

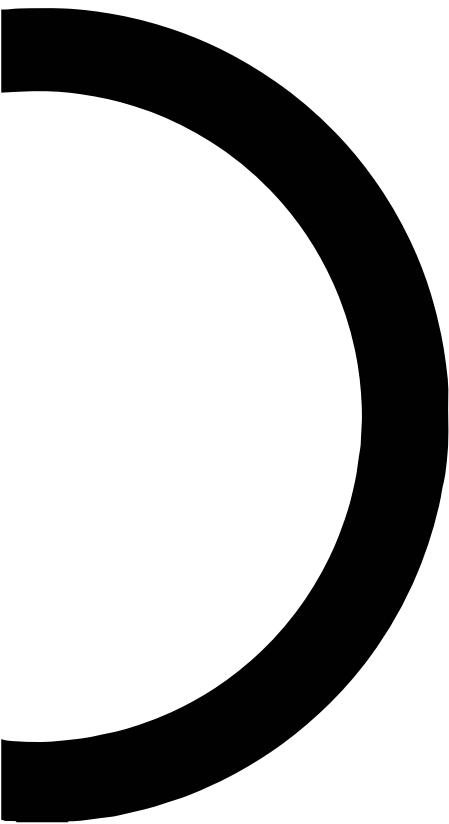
**Gehl R135 and GEN:2
Gehl R150 and GEN:2
Gehl R165**

**Mustang 1350R and NXT2
Mustang 1500R and NXT2
Mustang 1650R**

**Skid-Steer Loader
Service Manual**

50940256 Rev. B 03/20

Original Instructions



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Introduction

Safety Symbol and Signal Words

Manitou Americas, in cooperation with the Society of Automotive Engineers, has adopted this:



Safety Alert Symbol

This symbol identifies potential safety hazards, which, if not properly avoided, could result in injury. When you see this symbol in this manual or on the machine, you are reminded to **BE ALERT!** Your personal safety is involved!

Signal Words



DANGER

The word “**DANGER**” indicates an imminently hazardous situation, that, if not avoided, will result in serious injury or death.



WARNING

The word “**WARNING**” indicates a potentially hazardous situation that, if not avoided, could result in serious injury or death.



CAUTION

The word “**CAUTION**” indicates a potentially hazardous situation that, if not avoided, may result in minor or moderate injury.

IMPORTANT: *The word “IMPORTANT” indicates situations that can result in possible damage to the machine.*

NOTE: *The word “NOTE” indicates special or particularly useful information.*

Contents and Use of this Manual

This manual provides information about the safe and proper operation, maintenance and service procedures for the machine. Major points of safe operation, maintenance and service are detailed in the *Safety* chapter of this manual.

This manual also includes general troubleshooting and specification information about the machine.

Follow the instructions in the Safety, Operation and Maintenance chapters concerning accident prevention regulations, safety and occupational regulations, and machine and traffic regulations. Manitou Americas is not liable for damage resulting from the failure to follow these regulations.



CAUTION

Improper operation, inspection, maintenance and service of the machine can cause injury or death. Become familiar with the machine before operating it.

It is the owner’s or employer’s responsibility to fully instruct each operator in the proper and safe operation and maintenance of the machine.

A storage location is provided inside the operator’s compartment for storing the Operator’s Manual. After using the manual, return it to the storage container. Replace the operator’s manual promptly if it becomes damaged, lost or stolen.

Some illustrations in this manual may show doors, guards and shields open or removed for illustrative purposes only. **BE SURE** all doors, guards and

