitting at the counterbalance valve with an F (Fig. 1477).
5. Place absorbent towel inside the chassis under the right hand counterbalance valve.

6. Using a 1-1/8" crowfoot wrench, remove the rear wheel motor hydraulic line nut from the upper fitting on the front of the counterbalance valve (both marked F) (Fig. 1478).

7. Mark the hydraulic lines on the bulkhead F and R (Fig. 1479).

8. Using a 1-1/8" offset wrench, remove the hydraulic line nut from the bulkhead fitting marked R (Fig. 1480).

9. Using a 1-1/8" offset wrench, remove the hydraulic line nut from the bulkhead fitting marked F (Fig. 1481).

F: Front hydraulic line  R: Rear hydraulic line
10. Using a 13/16” offset wrench, remove the tilt cylinder hydraulic line from the 4-spool valve fitting (Fig. 1482).

![Fig. 1482](DSC-1903a)

11. Using a 1-1/8” crowfoot wrench, remove the counterbalance valve hydraulic line nut from the 4-spool valve fitting (Fig. 1483).

![Fig. 1483](DSC-1905a)

12. Using a 1-1/8” wrench, remove the hydraulic line nut from the fitting located on the top of the counterbalance valve (Fig. 1484).

![Fig. 1484](DSC-1910a)

13. Using a 7/16” socket and wrench, remove the counterbalance valve mounting bolt, washers, spacer and nut (Fig. 1485).

![Fig. 1485](DSC-1911a)
14. Slide the counterbalance valve assembly out the rear of the chassis so that the 2 hydraulic lines that are still attached can be accessed and removed (Fig. 1486).

15. Support the counterbalance valve by placing a 1-1/16” wrench on the front, lower counterbalance valve fitting. Use a 1-1/8” wrench to remove the rear wheel motor hydraulic line nut from the counterbalance valve fitting (Fig. 1487).

16. Support the counterbalance valve using a 1-1/16” wrench on the 90 degree fitting located on the bottom of the counterbalance valve. Use a 1-1/8” wrench to remove the hydraulic line nut from the counterbalance valve fitting (Fig. 1488).

17. Remove the counterbalance valve from the chassis (Fig. 1489).
18. Transfer 4 of the 7 hydraulic fittings from the old counterbalance valve to the new counterbalance valve (Fig. 1490).

**Note:** The 2 spool fittings and the tow valve do not get transferred. They come with the new counterbalance valve.

Right Hand Counterbalance Valve Assembly (Fig. 1491).

**Right Hand Counterbalance Valve Installation**

1. Position the counterbalance valve inside the chassis aligning the fitting on the bottom of the valve with the hydraulic line coming from the 4-spool valve. Loosely install the 4-spool valve hydraulic line nut to the fitting (Fig. 1492).

2. Align the rear wheel motor hydraulic line (marked with an R) to the lower fitting located on the front of the counterbalance valve. Loosely install the hydraulic line nut to the fitting (Fig. 1493).
3. Slide the counterbalance valve assembly into position in the chassis. Loosely install the other hydraulic line nut coming from the 4-spool valve to the fitting located on top of the counterbalance valve (Fig. 1494).

4. Loosely install the rear wheel motor hydraulic line nut to the rear bulkhead fitting (marked with an R) (Fig. 1495).

5. Loosely install the 4-spool valve hydraulic line nut to the 4-spool valve fitting (Fig. 1496).

6. Using a 1-1/8" crowfoot wrench, tighten the hydraulic line nuts to the counterbalance valve fittings as follows:
   a. On the bottom of the counterbalance valve (the line coming from the 4-spool valve) (Fig. 1497)
b. The lower fitting located on the front surface of the counterbalance valve (the line coming from the rear wheel motor) (Fig. 1498)

7. Loosely install the front wheel motor hydraulic line nut to the lower fitting located on the front surface of the counterbalance valve (the line coming from the front wheel motor) (Fig. 1499).

8. Loosely install the front wheel motor hydraulic line nut to the front bulkhead fitting (Fig. 1500).

9. Install a washer and spacer onto the counterbalance valve mounting bolt (Fig. 1501).
10. Install the bolt assembly into the lower slot on the counterbalance valve. Position the spacer between the counterbalance valve and the frame (Fig. 1502).

11. Install a washer onto the mounting bolt (Fig. 1503).

12. Using a 7/16” socket and wrench, install a nut onto the mounting bolt (Fig. 1504).

13. Using a 1-1/8” crow’s foot wrench, tighten the front wheel motor hydraulic line nut to the upper fitting located on the front surface of the counterbalance valve (Fig. 1505).
14. Using a 1-1/8" wrench, tighten the hydraulic line nut to the fitting located on the top surface of the counterbalance valve (Fig. 1506).

15. Using a 1-1/8" wrench, tighten the front and rear hydraulic line nuts to the bulkhead fittings (Fig. 1507).

16. Using a 1-18" crow's foot wrench, tighten the hydraulic line nut to the 4-spool valve fitting (Fig. 1508).

17. Using a 13/16" wrench, install the tilt cylinder hydraulic line nut to the 4-spool valve fitting (Fig. 1509).
18. Remove the absorbent towel.

19. Slide the fan onto the fan adapter (Fig. 1510).

20. Using a 7/16” socket, install 4 bolts and lock washers securing the fan to the fan adapter. Torque the 4 bolts to 100 ± 10 ft-lbs. (136 ± 14 Nm) (Fig. 1511).


22. Start the machine. Allow the air to purge from the hydraulic system. Check the hydraulic lines and fittings for leaks.

23. Turn the machine off and remove the key.

24. Check the hydraulic fluid level and add if necessary.
Hydraulic Tandem Pump Replacement

Hydraulic Tandem Pump Removal

1. Remove the radiator. Refer to “Radiator Removal” on page 6/4-92.

2. Using a 7/16” socket, remove the 4 bolts and lock washers securing the fan to the fan adapter (Fig. 1512).

3. Remove the fan (Fig. 1513).

4. Using a 9/16” socket, loosen the idler arm nut (Fig. 1514).

5. Slide the idler arm inward. Remove the belt from the idler pulley (Fig. 1515).
6. Slide the idler arm fully outward (Fig. 1516).

7. Using a 22mm socket, rotate the engine until the pump coupler set screws are accessible (Fig. 1517).

8. Using a 1/4" 8-point socket, loosen the 2 pump coupler set screws (Fig. 1518).

9. Place absorbent towel under the pump.

10. Loosen the hose clamp on the front pump suction hose (Fig. 1519).
11. Slide the front suction hose off the pump fitting (Fig. 1520).

12. Loosen the hose clamp on the rear pump suction hose (Fig. 1521).

Note: plug both hoses to prevent contamination.

13. Slide the rear suction hose off the pump fitting (Fig. 1522).

14. Mark the hydraulic pump lines and fittings F and R (Fig. 1523):

   F. Front hydraulic line
   R. Rear hydraulic line
15. Using a 15/16” wrench, remove the front hydraulic line from the pump fitting (Fig. 1524).

16. Using a 15/16” wrench, remove the rear hydraulic line from the pump fitting (Fig. 1525).

17. Using a 9/16” wrench, remove the 2 pump mounting bolts (Fig. 1526).

18. Slide the pump assembly out of the chassis (Fig. 1527).

Hydraulic Tandem Pump Installation

1. Turn the engine until the 2 pump coupler set screws are positioned at approximately 1 o’clock and 3 o’clock (Fig. 1528).

2. Ensure the key is installed in the pump shaft keyway (Fig. 1529).

3. Apply anti-seize compound to the pump shaft (Fig. 1530).

4. Install the pump shaft into the pump pulley aligning the key in the shaft with the keyway in the pulley (Fig. 1531).
5. Apply thread locking compound to the 2 pump mounting bolts (Fig. 1532).

6. Using a 9/16” wrench, install the 2 pump mounting bolts (Fig. 1533).

7. Using a 1/4” 8-point socket, tighten the 2 pump coupler set screws (Fig. 1534).

8. Slide the idler arm inward (Fig. 1535).
9. Route the belt around the idler arm pulley (Fig. 1536).

10. Move the idler arm outward to apply tension to the fan belt. Refer to “Checking the Alternator Belt Tension” on page 6/4-60. While applying tension, use a 9/16” socket to tighten the idler arm nut (Fig. 1537).

11. Slide the rear suction hose onto the rear pump suction fitting (Fig. 1538).

12. Slide the front suction hose onto the front pump suction fitting (Fig. 1539).
13. Position the 2 hose clamps and tighten to secure the 2 suction hoses (Fig. 1540).

14. Using a 15/16” wrench, install the rear hydraulic line to the rear pump fitting (Fig. 1541).

15. Using a 15/16” wrench, install the front hydraulic line to the front pump fitting (Fig. 1542).

16. Slide the fan onto the fan adapter (Fig. 1543).
17. Using a 7/16” socket, install 4 bolts and lock washers securing the fan to the fan adapter. Torque the 4 bolts to 100 ± 10 ft-lbs. (136 ± 14 Nm) (Fig. 1544).

18. Install the radiator. Refer to “Radiator Installation” on page 6/4-97.

19. Check and fill the Hydraulic fluid as necessary:
   - Hydraulic Tank Capacity: 17.25 gal. (67 l)
   - Use 10W-30 or 15W-40 detergent, diesel engine oil (API service CH-4 or higher).

   a. Clean the area around the filler neck of the hydraulic tank (Fig. 1545).

   b. Remove the cap from the filler neck and check the fluid level on the dipstick (Fig. 1545).

20. Start the machine.

21. Purge air from the hydraulic system.

22. Check for leaks.

23. Turn the machine off and remove the key.

24. Check the hydraulic fluid level and add if necessary.
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Loader Arm Replacement

Loader Arm Removal

1. Raise the loader arm 6” - 8” (15 - 20cm) away from frame and position attach plate flat (horizontally) (Fig. 1546).

2. 4-Paw machines: Remove the hood.