Safety

- Never use ether starting aids. Engine pre-heating is used for cold weather starting. Engine preheating can cause ether or other starting fluid to detonate, causing injury or damage.
 - Always perform a daily inspection of the machine before using it. Walk around the machine and look for damage, loose or missing parts, leaks, etc. Repair as required before using the machine.
 - Wear safety goggles and head protection while operating the machine. The operator must wear protective clothing when appropriate.
 - Adjust the seat to allow full actuation of the controls. Never adjust the seat during machine operation. After adjustments, make sure the seat is securely locked in place before using the machine.
 - Before working on or with the machine, remove jewelry and tie back long hair. Do not wear loose-fitting garments, such as, scarves, ties, unzipped jackets, etc., which could become caught in the moving parts of the machine and cause injury.
 - If a lighting system is installed, check its operation before working in darkness.
 - Always keep windows, lights and mirrors clean. Poor visibility can cause accidents.
 - Warn all nearby personnel before starting the machine.
 - Below-ground hazards also include water mains, tunnels and buried foundations. Know what is underneath the worksite before starting to dig. Contact the North American One-Call Referral System at 8-1-1 in the U.S., or 1-888-258-0808 in the U.S and Canada, for the local “Digger's Hotline” number or the proper local authorities for utility line locations. Accidental contact/rupture with/of any electrically charged conductor or gas line can result in electrocution or an explosion.
 - Machine stability is affected by:
 - The load being carried.
 - Height of the load.
 - Machine speed.
 - Abrupt control movements.
 - Driving over uneven terrain.
- DISREGARDING ANY OF THESE FACTORS CAN CAUSE THE MACHINE TO TIP, WHICH COULD THROW THE OPERATOR OUT OF THE SEAT OR MACHINE, AND COULD RESULT IN DEATH OR SERIOUS INJURY. Because of this, ALWAYS operate the machine with the seat belt fastened and the restraint bar lowered. Do not exceed the machine's Rated Operating Capacity. See “Payloads/Capacities” on page 347. Carry the load low. Move the controls smoothly and gradually, and operate at speeds appropriate for the conditions.
- Exhaust fumes can kill. Do not operate the machine in an enclosed area unless there is adequate ventilation. Internal combustion engines deplete the oxygen supply within enclosed spaces and may create a serious hazard. Operators should also be aware of any open windows, doors or duct work into which exhaust gases may be carried, exposing others to danger.
 - When parking the machine and before leaving the seat, check the restraint bar for proper operation. The restraint bar, when raised, deactivates the lift/tilt controls, auxiliary hydraulics, and applies the parking brake.

Safety Equipment

WARNING

Become familiar with all safety devices on the machine before starting. Know how to stop the machine before starting it. The machine is designed and intended to be used only with Manitou Americas-approved attachments or accessories. Manitou Americas cannot be responsible for operator safety if the machine is used with unapproved attachments.

Guards and Shields

Guards and shields are provided on the machine, wherever possible without effecting machine operation, to protect against potential hazards. In many places, safety decals are also provided to warn of potential hazards and/or to display special operating procedures.

WARNING

Read and thoroughly understand all safety decals before operating the machine. Do not operate the machine unless all factory-installed guards and shields are properly installed and secured in place.

Operator's Position

Operator's Seat

WARNING

Never adjust the seat during machine operation. Adjust the seat only when the machine is stopped and the restraint bar is in the raised position. After adjustments, make sure the seat is securely locked in place before using the machine.

Horizontal adjustment: The seat is mounted on rails to allow forward and back horizontal position adjustment.








Use lever (A, Fig. 2) to move the seat forward or back as desired. Release handle (A) when the seat is in the desired position. Make sure the seat is locked in position after adjusting.



Fig. 2 – Operator's Seat Horizontal Adjustment

Indicators and Controls

Table 2: Control Keypad Indicators

Indicator	Description	Details
	Battery Voltage Warning Indicator	Indicates battery charging system malfunction. During normal operation this indicator should be OFF.
	Engine Air Filter Restriction Indicator	Indicates engine air filter requires service. See “Engine Maintenance” on page 103. During normal operation this indicator should be OFF.
	Hydraulic Oil Filter Warning Indicator	Indicates hydraulic oil filter requires service. See “Changing Hydraulic Oil Filter” on page 115. During normal operation this indicator should be OFF.
	Hydraulic Oil Temperature Warning Indicator	Indicates hydraulic temperature is too high. During normal operation this indicator should be OFF.
	Engine Malfunction Indicator	Is lit when the engine electronic control unit (ECU) has detected an error condition. Refer to “Engine Diagnostic Trouble Codes (DTC)” on page 317.
	Coolant Temperature Warning Indicator	Indicates coolant temperature is too high. During normal operation this indicator should be OFF.
	Engine Oil Pressure Warning Indicator	Indicates engine oil pressure is too low. During normal operation this indicator should be OFF. IMPORTANT! Immediately shut down the engine if this indicator is lit. Correct the problem before restarting the engine.