3. Support the attach plate with a floor jack (Fig. 1547).

4. Using a 1/2” socket, remove the 3 bolts retaining the 3 pivot pins to the attach plate (Fig. 1548).

5. Remove the center pivot pin (Fig. 1549).
6. Remove the RH and LH pivot pins (Fig. 1550 and Fig. 1551).

7. Remove the attach plate (Fig. 1552).

8. Using a 1/2" socket, remove the bolt securing the upper tilt cylinder pivot pin to the tilt cylinder (Fig. 1553).
9. Remove the upper pivot pin (Fig. 1554).

**Note:** Support the cylinder with one hand as you remove the upper pivot pin.

10. Lay the tilt cylinder alongside the unit (Fig. 1555).

11. Mark the hydraulic lines to the flush face couplers with an M for male and F for female relating to the couplers (Fig. 1556).

12. Place an oil pan underneath the couplers to catch drainage.

13. Using a 1-1/8” wrench remove the hydraulic line to the male (M) flush face coupler (Fig. 1557).

**Note:** Use a plug to protect the line from contamination.
14. Using a 1-18" wrench remove the hydraulic line to the female (F) flush face coupler (Fig. 1558).

Note: Use a plug to protect the line from contamination.

15. Using a 1-1/4" wrench and 1-5/16" wrench remove the nut from the male flush face coupler (Fig. 1559) and remove the male flush face coupler (Fig. 1560).
16. Using a 1-5/16” wrench remove the nut from the female flush face coupler (Fig. 1561) and remove the female flush face coupler (Fig. 1562).

17. Remove the drain pan.

18. Using a properly rated strap or chain and hoist, support the cross-member of the loader arm (Fig. 1563).

19. Using a 1/2” socket remove the 2 bolts securing the lift cylinder pin to the loader arm and the loader arm pivot pin to the frame (2 per side, left side shown) (Fig. 1564).
20. Remove the left and right lift cylinder pin from the loader arm (Fig. 1565).

21. Remove the left and right loader arm pivot pin from the frame (Fig. 1566).

22. Remove the loader arm from the machine (Fig. 1567).
Loader Arm Installation

1. Inspect the loader arm and pivot pins for wear or damage. Replace as necessary (Fig. 1568).

2. Inspect the hydraulic cylinder yolks for wear or damage. Replace as necessary (Fig. 1569).

3. Inspect the attach plate for wear or damage. Replace as necessary (Fig. 1570).

4. Install the loader arm onto the unit, aligning the pivot points on the loader arm with the pivot points on the upper frame (Fig. 1571).
5. Install a pivot pin through the frame and loader arm pivot point (Fig. 1572).

6. Repeat for the opposite side.

7. Install a pivot pin through the lift cylinder and loader arm pivot point (Fig. 1573).

8. Repeat for the opposite side.

9. Using a 1/2" socket, install 4 bolts to secure the pivot pins to the upper frame and lift cylinders on both sides of the machine. Torque the bolts to 19 ft-lbs. (26 Nm) (Fig. 1574 and Fig. 1575).
10. Remove the support from the loader arm.

11. Position the female flush face coupler into the outside hole of the coupler bracket on the loader arm (Fig. 1576).

12. Using a 1-5/16” wrench install the nut to the female flush face coupler (Fig. 1577).

Note: Upon removal, all seals, o-rings and gaskets should be replaced. During installation, lightly lubricate all seals, o-rings and gaskets with clean petroleum jelly prior to assembly.

13. Position the male flush face coupler into the coupler bracket on the loader arm (Fig. 1578).

14. Using a 1-1/4” wrench and 1-5/16” wrench install the nut to the male flush face coupler (Fig. 1579).
15. Using a 1-1/8" wrench install the hydraulic line (F) to the female flush face coupler (Fig. 1580).

16. Using a 1-1/8" wrench install the hydraulic line (M) to the male flush face coupler (Fig. 1581).

17. With the fittings facing up toward the engine, position the tilt cylinder in the center of the loader arm (Fig. 1582).

18. Install the upper pivot pin through the tilt cylinder yoke and loader arm bracket (Fig. 1583).
19. Install a bolt to secure the pivot pin to the cylinder yoke. Torque the bolt to 19 ft-lbs. (26 Nm) (Fig. 1584).

20. Position the attach plate to the loader arm pivot points (Fig. 1585).

21. Install the right and left side pivot pins into the pivot points (Fig. 1586).

22. Align the tilt cylinder ram with the attach plate center pivot point. Install the center pivot pin securing the tilt cylinder to the attach plate (Fig. 1587).
23. Using a 1/2" socket, install 3 bolts securing each of the pivot pins to the attach plate (2) and the tilt cylinder ram (1) (Fig. 1588).

24. Torque the 3 pivot pin bolts to 19 ft-lbs. (26 Nm) (Fig. 1589).

25. Remove the floor jack.

26. 4-Paw machines: Install the hood.

27. Start the machine. Raise and lower the loader arm.

28. Check the hydraulic fluid level and add if necessary.

29. Grease the pivot points (using #2 general purpose lithium grease):
   - Left side (Fig. 1590)
Attach plate (Fig. 1591)

Right side (Fig. 1592)
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**Engine Replacement**

**Engine Removal**

1. Remove the radiator. Refer to “Radiator Removal” on page 6/4-92.

2. Using a 7/16" socket, remove the 4 bolts and lock washers securing the fan to the fan adapter (Fig. 1593).

3. Remove the fan assembly (Fig. 1594).

4. Using a 1/2" socket, loosen the 2 bolts securing the rear access door to the frame (Fig. 1595).

5. Lift the rear access door and remove it from the machine (Fig. 1596).
6. Position a drain pan under the oil drain line or hose. Using a 1/4" socket, loosen the hose clamp securing the oil drain plug to the oil drain line (Fig. 1597).

7. Remove the oil drain plug (Fig. 1598).

8. Cut the cable tie securing the 2 fuel lines (Fig. 1599).

9. Slide the fuel line hose clamp away from the fuel filter fitting (Fig. 1600).
10. Remove the fuel line from the fuel filter fitting and drain the fuel out of the fuel tank into a proper receptacle (Fig. 1601).

11. Slide the fuel line hose clamp away from the fuel tank fitting (Fig. 1602).

12. Slide the fuel line off of the fuel tank fitting (Fig. 1603).

13. Using a 3/8” socket, loosen the air cleaner hose clamp (Fig. 1604).
14. Slide the air cleaner hose off the intake manifold (Fig. 1605).

15. Using a 1/2" wrench, loosen the 2 nuts securing the air cleaner bracket to the frame (Fig. 1606).

16. Remove the air cleaner assembly (Fig. 1607).

17. Disconnect the fuel solenoid from the harness (Fig. 1608).
18. Using a 7mm socket remove the nut that secures the glow plug power wire to the glow plug bus bar (Fig. 1609).

19. Remove the glow plug power wire from the glow plug bus bar (Fig. 1610).

20. Using a 7/16" socket, remove the nut from the bolt securing the throttle cable r-clamp to the fuel filter bracket (Fig. 1611).

21. Loosen the throttle cable clamp swivel using a 5/16" wrench and a 1/2" wrench (Fig. 1612).
22. Slide the throttle cable out of the throttle cable clamp swivel (Fig. 1613).

23. Unplug the water temperature sensor terminal (Fig. 1614).

24. Remove the operator’s manual tube (Fig. 1615).
25. Using a 1/2” socket, remove the 4 bolts securing the battery cover to the frame (Fig. 1616 and Fig. 1617).

26. Remove the battery cover (Fig. 1618).

27. Disconnect the negative battery cable from the battery (Fig. 1619).
28. Lift up the red boot covering the positive battery cable connection. Disconnect the positive battery cable from the battery (Fig. 1620).

29. Using a 17mm socket, remove the bolt securing the ground wires to the chassis (Fig. 1621).

30. Slide the red boot off the starter terminal (Fig. 1622).

31. Using a 12mm socket, remove the nut from the starter terminal (Fig. 1623).
32. Remove the lock washer from the starter terminal (Fig. 1624).

33. Remove the positive battery cable from the starter terminal (Fig. 1625).

34. Remove the harness wire terminal from the starter terminal (Fig. 1626).

35. Unplug the starter connector from the fusible link (Fig. 1627).
36. Unplug the harness wire (blue) from the solenoid terminal (Fig. 1628).

37. Using a Phillips screw driver, remove the screw securing the oil sensor wire to the oil sensor (Fig. 1629).

38. Using a 1/4" socket, remove the self tapping screw and washer securing the harness wire r-clamp to the frame (Fig. 1630).

39. Unplug the dynamo (alternator) wires from the harness wires (Fig. 1631).
40. Using a 1/4" wrench, remove the screw securing the spark arrester to the muffler (Fig. 1632).

41. Remove the spark arrester from the muffler (Fig. 1633).

42. Place an absorbent towel under the hydraulic pump.

43. Loosen the hose clamp on one of the pump suction hoses (Fig. 1634).

44. Slide the suction hose off the pump fitting (Fig. 1635).
45. Loosen the hose clamp on the other pump suction hose (Fig. 1636).

46. Slide the suction hose off the pump fitting (Fig. 1637).

**Note:** Plug both lines to prevent contamination.

47. Mark the hydraulic pump lines and fittings (Fig. 1638):

F: Front fitting and line  R: Rear fitting and line

48. Using a 15/16” wrench, remove the front hydraulic line from the pump fitting (Fig. 1639).
49. Using a 15/16” wrench, remove the rear hydraulic line from the pump fitting (Fig. 1640).

50. Using a 1/2” socket, remove the 4 engine mount mounting bolts and washers (Fig. 1641 and Fig. 1642).
51. Discard the 4 mounting bolts, but retain the 4 washers for installation.

52. Place suitable lumber on the operator’s platform. Slide the engine backward so that it rests on the lumber being careful to clear the muffler tail pipe from the hole in the frame (Fig. 1643).

53. Position an approved engine hoist and connect a chain to the 2 engine lift points. Remove the engine from the frame (Fig. 1644).

54. Position engine on a suitable workstation and disconnect the chain from the 2 engine lift points.

55. Using a 5/16” socket, remove the hose clamp from the top radiator hose (Fig. 1645).

56. Remove the top radiator hose (Fig. 1646).
57. Remove the previously disconnected lower radiator hose from the engine (Fig. 1647).

58. Using a 9/16" socket, loosen the idler arm nut (Fig. 1648).

59. Slide the idler arm inward (Fig. 1649).

60. Remove the belt from the idler pulley (Fig. 1650).
61. Using a 22mm socket, rotate the engine until the pump coupler set screws are accessible (Fig. 1651 and Fig. 1652).

62. Using a 1/4" 8-point socket, loosen the 2 pump coupler set screws (Fig. 1653).

63. Using a 1/2" socket, remove the 4 pump mount mounting bolts and lock washers (Fig. 1654).
64. Remove the pump, pump mount/idler assembly (Fig. 1655).

![Image](Fig. 1655 DSC-0063a)

65. Remove the fan belt (Fig. 1656).

![Image](Fig. 1656 DSC-0064a)

66. Use a 22mm socket on the opposite end of the engine to prevent the engine from rotating (Fig. 1657). Using a 1/2" socket, remove the 2 screws securing the engine pulley to the flywheel adapter (Fig. 1658).

![Image](Fig. 1657 DSC-0068a)

![Image](Fig. 1658 DSC-0066a)
67. Remove the engine pulley and adapter spacer from the flywheel adapter (Fig. 1659).

68. Using a 15mm socket, remove the 5 bolts and lock washers securing the flywheel adapter to the engine (Fig. 1660).

69. Remove the flywheel adapter (Fig. 1661).

70. Using a 13mm wrench, loosen the lower muffler mounting bolt (Fig. 1662).
71. Using a 1/2" wrench and socket, remove the 3 upper muffler mounting bolts, lock washers and nuts (Fig. 1663).

72. Remove the muffler (Fig. 1664).

73. Remove the manifold gasket (Fig. 1665).

74. Remove the previously loosened lower muffler mounting bolt and discard (Fig. 1666).
75. Remove the cotter pin securing the rod linkage to the engine stop lever (Fig. 1667).

76. Remove the rod linkage from the engine stop lever (Fig. 1668).

77. Using a 13mm socket, remove the 2 bolts and lock washers securing the solenoid mount to the engine block (Fig. 1669).

78. Remove the solenoid and mount from the engine (Fig. 1670).
79. Slide the hose clamp away from the #3 injector and remove the fuel line (Fig. 1671 and Fig. 1672).

80. Using a 9/16” wrench, remove the water temperature sensor from the engine (Fig. 1673).

81. Using a 1/4” socket, loosen the hose clamp from the engine oil drain line (Fig. 1674).
82. Remove the engine oil drain line (Fig. 1675).

83. Position an approved engine hoist and connect a chain to the 2 engine lift points (Fig. 1676).

84. Support the engine.

85. Using a 17mm socket, remove the 4 bolts and lock washers securing the engine plate mount to the engine (Fig. 1677).

86. Using a 9/16" socket and an 11/16" wrench, remove the bolts and nuts from the engine mount (Fig. 1678).
87. Remove the flat washers (Fig. 1679).

88. Remove the snubbing washers (Fig. 1680).

89. Remove the engine mount washers (Fig. 1681).

90. Remove the engine mount plate from the engine mount (Fig. 1682).
91. Using a 12mm socket, remove the lower starter mounting bolt and lock washer (Fig. 1683).

92. Using a 17mm socket, remove the bolt securing the breather hose R clamp to the engine mount plate and engine block. Using a 17mm socket, remove the remaining 2 bolts and lock washers (Fig. 1684).

93. Remove the r-clamp from the breather hose and retain it to transfer to the breather hose on the new engine (Fig. 1685).

94. Lift and separate the engine from the engine mount assembly (Fig. 1686).
95. Clean, inspect and replace any parts of the engine mount assembly showing evidence of wear (Fig. 1687 and Fig. 1688).

96. If the rubber engine mounts need to be replaced: They are not interchangeable. They are identified by the following:

- The rubber mounts located on the flywheel end of the mount assembly have a blue identification mark and has a lip underneath the flange (Fig. 1689).

- The rubber mounts located on the oil drain end of the mount assembly have a white or green identification mark and do not have a lip underneath the flange (Fig. 1690).
Engine Installation

1. Secure the new engine with an approved hoist.

2. Slide the r-clamp onto the breather hose (Fig. 1691).

3. Position and lower the engine into the engine mount assembly (Fig. 1692).

4. Apply thread locking compound to the breather hose r-clamp mounting bolt (no washer). Apply thread locking compound to the 2 engine plate mounting bolts with lock washers (Fig. 1693 and Fig. 1694).
5. Install the mounting bolt (no washer) through the breather hose r-clamp and engine mount plate and into the engine block to secure (Fig. 1695). Install the 2 engine plate mounting bolts with lock washers through the engine mounting plate and into the engine block to secure (Fig. 1696).

6. Using a 17mm socket, torque the 3 engine mount plate bolts to 38 ± 4 ft-lbs. (51.5 ± 5.4 Nm) (Fig. 1697).

7. Using a 12mm socket, install the lower starter housing mounting bolt and lock washer through the starter housing and into the engine block. Torque to 17.4 to 20.3 ft-lbs. (23.5 to 27.5 Nm) (Fig. 1698).
8. Position the engine mount plate (Fig. 1699).

9. Apply thread locking compound to the 4 engine mount plate mounting bolts (with lock washers) (Fig. 1700).

10. Install the 4 mounting bolts (with lock washers) to secure the engine mount plate to the engine block. Torque to 38 ± 4 ft-lbs. (51.5 ± 5.4 Nm) (Fig. 1701).

11. Install the engine mount washer (Fig. 1702).
12. Install the snubbing washer (Fig. 1703).

13. Install the flat washer (Fig. 1704).

14. Install the bolt (Fig. 1705).

15. Loosely install the nut (Fig. 1706).
16. Using a 9/16" socket and 11/16" wrench, tighten the engine mount assembly (Fig. 1707).

17. Install the engine oil drain line (Fig. 1708).

18. Install the engine oil drain plug (Fig. 1709).

19. Using a 1/4" socket, tighten the hose clamps securing the engine oil drain line and engine oil drain plug (Fig. 1710).
20. Apply pipe sealant to the threads on the water temperature sensor (Fig. 1711).

21. Install the water temperature sensor. Use a 9/16" wrench to tighten (Fig. 1712).

22. Slide the fuel line onto the #3 injector barb. Slide the hose clamp into position to secure (Fig. 1713).

23. Apply thread locking compound to the 2 fuel solenoid assembly mounting bolts (Fig. 1714).
24. Position the fuel solenoid assembly to the engine block (Fig. 1715).

![Fig. 1715](DSC-2463a)

25. Install the 2 fuel solenoid mounting bolts. Torque to 19 ± 2 ft-lbs. (25.76 ± 2.7 Nm) using a 13mm socket (Fig. 1716).

![Fig. 1716](DSC-2467a)
26. With the fuel solenoid spring loose, position the fuel stop so it is up against the fuel stop adjusting screw. If the solenoid rod end does not align with the hole in the fuel stop (Fig. 1717), loosen the fuel solenoid jam nut (Fig. 1718) and rotate the solenoid rod in or out (Fig. 1719) until it can be inserted into the fuel stop (Fig. 1720). Tighten the jam nut to secure the fuel solenoid rod (Fig. 1721).
27. Install a cotter pin into the solenoid rod to secure (Fig. 1722).

![Fig. 1722](DSC-2478a)

28. Slide the fuel filter hose onto the fuel barb on the engine (Fig. 1723).

![Fig. 1723](DSC-2482a)

29. Position the fuel filter assembly to the engine aligning the bracket mounting holes on the fuel filter assembly with the bracket mounting holes on the engine mount. Install 2 bolts and nuts to secure the fuel filter bracket to the engine mount (Fig. 1724).

![Fig. 1724](DSC-2483a)

30. Using a 1/2" wrench and socket, tighten the fuel filter assembly mounting bolts and nuts (Fig. 1725).

![Fig. 1725](DSC-2486a)
31. Slide the hose clamp into position to secure the fuel line to the engine (Fig. 1726).

32. **Lower muffler mounting bolt:** A special bolt with high temperature thread locking compound that is factory applied (Fig. 1727).

33. Using a 13mm socket, loosely thread a new lower muffler mounting bolt and washer into the engine block (Fig. 1728).

**Note:** Do not tighten the bolt. Leave it loose enough to slide the muffler bracket onto it.

34. Insert the 3 muffler manifold mounting bolts through the engine manifold (Fig. 1729).
35. Slide the manifold gasket onto the 3 mounting bolts (Fig. 1730).

36. Position the muffler to the engine by sliding the lower muffler bracket onto the lower muffler mounting bolt (Fig. 1731).

37. Slide the muffler manifold onto the 3 mounting bolts (Fig. 1732).

38. Install 3 nuts and lock washers onto the muffler manifold mounting bolts (Fig. 1733).
39. Using a 1/2" wrench and socket, tighten the 3 upper muffler mounting bolts, lock washers and nuts (Fig. 1734).

40. Using a 13mm wrench, tighten the lower muffler mounting bolt (Fig. 1735).

41. Apply thread locking compound to the 5 flywheel adapter mounting bolts (Fig. 1736).

42. Position the Flywheel adapter to the flywheel (Fig. 1737).
43. Using a 15mm socket, install 5 bolts and lock washers securing the flywheel adapter to the flywheel (Fig. 1738 and Fig. 1739).