Indicators and Controls

Table 7: Status, Maintenance and Error Code Screens

Display Mode	Description																																
<div style="border: 1px solid black; padding: 5px;"> <p>DIAGNOSTICS OUTPUTS</p> <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%;">High Gear</td> <td style="width: 10%; text-align: center;">○</td> <td style="width: 40%;">Float</td> <td style="width: 10%; text-align: center;">○</td> </tr> <tr> <td>Self Level</td> <td style="text-align: center;">○</td> <td>Marker Lts</td> <td style="text-align: center;">○</td> </tr> <tr> <td>Hydro Glide</td> <td style="text-align: center;">○</td> <td>Rear Work Lts</td> <td style="text-align: center;">○</td> </tr> <tr> <td>Fuel Pump</td> <td style="text-align: center;">○</td> <td>Front Work Lts</td> <td style="text-align: center;">○</td> </tr> <tr> <td>Glow Plug</td> <td style="text-align: center;">○</td> <td>KP Beacon Lts</td> <td style="text-align: center;">○</td> </tr> <tr> <td>Starter</td> <td style="text-align: center;">○</td> <td>KP Dome Lt</td> <td style="text-align: center;">○</td> </tr> <tr> <td>All Tach Lock</td> <td style="text-align: center;">○</td> <td>Disable Park Brake</td> <td style="text-align: center;">○</td> </tr> <tr> <td>All Tach Unlock</td> <td style="text-align: center;">○</td> <td>Tilt/Lift</td> <td style="text-align: center;">○</td> </tr> </table> </div>	High Gear	○	Float	○	Self Level	○	Marker Lts	○	Hydro Glide	○	Rear Work Lts	○	Fuel Pump	○	Front Work Lts	○	Glow Plug	○	KP Beacon Lts	○	Starter	○	KP Dome Lt	○	All Tach Lock	○	Disable Park Brake	○	All Tach Unlock	○	Tilt/Lift	○	<p style="text-align: center;">Output Status</p> <p>Displays output information from electronic control modules, showing real-time feedback state of machine components. Status colors indicate the following:</p> <ul style="list-style-type: none"> • Green – Active • Black – Inactive • Yellow – Standby or Not Applicable • Red – Short Circuit
High Gear	○	Float	○																														
Self Level	○	Marker Lts	○																														
Hydro Glide	○	Rear Work Lts	○																														
Fuel Pump	○	Front Work Lts	○																														
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Starter	○	KP Dome Lt	○																														
All Tach Lock	○	Disable Park Brake	○																														
All Tach Unlock	○	Tilt/Lift	○																														

Controls

Ignition Keyswitch



Fig. 25 – Ignition Keyswitch

The Ignition keyswitch is located near the top of the right door pillar. Ignition keyswitch positions are:

- **OFF Position** : With the key turned fully counterclockwise, power from the electrical system is disconnected from the controls and instruments. This is the only position from which the key can be inserted or removed.
- **ON/RUN Position** : With the key turned one position clockwise from the OFF position, electrical power is supplied to all controls and instruments.

- **START Position** : With the key turned and held fully clockwise, the electric starter engages. Release the key to ON/RUN position when the engine starts.

Throttle Controls

Engine speed is controlled with throttle knob (Q, Fig. 26) or throttle lever (T, Fig. 27) and optional foot throttle (P, Fig. 28).