**Note:** Use a 22mm socket or wrench on the opposite end of the engine to prevent the engine from turning while tightening the flywheel adapter mounting bolts.

44. Torque the 5 mounting bolts to 19 ± 2 ft-lbs. (26 ± 3 Nm) (Fig. 1740).

45. Apply thread locking compound to pump pulley shoulder bolts (Fig. 1741).
46. Position adapter spacer and pump pulley to the flywheel adapter (Fig. 1742).

47. Install the 2 pump pulley mounting bolts (Fig. 1743).

48. Torque the 2 pump pulley mounting bolts to 15 -19 ft-lbs. (20 - 26 Nm) (Fig. 1744).

49. Rotate the engine so the pump mount set screws are located at the 1 o’clock and 4 o’clock positions (Fig. 1745).
50. Place the fan belt around pump pulley (Fig. 1746).

51. Rotate the pump shaft so that the key in the pump shaft will align with the keyway in the pump pulley (Fig. 1747).

52. Apply thread locking compound to the 4 pump mount mounting bolts (Fig. 1748).

53. Apply anti-seize to the pump shaft (Fig. 1749).
54. Slide the pump shaft into the pump pulley aligning the key with the keyway (Fig. 1750).

55. Route the fan belt around the upper pulley on the pump mount assembly (Fig. 1751).

56. Continue sliding the pump shaft into the pump pulley. Align the pump mount assembly mounting holes with the mounting holes located on the engine. Install 4 pump mount assembly mounting bolts and lock washers (Fig. 1752).

57. Using a 1/2" socket, torque the 4 pump mount assembly mounting bolts to 17-21 ft-lbs. (23-28 Nm) (Fig. 1753).
58. Using a 1/4” 8-point socket, tighten the 2 pump coupler set screws (Fig. 1754).

60. Route the belt around the idler pulley (Fig. 1756).

59. Slide the idler arm inward (Fig. 1755).

61. Move the idler arm outward to apply tension to the fan belt. While applying tension, use a 9/16” socket to tighten the idler arm nut (Fig. 1757).
62. Check and adjust the alternator belt tension. Refer to “Checking the Alternator Belt Tension” on page 6/4-60.

63. Place suitable lumber on the operator’s platform. Raise the engine and place it on the lumber (Fig. 1758).

66. Remove the lumber from the operator’s platform.

67. Using a 1/2" socket, Install 4 new special cap screws and washers to secure the engine mount to the frame (Fig. 1760).

Note: The cap screws have a dri-lock adhesive on the threads and must be replaced upon removal.

64. Remove the hoist chains and hoist.

65. Slide the engine into the frame aligning the mounting holes on the engine mount with the holes in the frame (Fig. 1759).

68. Using a 1/2" socket, torque the 4 cap screws to 35 to 45 ft-lbs. (47 to 61 Nm) (Fig. 1761).
69. Slide the rear suction hose onto the rear pump fitting (Fig. 1762).

70. Position the hose clamp and tighten to secure (Fig. 1763).

71. Slide the front suction hose onto the front pump fitting (Fig. 1764).

72. Position the hose clamp and tighten to secure (Fig. 1765).
73. Route the rear hydraulic pump line between the two suction hoses and under the pump to the hydraulic line fitting side of the pump. Route the front hydraulic pump line in front of the front suction line and under the pump to the hydraulic line fitting side of the pump (Fig. 1766).

74. Install the rear hydraulic pump line to the rear hydraulic pump fitting (Fig. 1767).

75. Install the front hydraulic pump line to the front hydraulic pump fitting (Fig. 1768).

76. Slide the fan onto the fan adapter (Fig. 1769).
77. Using a 7/16" socket, install 4 bolts and lock washers securing the fan to the fan adapter. Torque the 4 bolts to 100 ± 10 ft-lbs. (136 ± 14 Nm) (Fig. 1770).

78. Slide the spark arrester onto the muffler (Fig. 1771).

79. Using a 1/4" wrench, install a screw to secure the spark arrester to the muffler (Fig. 1772).

80. Plug the dynamo (alternator) wires into the harness wires (Fig. 1773).
81. Using a 1/4" socket, install the self tapping screw and washer securing the harness wire r-clamp to the frame (Fig. 1774).

82. Using a Phillips screw driver, install the screw securing the oil sensor wire to the oil sensor (Fig. 1775).

83. Plug the harness wire (blue) onto the solenoid terminal (Fig. 1776).

84. Plug the starter connector into the fusible link (Fig. 1777).
85. Install the harness wire terminal onto the starter terminal (Fig. 1778).

86. Install the positive battery cable onto the starter terminal (Fig. 1779).

87. Install a lock washer onto the starter terminal (Fig. 1780).

88. Using a 12mm socket, install a nut onto the starter terminal (Fig. 1781).
89. Position the red protective boot over the starter terminal (Fig. 1782).

90. Apply thread locking compound to the ground bolt (Fig. 1783).

91. Slide the negative battery cable onto the ground bolt (Fig. 1784).

92. Slide the harness ground wire onto the ground bolt (Fig. 1785).
93. Using a 17mm socket, install the ground bolt to the engine mount plate, securing the ground wires to the engine mount (Fig. 1786).

94. Plug the temperature sensor terminal onto the temperature sensor (Fig. 1787).

95. Install the glow plug power wire onto the glow plug bus bar terminal (Fig. 1788).

96. Using a 7mm socket, install a nut to secure the glow plug power wire to the glow plug bus bar (Fig. 1789).
97. Plug the fuel solenoid into the harness (Fig. 1790).

98. Install the positive battery cable onto the positive battery terminal. Cover the connection with the red protective boot (Fig. 1791).

99. Install the negative battery cable onto the negative battery terminal (Fig. 1792).

100. Position the battery cover over the battery (Fig. 1793).
101. Using a 1/2” socket, install the 4 bolts securing the battery cover to the frame (Fig. 1794).

**Note:** The short bolts are installed on the top and the long bolts are installed on the bottom.

102. Install the operator’s manual tube (Fig. 1795).

103. Position the r-clamp on the throttle to the mounting hole in the fuel shut-off bracket (Fig. 1796).

104. Install a bolt through the r-clamp and bracket (Fig. 1797).
105. Position the throttle lever into the slow position (Fig. 1798).

107. Insert the throttle cable clamp into the throttle linkage lever (Fig. 1800).

106. Slide the throttle cable into the throttle cable clamp swivel (Fig. 1799).

108. Using a 7/16” wrench, loosely install a nut onto the cable clamp swivel securing it to the throttle linkage (Fig. 1801).
109. Move the throttle lever to the fast position (Fig. 1802).

110. Hold the throttle linkage in the fast position (Fig. 1803).

111. Use 5/16” and 1/2” wrenches to tighten the swivel screw securing the throttle cable in the swivel (Fig. 1804).

112. Use 7/16” and 1/2” wrenches to tighten the cable clamp swivel nut securing it to the throttle linkage (Fig. 1805).
113. Slide the lower radiator hose onto the engine flange (Fig. 1806).

114. Position the hose clamp and tighten to secure (Fig. 1807).

115. Slide the upper radiator hose onto the engine flange (Fig. 1808).

116. Position the hose clamp and tighten to secure (Fig. 1809).
117. Position the air cleaner assembly hose onto the engine air intake (Fig. 1810).

118. Position the air cleaner bracket onto the mounting bolts located on the frame (Fig. 1811).

119. Position the air intake hose clamp and tighten to secure the air intake hose to the engine intake (Fig. 1812).

120. Using a 1/2" wrench, tighten the 2 nuts securing the air cleaner bracket to the frame (Fig. 1813).
121. Slide the fuel line onto the fuel tank fitting (Fig. 1814).

122. Position the fuel line hose clamp to secure (Fig. 1815).

123. Slide the fuel line onto the fuel filter fitting (Fig. 1816).

124. Position the fuel line hose clamp to secure (Fig. 1817).
125. Install a cable tie to secure the 2 fuel lines just below the fuel filter fitting (Fig. 1818).

126. Open the fuel shut-off valve (Fig. 1819).

127. Fill the engine with oil:
   • Oil Type: Diesel engine oil (API service CD or higher)
   • Crankcase Capacity: w/filter, 0.84 gal. (3.2 l)
   a. Remove the oil fill cap and slowly pour approximately 80% of the specified amount of oil in through the valve cover.
   b. Check the oil level.
   c. Slowly add additional oil to bring the level to the upper mark/hole on the dipstick.
   d. Replace the fill cap.

128. Install the radiator. Refer to “Radiator Installation” on page 6/4-97.
129. Check and fill the Hydraulic fluid:
   - Hydraulic Tank Capacity: 17.25 gal. (67 l)
   - Use 10W-30 or 15W-40 detergent, diesel engine oil (API service CH-4 or higher).

a. Clean the area around the filler neck of the hydraulic tank (Fig. 1820).

b. Remove the cap from the filler neck and check the fluid level on the dipstick (Fig. 1820).

c. If the level is low, add enough fluid to raise it to the proper level.

d. Install the cap on the filler neck.

130. Start the machine.

131. Purge air from the hydraulic system.

132. Check for leaks.

133. Turn the machine off and remove the key.

134. Check the hydraulic fluid level and add if necessary.

135. Position the rear access door onto the unit (Fig. 1821).

136. Using a 1/2” socket, tighten the 2 bolts securing the rear access door to the frame (Fig. 1822).
137. Close and secure the rear access door (Fig. 1823 and Fig. 1824).

Checking the Alternator Belt Tension

1. Measure the deflection (A) by depressing the belt halfway between the fan drive pulley and alternator pulley at the specified force of 22 lbs. (98 N, 10kgf).

2. If the measurement is not within the factory specifications, loosen the alternator mounting screws and relocate the alternator to adjust and re-tighten the mounting screws.