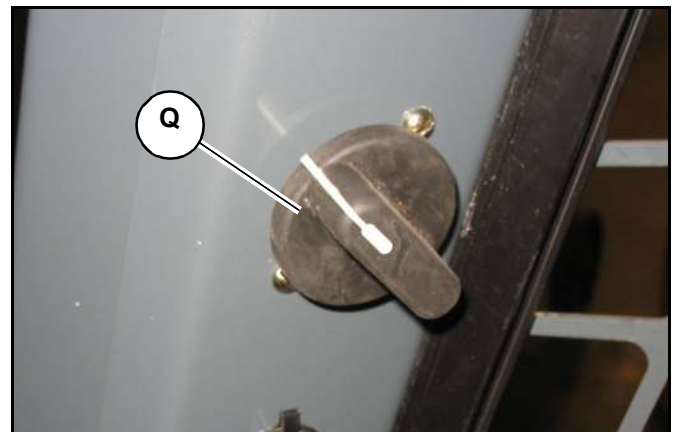


Fig. 26 – Throttle Knob

Throttle knob (Q, Fig. 26) or throttle lever (T, Fig. 27) is the primary throttle control. The throttle is set to the desired idle/run position.

Indicators and Controls

Two-Speed Drive (Option)

Machines equipped with the two-speed drive options have two travel speed ranges:

- Low-speed range: 0 - 12,6 km/h (7.8 mph).
- High-speed range: 0 - 19,3 km/h (12.0 mph).

NOTE: *Speed varies slightly with tire size.*



WARNING

Reduce speed before shifting from two-speed to single-speed drive. Down-shifting from high speed to low speed drive while traveling at high speed may cause the machine to tip and can cause injury, loss of control and damage to the machine.

Press button (C, Fig. 38) to switch between high and low two-speed drive ranges. When the high-speed two-speed drive range is activated, the high-speed indicator (H) on the control pad is lit.

Left T-Bar



Left Joystick



Left Hand Control



Fig. 38 – Two-Speed Drive Control Button

Operation

Before Starting the Engine



Before starting the engine and operating the machine:

- Review and comply with all safety recommendations in the Safety chapter of this manual.
- Know how to stop the machine before starting it.
- Fasten and properly adjust the seat belt(s) and lower the operator restraint bar.

Before starting the engine and running the machine, refer to “Safety Equipment” starting on page 29 and “Indicators and Controls” starting on page 37. Become familiar with the safe operation of the machine and the various operating controls, indicators and safety devices on the machine.

Operational Checks

Pre-Start Checks

Complete the following checks before starting the engine and using the machine. Correct/repair any problems before using the machine.

Table 11: Pre-Start Checks

Check	Refer To:
Fuel tank filled?	“Adding Fuel” on page 106.
Engine oil level correct?	“Checking Engine Oil Level” on page 104.
Hydraulic system oil level correct?	“Checking Hydraulic Oil Level” on page 114.
Engine coolant level correct?	“Checking Coolant Level” on page 112.
Windshield washer reservoir filled?	“Windshield Washer Reservoir” on page 123.

Table 11: Pre-Start Checks

Check	Refer To:
Grease fittings properly lubricated?	“General Lubrication” on page 100.
V-belt condition good/tension adjustment correct?	“V-Belt Maintenance” on page 111.
Tires properly inflated/tire condition good?	“Tires” on page 119.
Lights, signals, indicators, warning lights, indicators and horn operating properly?	“Control Keypad” on page 38. “Controls” on page 49.
Windows, lights and steps clean?	
Attachment securely fastened to hitch?	“Connecting Attachments” on page 80.
Overall machine condition (including attachments) for bends, cracks, broken, loose or missing parts, etc.	
Engine cover securely closed and latched?	
Rags, tools, debris and other loose objects removed? (check especially after maintenance)	
Approved warning triangle, hazard warning light and first aid kit in the machine?	
Perform safety interlock system test	“Safety Interlock System Test” on page 32
Seat position correctly adjusted?	“Operator’s Seat” on page 29.
Seat belt fastened?	“Seat Belt” on page 30.

Operation

Lift Arm Float



Make sure the bucket is lowered to the ground before activating the lift arm float. Activating float with an attachment raised will cause the lift arm to fall to the ground, which can cause severe injury or death.

Do not drive the machine forward with the lift arm float activated. Damage to the machine and/or loss of control can result.

Float allows the lowered lift arm to follow the ground contour while traveling over changing ground conditions. It is useful when grading surfaces while driving the machine in reverse.