A. 0.28 to 0.35" (7.0 to 9.0mm)
Fan Belt Replacement

Fan Belt Removal

1. Remove the radiator. Refer to “Radiator Removal” on page 6/4-92.

2. Using a 7/16” socket, remove the 4 bolts and lock washers securing the fan to the fan adapter (Fig. 1826).

3. Remove the fan (Fig. 1827).

4. Using a 9/16” socket, loosen the idler arm nut (Fig. 1828).

5. Slide the idler arm inward. Remove the belt from the idler pulley (Fig. 1829).
6. Slide the idler arm fully outward (Fig. 1830).

7. Using a 22mm socket, rotate the engine until the pump coupler set screws are accessible (Fig. 1831).

8. Using a 1/4" 8-point socket, loosen the 2 pump coupler set screws (Fig. 1832).

9. Place absorbent towel under the pump.

10. Loosen the hose clamp on the front pump suction hose (Fig. 1833).
11. Slide the front suction hose off the pump fitting (Fig. 1834).

12. Loosen the hose clamp on the rear pump suction hose (Fig. 1835).

13. Slide the rear suction hose off the pump fitting (Fig. 1836).

**Note:** Plug the hoses to prevent contamination.

14. Mark the hydraulic pump lines and fittings F and R (Fig. 1837):
   - F. Front hydraulic line
   - R. Rear hydraulic line
15. Using a 15/16” wrench, remove the front hydraulic line from the pump fitting (Fig. 1838).

16. Using a 15/16” wrench, remove the rear hydraulic line from the pump fitting (Fig. 1839).

17. Using a 9/16” wrench, remove the 2 pump mounting bolts (Fig. 1840).

18. Slide the pump assembly out of the chassis (Fig. 1841).
19. Remove the fan belt from the upper pulley (Fig. 1842).

20. Using a 1/2" socket, remove the 4 pump mount assembly mounting bolts and lock washers (Fig. 1843).

Note: The bottom 2 mounting bolts are located below the pump mount opening. They bolt the bottom of the plate to the engine block.

21. Remove the pump mount/idler assembly (Fig. 1844).

22. To service the pump mount idler assembly, refer to “Pump Mount Assembly Rebuild” on page 6/4-103.

23. Remove the fan belt (Fig. 1845).
3. Position the pump mount/idler assembly to the drive pulley. Route the belt around the drive pulley. Loosely install the 4 bolts and lock washers securing the pump mount/idler assembly to the engine block (Fig. 1848).

4. Using a 1/2" socket, tighten the 4 pump mount assembly mounting bolts (Fig. 1849).

**Note:** The bottom 2 mounting bolts are located below the pump mount opening and bolt the bottom of the pump mount to the engine block.
5. Turn the engine until the 2 pump coupler set screws are positioned at approximately 1 o’clock and 3 o’clock (Fig. 1850).

6. Ensure the key is installed in the pump shaft keyway (Fig. 1851).

7. Apply anti-seize compound to the pump shaft (Fig. 1852).

8. Install the pump shaft into the pump pulley aligning the key in the shaft with the keyway in the pulley (Fig. 1853).
9. Apply thread locking compound to the 2 pump mounting bolts (Fig. 1854).

10. Using a 9/16” wrench, install the 2 pump mounting bolts (Fig. 1855).

11. Using a 1/4” 8-point socket, tighten the 2 pump coupler set screws (Fig. 1856).

12. Slide the idler arm inward (Fig. 1857).
13. Route the belt around the idler arm pulley (Fig. 1858).

14. Move the idler arm outward to apply tension to the fan belt. Refer to “Checking the Alternator Belt Tension” on page 6/4-60. While applying tension, use a 9/16” socket to tighten the idler arm nut (Fig. 1859).

15. Slide the rear suction hose onto the rear pump suction fitting (Fig. 1860).

16. Slide the front suction hose onto the front pump suction fitting (Fig. 1861).
17. Position the 2 hose clamps and tighten to secure the 2 suction hoses (Fig. 1862).

18. Using a 15/16” wrench, install the rear hydraulic line to the rear pump fitting (Fig. 1863).

19. Using a 15/16” wrench, install the front hydraulic line to the front pump fitting (Fig. 1864).

20. Slide the fan onto the fan adapter (Fig. 1865).
21. Using a 7/16" socket, install 4 bolts and lock washers securing the fan to the fan adapter. Torque the 4 bolts to 100 ± 10 ft-lbs. (136 ± 14 Nm) (Fig. 1866).

22. Install the radiator. Refer to “Radiator Installation” on page 6/4-97.

23. Check and fill the Hydraulic fluid as necessary:
   • Hydraulic Tank Capacity: 17.25 gal. (67 l)
   • Use 10W-30 or 15W-40 detergent, diesel engine oil (API service CH-4 or higher).
   a. Clean the area around the filler neck of the hydraulic tank (Fig. 1867).
   b. Remove the cap from the filler neck and check the fluid level on the dipstick (Fig. 1867).

24. Start the machine.

25. Purge air from the hydraulic system.

26. Check for leaks.

27. Turn the machine off and remove the key.

28. Check the hydraulic fluid level and add if necessary.
Fan Replacement

Fan Removal

1. Remove the radiator. Refer to “Radiator Removal” on page 6/4-92.

2. Using a 7/16” socket, remove the 4 bolts and lock washers securing the fan to the fan adapter (Fig. 1868).

3. Remove the fan (Fig. 1869).

Fan Installation

1. Slide the fan onto the fan adapter (Fig. 1870).

2. Using a 7/16” socket, install 4 bolts and lock washers securing the fan to the fan adapter. Torque the 4 bolts to 100 ± 10 in-lbs. (11.3 ± 1 Nm) (Fig. 1871).

3. Install the radiator. Refer to “Radiator Installation” on page 6/4-97.
Fuel Shut Down Solenoid Replacement

Fuel Shut Down Solenoid Removal

1. Park the machine. Shut-off the engine and remove the key.

2. Open the rear access door (Fig. 1872).

3. Unplug the fuel shut down solenoid from the wire harness connector (Fig. 1873).

4. Remove the cotter pin from the end of the fuel shut down solenoid stop arm (Fig. 1874).

5. Remove the 2 bolts and nuts securing the solenoid to the mounting bracket (Fig. 1875).

Note: The air cleaner cover was removed for photo purposes.
6. Remove the solenoid (Fig. 1876).


Fuel Shut Down Solenoid Installation

1. Position the solenoid on the mounting bracket (Fig. 1877).

2. Install 2 bolts and nuts to secure the solenoid to the mounting bracket (Fig. 1878).

Note: The air cleaner cover was removed for photo purposes.
3. Adjust the stop arm (Fig. 1879):
   a. Position the stop rod to the engine linkage.
   b. Loosen the stop rod jam nut.
   c. Push stop rod in and the engine linkage lever forward.
   d. Adjust the stop rod by threading it in or out of the solenoid until it falls into the engine linkage hole.
   e. Lock the jam nut.

4. Install a cotter pin into the end of the fuel shut down solenoid stop arm to secure (Fig. 1880).

5. Plug the fuel shut down solenoid connector into the wire harness connector (Fig. 1881).
Glow Plug Replacement

Glow Plug Removal

1. Park the machine on a level surface.
2. Shut engine off and remove the key.
3. Allow the engine to cool.
4. Open the rear engine cover.
5. Using a 10mm socket, remove the 3 nuts securing the power wire and glow plug bus bar to the glow plugs (Fig. 1882).
6. Remove the glow plug bus bar and clean the area around the glow plugs to prevent debris from entering the engine.
7. Use a 10mm socket to remove the glow plug(s) that need to be replaced (Fig. 1883).
Glow Plug Installation

1. Thread the new glow plug(s) into the cylinder head (Fig. 1884).

2. Torque the glow plug(s) to 5.8 to 10.8 ft-lbs. (7.8 to 14.6 Nm) (Fig. 1885).

3. Install the glow plug bus bar onto the glow plugs.

4. Install the power wire onto the glow plug located farthest back on the engine.

5. Thread a nut onto each of the glow plugs to secure to glow plug power wire and bus bar.

6. Tighten the 3 nuts.

7. Close the rear cover.

Muffler Replacement

Muffler Removal

1. Remove the radiator. Refer to “Radiator Removal” on page 6/4-92.

2. Using a 7/16” socket, remove the 4 bolts and lock washers securing the fan to the fan adapter (Fig. 1886).

3. Remove the fan assembly (Fig. 1887).
4-PAW DIESEL/ENGINE

4. Using a 9/16" socket, loosen the idler arm nut (Fig. 1888).

5. Slide the idler arm inward. Remove the belt from the idler pulley (Fig. 1889).

6. Slide the idler arm outward (Fig. 1890).

7. Using a 22mm socket, rotate the engine until the pump coupler set screws are accessible (Fig. 1891).
8. Using a 1/4" 8-point socket, loosen the 2 pump coupler set screws (Fig. 1892).

9. Place absorbent towel under the pump.

10. Loosen the hose clamps on the suction hoses (Fig. 1893).

11. Slide the suction hoses off the pump fittings (Fig. 1894).

   **Note:** Plug the hoses to prevent contamination.

12. Mark the hydraulic pump hoses and fittings (Fig. 1895):
   - F. Front hydraulic line
   - R. Rear hydraulic line
13. Using a 15/16” wrench, remove the front hydraulic line from the front pump fitting (Fig. 1896).

14. Using a 15/16” wrench, remove the rear hydraulic line from the pump fitting (Fig. 1897).

15. Using a 9/16” wrench, remove the 2 pump mounting bolts (Fig. 1898).

16. Slide the pump assembly out of the chassis (Fig. 1899).
17. Remove the fan belt from the upper pulley (Fig. 1900).

18. Using a 1/2" socket, remove the 4 pump mount assembly mounting bolts and lock washers (Fig. 1901).

**Note:** The bottom 2 mounting bolts are located below the pump mount opening. They bolt the bottom of the mount plate to the engine block.

19. Remove the pump mount/idler assembly (Fig. 1902).

20. Remove the fan belt (Fig. 1903).
21. Using a 13mm wrench, loosen the lower muffler mounting bolt (Fig. 1904).

22. Using a 1/2" wrench and socket, remove the 3 manifold mounting bolts, lock washers and nuts (Fig. 1905).

23. Remove the muffler from the chassis (Fig. 1906).

24. Using a 13mm socket, remove the lower muffler mounting bolt and washer. Discard the bolt, save the washer for installation (Fig. 1907).
25. Using a 1/4” socket, remove the screw securing the spark arrester to the muffler (Fig. 1908).

26. Remove the spark arrester from the muffler (Fig. 1909).

27. Remove the old manifold gasket from the engine manifold (Fig. 1910).
Muffler Installation

1. Slide the spark arrester onto the muffler (Fig. 1911).

2. Use a 1/4" socket to install the screw securing the spark arrester to the muffler (Fig. 1912).

3. Loosely install the lower muffler mounting bolt (new) and washer (Fig. 1914).

Note: Use a new lower muffler mounting bolt; reuse the washer (Fig. 1913).
4. Insert 3 manifold mounting bolts into the engine manifold (Fig. 1915).

5. Position a new manifold gasket on the 3 manifold mounting bolts (Fig. 1916).

6. Position the muffler into the chassis. Slide the lower mounting bracket slot onto the mounting bolt that was previously loosely installed (Fig. 1917).  

   **Note:** The bracket should be between the washer and the engine block.

7. Slide the muffler manifold flange onto the 3 manifold mounting bolts. Install 3 lock washers and nuts to secure the muffler to the engine manifold (Fig. 1918).
8. Using a 1/2" wrench and socket, tighten the 3 manifold mounting bolts and nuts. Torque them to 200 ± 25 in-lbs. (23 ± 3 Nm) (Fig. 1919).

9. Using a 13mm wrench and socket, tighten the lower muffler mounting bolt. Torque to 19 ± 2 ft-lbs. (26 ± 3 Nm) (Fig. 1920).

10. Route the fan belt around the driven fan pulley (Fig. 1921).

11. Apply thread locking compound to the 4 pump mount mounting bolts (Fig. 1922).
12. Position the pump mount/idler assembly to the engine block. Route the belt around the drive pulley. Loosely install the 4 bolts and lock washers securing the pump mount/idler assembly to the engine block (Fig. 1923).

Note: The bottom 2 mounting bolts are located below the pump mount opening and bolt the bottom of the pump mount to the engine block. Using a 1/2" socket, tighten the 4 pump mount assembly mounting bolts.

13. Turn the engine until the 2 pump coupler set screws are positioned at approximately 1 o’clock and 3 o’clock (Fig. 1924).

14. Ensure the key is installed in the pump shaft keyway (Fig. 1925).
15. Apply anti-seize compound to the pump shaft (Fig. 1926).

16. Install the pump into the pump pulley aligning the key in the pump shaft with the keyway in the pulley (Fig. 1927).

17. Apply thread locking compound to the 2 pump mounting bolts (Fig. 1928).

18. Using a 9/16" wrench, install the 2 pump mounting bolts (Fig. 1929).
19. Using a 1/4" 8-point socket, tighten the 2 pump coupler set screws (Fig. 1930).

20. Slide the idler arm inward (Fig. 1931).

21. Route the belt around the idler arm pulley (Fig. 1932).

22. Move the idler arm outward to apply tension to the fan belt. While applying tension, use a 9/16" socket to tighten the idler arm nut (Fig. 1933).
23. Check and adjust the alternator belt tension. Refer to “Checking the Alternator Belt Tension” on page 6/4-60.

24. Slide the rear suction hose onto the rear pump suction fitting (Fig. 1934).

25. Slide the front suction hose onto the front pump suction fitting (Fig. 1935).

26. Position the 2 hose clamps and tighten to secure the 2 suction hoses (Fig. 1936).

27. Using a 15/16” wrench, install the rear hydraulic line to the rear pump fitting (Fig. 1937).
28. Using a 15/16" wrench, install the front hydraulic line to the front pump fitting (Fig. 1938).

29. Slide the fan onto the fan adapter (Fig. 1939).

30. Using a 7/16" socket, install 4 bolts and lock washers securing the fan to the fan adapter. Torque the 4 bolts to 100 ± 10 ft-lbs. (136 ± 14 Nm) (Fig. 1940).

31. Install the radiator. Refer to “Radiator Installation” on page 6/4-97.
32. Check and fill the Hydraulic fluid as necessary:
   • Hydraulic Tank Capacity: 17.25 gal. (67 l)
   • Use 10W-30 or 15W-40 detergent, diesel engine oil (API service CH-4 or higher).
   a. Clean the area around the filler neck of the hydraulic tank (Fig. 1941).
   b. Remove the cap from the filler neck and check the fluid level on the dipstick (Fig. 1941).
   c. If the level is low, add enough fluid to raise it to the proper level.
   d. Install the cap on the filler neck.
33. Start the machine.
34. Purge air from the hydraulic system.
35. Check for leaks.
36. Turn the machine off and remove the key.
37. Check the hydraulic fluid level and add if necessary.

Radiator Replacement

Radiator Removal

1. Raise the loader arms to the fully raised position.
2. Stop the engine and remove the key.
3. Remove the loader arm cylinder locks from the hydraulic lines (Fig. 1942).
4. Position a loader arm cylinder lock over each lift cylinder rod (Fig. 1943).

5. Secure each loader arm cylinder lock with a clevis pin and cotter pin (Fig. 1944).

6. Lower the loader arms until they are resting on the cylinder locks.

7. Open the rear access door (Fig. 1945 and Fig. 1946).
8. Place a drain pan underneath the compartment hinge (on the platform) (Fig. 1947).

9. Loosen the radiator hose clamp (Fig. 1948).

10. Remove the radiator hose from the hose flange and allow the fluid to drain into the pan (Fig. 1949).

11. Loosen the 4 self-tapping screws on the either side of the hood (2 RH and 2 LH) (Fig. 1950).
12. Remove the hood from the machine (Fig. 1951).

13. Loosen the clamp securing the top radiator hose to the radiator (Fig. 1952).

14. Remove the top radiator hose from the radiator (Fig. 1953).

15. Slide the hose clamp that secures the overflow hose to the radiator filler neck away from the filler neck (Fig. 1954).
16. Slide the overflow hose off the overflow flange (Fig. 1955).

17. Remove the 4 mounting bolts located on either side of the radiator (2 RH and 2 LH) (Fig. 1956).

18. Lift and tilt the radiator away from the machine (Fig. 1957).

19. Loosen the hose clamp that secures the lower radiator hose to the radiator (Fig. 1958).
20. Remove the lower radiator hose from the radiator (Fig. 1959).

21. Remove the radiator assembly from the machine (Fig. 1960).

22. To remove the radiator mount from the radiator, refer to “Radiator Mount Removal” on page 6/4-101.

Radiator Installation

1. To install the radiator mount to the radiator, refer to “Radiator Mount Installation” on page 6/4-102.

2. Position the radiator onto the machine (Fig. 1961).

3. Slide the lower radiator hose onto the bottom radiator flange (Fig. 1962).
4. Position the hose clamp and tighten to secure (Fig. 1963).

5. Slide the radiator into the unit. Slide the top radiator hose onto the top flange on the radiator (Fig. 1964).

6. Position the hose clamp and tighten to secure (Fig. 1965).

7. Ensure that the hydraulic vent hose runs in front of the radiator and is not pinched under it (Fig. 1966).
8. Install the 4 mounting bolts securing either side of the radiator to the frame (2 RH and 2 LH) (Fig. 1967).

9. Slide the overflow hose onto the radiator overflow flange (Fig. 1968).

10. Position the overflow hose clamp to secure it to the flange (Fig. 1969).

11. Slide the radiator hose onto the engine hose flange (Fig. 1970).
12. Position the hose clamp and tighten to secure (Fig. 1971).

13. Slowly add a 50/50 mixture of water and permanent ethylene coolant to the filler neck of the radiator (Fig. 1972).

14. Add coolant up to the cold fill line on the reservoir bottle.

15. With the radiator cap off, start the engine and let it run in a well ventilated area until the thermostat opens. When the thermostat opens the coolant mixture will begin to flow through the radiator.

16. Add more coolant into the radiator so the top of the radiator cores are covered with coolant (Fig. 1973).

17. Shut engine off and let engine cool. Remove the key.

18. Add more coolant mixture until the level is to the filler neck (Fig. 1973).

19. Install the radiator cap (Fig. 1974).
20. Check for leaks.

21. Position the hood onto the unit (Fig. 1975).

22. Install 4 self-tapping screws on the either side of the hood (2 RH and 2 LH) to secure (Fig. 1976).

Radiator Mount Replacement

Radiator Mount Removal

1. Using a 1/2" socket wrench, remove the 8 bolts and flat washers securing either side of the radiator mount to the radiator (4 RH and 4 LH) (Fig. 1977).

2. Remove the radiator mount from the radiator (Fig. 1978).
3. Remove the radiator cap (Fig. 1979).

Radiator Mount Installation

1. Position the radiator mount onto the radiator (Fig. 1980).

2. Using a 1/2" socket, install 8 bolts with flat washers securing both sides of the radiator mount to the radiator (4 RH and 4 LH) (Fig. 1981).
Pump Mount Assembly Rebuild

1. Remove the bolt, flat washer, idler pulley, spacer, and nut securing the tensioner arm to the pump mount assembly (Fig. 1982).

2. Remove the locknut, 2 spacers, and carriage bolt securing the top of the tensioner arm to the pump mount assembly (Fig. 1983).

3. Remove locknut, 2 washers, spacer, and bolt securing the bottom of the tensioner arm to the pump mount assembly (Fig. 1984).

4. Loosen the two square head set screws securing the pulley to the pump mount fan shaft (Fig. 1985).
5. Remove the two locknuts and washers located on each end of the pump mount fan shaft (Fig. 1986).

6. Remove the fan adapter from the fan shaft (Fig. 1987).

7. Remove the square key from the fan shaft (Fig. 1988).

8. Remove the pulley from the fan shaft (Fig. 1989).
9. Remove the square key from the fan shaft (Fig. 1990).

10. With a dead blow hammer, drive one of the bearings out of the housing (Fig. 1991).

11. Turn the pump mount assembly over and drive out the other bearing (Fig. 1992).

12. Install a new bearing into the pump mount assembly (Fig. 1993).
13. Turn the assembly over and install the fan shaft into the pump mount assembly bearing (Fig. 1994).

14. Using a driver, install a new bearing into the pump mount assembly until the bearing seats up against the fan shaft (Fig. 1995).

15. Install a square key into the fan shaft (Fig. 1996).

16. Install the pulley onto the fan shaft so that the pulley hub (with the square head set screws) faces the bearing (Fig. 1997).
17. Install a washer and a lock nut to secure the pulley to the fan shaft (Fig. 1998).

18. Turn the pump mount assembly over and install a square key in the fan shaft (Fig. 1999).

19. Slide the fan adapter onto the fan shaft with the flat hub side toward the bearing (Fig. 2000).

20. Install a washer and lock nut to secure the fan adapter to the shaft (Fig. 2001).
21. Tighten both lock nuts until both the pulley and fan adapter seat up against the bearings (Fig. 2002).

22. Tighten the two square head set screws on the pulley (Fig. 2003).

23. Install bolt with a washer through the bottom of the tensioner arm. Slide a spacer onto the bolt. Install the bolt/tensioner arm assembly onto the pump mount assembly. Slide a washer onto the bolt and install a lock nut. Tighten the lock nut ensuring there is still rotational movement on the tensioner arm (Fig. 2004).

24. Install a carriage bolt through the upper hole in the tensioner arm. Slide a spacer onto the bolt. Slide the bolt through the pump mount hole. Install a spacer and a nut onto the bolt. Tighten the nut, but ensure there is still rotational movement on the tensioner arm (Fig. 2005).
25. Slide a washer onto a shoulder bolt. Slide the idler pulley onto the shoulder bolt with the hub facing away from the washer. Slide a spacer onto the bolt (Fig. 2006).

![Fig. 2006](IMG-0658a)

A. Spacer  
B. Pulley  
C. Washer  
D. Bolt

26. Install the tensioner arm assembly onto the pump mount assembly. Install a nut to secure the idler pulley to the tensioner arm (Fig. 2007).

![Fig. 2007](IMG-0659a)

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**Fan Drive Pulley, Rubber Coupler & Flywheel Adapter Replacement**

**Fan Drive Pulley, Rubber Coupler & Flywheel Adapter Removal**


2. Remove the fan belt from the driven fan pulley (Fig. 2008).

![Fig. 2008](DSC-1628a)
3. Using a 1/2" socket, remove the 4 pump mount assembly mounting bolts and lock washers (Fig. 2009).

**Note:** The bottom 2 mounting bolts are located below the pump mount opening. They bolt the bottom of the mount plate to the engine block.

4. Remove the pump mount/idler assembly (Fig. 2010).

5. Remove the fan belt (Fig. 2011).

6. Using a 1/2" socket, remove the 2 bolts securing the pulley to the flywheel adapter (Fig. 2012).
7. Remove the pulley and coupler assembly from the flywheel adapter (Fig. 2013).

Note: The coupler spacer will fall away from the coupler as soon as the 2 mounting bolts are removed.

8. Using a 13mm wrench, remove the 5 bolts securing the flywheel adapter to the flywheel (Fig. 2014).

9. Remove the flywheel adapter assembly from the flywheel (Fig. 2015).

10. Using a 1/2” socket and wrench, remove the 2 bolts and nuts securing the rubber coupler assembly to the fan drive pulley (Fig. 2016).
11. Remove the rubber couplers from the pulley (Fig. 2017).

13. Separate the 2 rubber couplers (Fig. 2019).

12. Remove the coupler spacer (Fig. 2018).

14. Remove the 2 spacers from each rubber coupler (Fig. 2020).
15. Remove the 2 set screws from the pulley hub (Fig. 2021).

16. Inspect the pulley assembly components (Fig. 2022):

- A. Bolt (2)
- B. Pulley
- C. Bolt (2)
- D. Coupler spacer (2)
- E. Rubber coupler (2)
- F. Spacer (4)
- G. Nuts (2)
- H. Bolt (5)
- I. Lock washer (5)
- J. Flywheel adapter
- K. Set Screw (2)

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**Fan Drive Pulley, Rubber Coupler & Flywheel Adapter Installation**

1. Loosely install 2 set screws in the fan drive pulley hub (Fig. 2023).

2. Insert 2 shoulder bolts into the fan drive pulley (Fig. 2024).
3. Slide the coupler spacer onto the 2 shoulder bolts (Fig. 2025).

4. Position the two rubber couplers together (Fig. 2026).

5. Insert 4 spacers into the rubber coupler assembly (opposite direction of each other, as shown) (Fig. 2027 and Fig. 2028).
6. Slide the rubber coupler assembly onto the 2 shoulder bolts so the non-flanged side of the spacers is installed first (Fig. 2029).

7. Install 2 nuts onto the shoulder bolts securing the rubber coupler assembly to the fan drive pulley and coupler spacer (Fig. 2030).

8. Using a 1/2” socket and wrench, torque the coupler shoulder bolts to 300 ± 30 in-lbs. (34 ± 3 Nm) (Fig. 2031).

9. With the lock washers installed, apply thread locking compound to the 5 flywheel mounting bolts (Fig. 2032).
10. Position the flywheel adapter to the flywheel (Fig. 2033).

11. Loosely install the 5 flywheel adapter mounting bolts (Fig. 2034).

12. Using a 13mm wrench, torque the 5 flywheel adapter mounting bolts to 17 - 21 ft-lbs. (23 - 28 Nm) securing the flywheel adapter to the flywheel (Fig. 2035).

13. Apply thread locking compound to the 2 pulley/coupler mounting bolts (Fig. 2036).
14. Insert the 2 shoulder bolts through the flanged coupler spacers (Fig. 2037).

15. Slide the coupler spacer onto the 2 shoulder bolts (Fig. 2038).

16. Position the pulley and coupler assembly to the flywheel adapter. Using a 1/2" socket, install the 2 shoulder bolts securing the pulley and couplers to the flywheel adapter (Fig. 2039).

17. Torque the 2 shoulder bolts to 300 ± 30 in-lbs. (34 ± 3 Nm) (Fig. 2040).
18. Route the fan belt around the driven fan pulley (Fig. 2041).

19. Apply thread locking compound to the 4 pump mount mounting bolts (Fig. 2042).

20. Position the pump mount/idler assembly to the engine block. Route the belt around the fan drive pulley. Loosely install the 4 bolts and lock washers securing the pump mount/idler assembly to the engine block (Fig. 2043).

   **Note:** The bottom 2 mounting bolts are located below the pump mount opening and bolt the bottom of the pump mount to the engine block. Using a 1/2” socket, tighten the 4 pump mount assembly mounting bolts.

Ignition Switch

Purpose

This component provides the proper switching for the starter, Ignition, accessories, and safety circuits.

Location

The ignition switch is mounted on the right hand side of the upper frame assembly (Fig. 2044).

How It Works

Detents inside the ignition switch give it 3 positions: OFF, RUN, and START. The START position is spring loaded so the cylinder automatically returns to RUN once the key is released.

Testing

1. Disconnect the switch from the wiring harness.

2. Verify that continuity exists between the terminals listed for the START and RUN switch positions. Verify that there is NO continuity between the terminals in the OFF switch position (Fig. 2045).

<table>
<thead>
<tr>
<th>Position</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>OFF</td>
<td>No continuity</td>
</tr>
<tr>
<td>RUN</td>
<td>B + I + A and X + Y</td>
</tr>
<tr>
<td>START</td>
<td>B + I + S</td>
</tr>
</tbody>
</table>

Fig. 2044  IMG-0149

Fig. 2045  IMG-0554a
Relay

Purpose

The 4-Paw Diesel Wheeled CUL uses two relays. One to direct current flow to the start relay and the other to direct flow to the glow plug relay.

Location

The relays are located inside of the lower frame assembly, to the right of the engine (Fig. 2046).

How It Works

A relay is an electrically actuated switch.

1. Coil: Terminals 85 and 86 are connected to a coil. Applying 12 volts to these terminals energizes the coil turning it into an electromagnet.

2. Switch: Terminals 30, 87 and 87a are actually part of a single pole, double throw (SPDT) switch. Terminal 30 is the common lead. The switch is spring loaded so that 30 and 87a are connected when the coil is not energized. When the coil is energized the switch is “thrown” and 30 and 87 are connected (Fig. 2047).

A. Inside – Glow Plug Relay
B. Outside – Start Relay
Testing

1. Disconnect the relay from the harness.

2. Verify the coil resistance between terminals 85 and 86 with a multimeter (ohms setting). Resistance should be from 70 to 90 ohms. There should be continuity between terminals 87a and 30 (Fig. 2048).

3. Connect the multimeter (ohms setting) leads to relay terminals 30 and 87. Ground terminal 86 and apply +12 VDC to terminal 85. The relay should make and break continuity between terminals 30 and 87 as 12 VDC is applied and removed from terminal 85 (Fig. 2048).

4. Connect the multimeter (ohms setting) leads to relay terminals 30 and 87a. Apply +12 VDC to terminals 85. With terminal 86 still grounded, the relay should break and make continuity between terminals 30 and 87a as 12 VDC is applied and removed from the terminal (Fig. 2048).

5. Disconnect voltage and multimeter leads from relay terminals.

Fig. 2048  xl relay
Fuses

Purpose

Fuses are used in the circuits to limit wiring damage in the event of excessive current flow. If a fuse fails, look for a short circuit, a corroded/poor connection, or any component that appears to have been overheated. A failed fuse is a sign of a problem in that circuit.

Testing

A failed fuse will often be discolored or melted. Please note that not all fuse failures are easy to see. A fuse can be checked with a continuity tester if there is doubt. If there is no continuity between the fuse terminals, replace the fuse, even if it appears good.

Location

The fuses are located on the right hand side of the lower frame assembly, above the relays, next to the engine (Fig. 2049):

A. 10 amp fuse (Shut-Down Solenoid & Glow Plug Circuit)
B. 25 amp fuse (Charge Circuit)
C. 30 amp fuse (Start Circuit)

How It Works

The fuse block is the point where the wires that carry 12 volts meet the wires that need 12 volts to operate a component or function. The fuse makes the connection between the 12 volt wire that needs the current.
Neutral Safety Switches

Purpose

The normally closed ball type switches are used on the 4-spool hydraulic valve. These are safety switches to make sure the control levers are in the neutral detent (Fig. 2050).

![Neutral Safety Switches](Fig. 2050_IMG-0547a)

How It Works

The switch has a spring loaded ball. When the 4-spool hydraulic valve control handles for forward and reverse are in the neutral position, the ball moves into a machined notch located in the spool. The normally closed switch then provides a ground to the start circuit. When the 4-spool valve control handles (forward and reverse levers) are moved out of neutral, the spool pushes against the ball end of the switch and opens the ground circuit which prevents the engine from starting.

Testing

1. Disconnect the switch from the wire harness. The ball end of the switch should remain installed in the 4-spool hydraulic valve.

2. With the VOM multimeter (ohms setting) leads connected to the two wire terminals, move the 4-spool hydraulic valve lever to either forward or reverse position; there should be NO continuity. In the neutral position, there SHOULD be continuity.

Location

The neutral switches are threaded into the lower portion of the 4-spool hydraulic valve, located under the upper frame assembly (Fig. 2051).

![Neutral Safety Switches](Fig. 2051_DSC-3165)
Auxiliary Neutral Switch

Purpose

The normally closed ball type switch is used on the auxiliary hydraulic valve. This is a safety switch to make sure the auxiliary hydraulic valve is in the neutral detent (Fig. 2052).

How It Works

The switch has a spring loaded ball. When the auxiliary hydraulic valve is in the neutral position, the ball moves into a machined notch located in the spool. The normally closed switch then provides a ground to the start circuit. When the auxiliary lever is moved out of neutral, the spool pushes against the ball end of the switch and opens the ground circuit which prevents the engine from starting.

Testing

1. Disconnect the switch from the wire harness. The ball end of the switch should remain installed in the auxiliary hydraulic valve.

2. With the VOM multimeter (ohms setting) leads connected to the two wire terminals, move the auxiliary hydraulic valve handle to either the reverse flow or forward flow position. There should be NO continuity. In the neutral position, there SHOULD be continuity.

Location

The neutral switch is threaded into the lower portion of the auxiliary hydraulic valve, located on the right side of the upper frame assembly (Fig. 2053).
Hour Meter

Purpose

The digital hour meter displays engine run time and is a service reminder. When the engine is off, the hour meter displays the number of operation hours that have been logged on the traction unit.

After 50 hours and then every 100 hours thereafter (that is 150, 250, 350, etc.) the screen displays CHG OIL to remind you to change the engine oil. After every 100 hours, the screen displays SVC to remind you to perform the other maintenance procedures based on a 100, 200 or 400 hour schedule. These reminders appear starting three hours prior to the service interval time and flash at regular intervals for six hours.

Location

The hour meter is mounted below the ignition switch on the upper frame assembly (Fig. 2054).

Testing

The digital hour meter should be replaced if any of the functions do not work properly. Prior to replacing the hour meter, verify that 12 volts DC is present across the two terminals when the engine is running and the ignition key is in the RUN position. If so, and the meter is not running, replace the meter. If 12 volts is not present, check the connections.

How It Works

The digital hour meter is an electronic clock. It is not repairable or resettable (Fig. 2055).
Indicator Lights

**Purpose**

To alert the operator in case of a system malfunction and, in the case of the glow plug light, indicate that the glow plugs are on.

**Location**

Located on top of the upper frame assembly, to the right side of the 4-spool hydraulic valve (Fig. 2056).

**Engine Oil Pressure Light**

The oil pressure light should come on when the ignition switch is in the RUN position with the engine not running. Also, it should light with the engine is running if the engine oil pressure drops below 4.3 PSI (0.3 kg/cm).

**Battery Light**

The battery light or charge indicator light should come on when the ignition switch is in the RUN position with the engine not running or when the operating charging circuit functions improperly while the engine is running.

**Engine Temperature Light**

If the engine coolant temperature rises to approximately 220° (104°C), the high temperature light should come on when the normally open temperature sender closes.

**Glow Plug Indicator Light**

The glow plug light should come on when the ignition switch is placed in the RUN position prior to placing the ignition switch in START. The light should stay lit for approximately 6 seconds while the ignition switch is left in the RUN position.

A. Oil pressure light
B. Battery light
C. Engine temperature light
D. Glow plug light
Testing Indicator Lights

1. Apply 12 VDC to terminals A and B (Fig. 2057).

2. Ground terminals C and D (Fig. 2057).

3. Both indicator lights should illuminate.
Glow Controller

Purpose

1. When the ignition switch is placed in the RUN position, the controller energizes the glow plugs and lights the glow plug indicator lamp for 6 seconds (Fig. 2058).

2. When the ignition switch is held in the START position, the glow plugs will energize while the switch is held and glow plug indicator light will not light.

3. When the ignition switch is released from the START to RUN, the glow plugs will de-energize and the glow plug indicator light will remain off.

Location

The glow controller is attached to the wire harness and is located under the 4-spool hydraulic valve above the engine (Fig. 2059).

Note: The 4-spool valve has been removed for photo clarity.

How It Works

The controller receives 12 volts from the key switch when turned to the Run/On position and also powers the glow plug light.

The controller provides power and ground to the glow plug relay that provides voltage to the glow plugs.

The controller module has a built-in timer that limits the time 12 volt power is provided to the glow plugs to pre-heat the combustion chambers.
Testing

1. Make sure there is power from the battery.

2. Disconnect the wire harness connector from the fuel stop solenoid to prevent the engine from starting.

3. Place ignition switch in the RUN position. Verify the following while in the RUN position:
   A. Glow plug indicator light is on.
   B. Glow plug relay is energized.
   C. Glow plugs are energized.
   D. Glow plug indicator light goes out and glow plugs de-energized after approximately 6 seconds.

4. Place ignition switch in the START position. Verify the following while in the START position.
   A. Glow plug indicator light is out.
   B. Glow plug relay is energized.
   C. Glow plugs are energized.
   D. Power exists at terminal 1 of the glow controller (Fig. 2060).

Note: If there is no power at terminal 1 of the glow controller, verify continuity of the circuitry from the ignition switch to the controller and perform Step 4 again.

5. If any of the conditions in Step 3 are not met or power to terminal 1 exists and any of the other conditions in Step 4 are not met:
   A. Verify continuity of the circuitry from the battery to the glow plug relay and glow plugs.
   B. Verify continuity of the circuitry from the battery to ignition switch, glow controller, glow plug indicator light, glow plug relay, and ground.
   C. Replace parts as necessary.

6. Plug the fuel stop solenoid connector back into the harness connector.
Fuel Shut Down Solenoid

Purpose

When the ignition switch is in the START position, the fuel shut down solenoid pulls the speed control plate on the injection pump to allow fuel to the engine. When the ignition switch is in the OFF position, the fuel shut down solenoid moves the speed control plate on the injection pump to stop fuel flow to the engine.

Location

The fuel shut down solenoid is located on the left side of the engine (Fig. 2061).

How It Works

The fuel shut down solenoid has a coil wrapped around and iron core. Whenever 12 volts is applied to the coil, it becomes a magnet. The magnet pulls the linkage rod in. This moves the speed control plate on the injection pump (Fig. 2062).

The fuel shut off solenoid must be continuously energized to keep the engine running.

The fuel shut off solenoid has two circuits. The first is the Pull Coil, energized when the ignition switch is in the START position. Since the power to this coil is lost when the ignition switch is released to RUN, there is a second circuit called the Hold Coil. The Hold Coil will be energized as long as the ignition switch is in the RUN position.
Testing

The solenoid has 3 wires:
- **White wire** is energized when the key is turned to the START position and energizes the Pull Coil to draw in the plunger and return spring, in turn moving the speed control plate. The white wire is spliced to the blue fusible link wire that is connected to the push-on terminal on the starter.
- **Red (or Pink) wire** energizes the Hold Coil after the engine starts and the key is released to RUN position. It is connected to the ignition switch I terminal.
- **Black wire** is connected to ground.

When the key is turned to the OFF position all voltage to the solenoid is lost; the return spring in the solenoid moves the speed control plate to cut off fuel flow and shut down the engine.

Troubleshooting

1. Check that the speed control plate and related linkage is free to move.

2. If the engine cranks, check that the fuel shut down solenoid is moving the speed control plate to admit fuel to the injector pump. If not, check for 12VDC at the white wire when the ignition switch is in the START position.

3. Check for 12VDC at the red (or pink) wire with the ignition switch in the START or RUN position.

4. If the engine starts but quits as soon as the key is released, there is a problem with the Hold Coil circuit.

5. If the electrical supply to the shut down solenoid checks OK:

   **Symptom:** Engine will crank, but not start, or starts and then quits. The Pull or Hold coil may be weak, or there is a mechanical problem inside the solenoid.

   Open the engine cover and push on the solenoid linkage to open fuel flow to the injector pump. If the engine starts and runs while holding the linkage, the shut down solenoid is faulty.
Fig. 2064  3354-735 22303-2006
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Chain Drive / 4-Paw Gas / 4-Paw Diesel