NOTE: *Lift arm float is not effective if the lift arm is lowered against the chassis frame.*

See “Lift Arm Float” on page 60 for details about the lift arm float control.

Hydraglide™ Ride Control System

Hydraglide™ cushions lift arm loads during transport. It provides a smoother ride over uneven surfaces.



When ride control is activated, the lift arm may drop slightly without a load, or several inches with a heavy load.



Do not use Hydraglide™ when using pallet forks.

IMPORTANT: *Do not use Hydraglide™ when digging. Precise control of the digging operation is difficult with the Hydraglide™ option activated.*

NOTE: *Hydraglide™ is not effective if the lift arm is lowered against the chassis frame.*

See “Hydraglide™ Ride Control System” on page 61 for details about Hydraglide™ control.

Maintenance

Fuel Tank Drain

WARNING

NEVER service the fuel system while smoking, while near an open flame, or if the engine is hot

Follow all fuel system precautions listed at the beginning of the “Fuel System Maintenance” section, starting on page 105, and in the “Safety” section, starting on page 17.

The fuel tank drain plug (P, Fig. 95) is accessed from underneath the machine at the left rear corner.

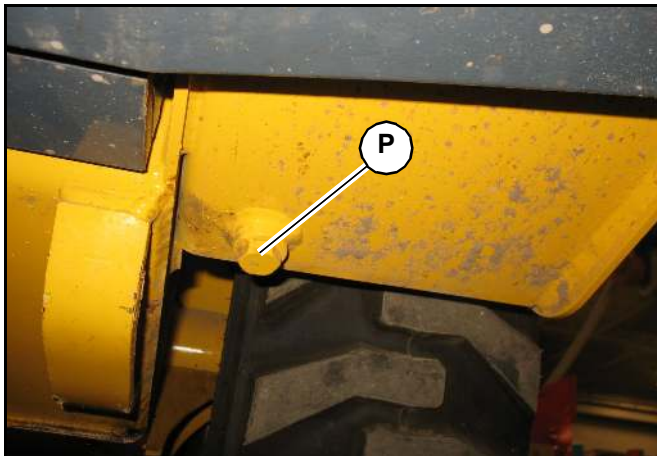


Fig. 95 – Fuel Tank Drain

NOTE: Fuel tank capacity is 62.5 L (16.5 gal.).

Maintenance

Seat and Restraint Bar Switches

Electrical switches in the seat and restraint bar must be closed (operator sitting in the seat and restraint bar lowered) and the auxiliary hydraulics must be in neutral to complete the circuit and start the engine.

Bucket Cutting Edge

The bucket cutting edge should be replaced when it is worn to within 25 mm (1 in.) of the bucket body.

Wheel Nuts

Wheel nut torque must be checked before initial operation and every two hours thereafter until the wheel mounting hardware torque stabilizes at the following recommended settings:

- **Models R135/1350R:** 161-175 Nm (120-130 lb.-ft.)
- **Models R150/R165/1500R/1650R:** 244 Nm (180 lb.-ft.)

When tires are removed and replaced, this procedure must be repeated.

Tires

Rear tires usually wear faster than the front ones. To keep tire wear even, rotate the tires from front to rear and rear to front.

It is important to keep the same size tire on both sides of the machine to prevent excessive wear on tires or other damage. If different sizes are used, each tire will be turning at different speeds, causing excessive wear.

The tread bar of all tires must face the same direction.

Mounting Tires



WARNING

Servicing tires can be dangerous. When possible, trained personnel should service and mount tires. To avoid possible death or serious injury, follow the safety precautions below.

IMPORTANT: *The tread bars of all tires should point the same direction.*

- Be sure the rim is clean and free of rust.
- Lubricate the tire beads and rim flanges with a soap solution. Do not use oil or grease.
- Use a clip-on tire chuck with remote hose and gauge, allowing you to stand clear while inflating the tire. Do not place your fingers on the tire bead or rim during inflation.
- Never inflate beyond 240 kPa (35 psi) to seat the beads. If the beads have not seated by the time the pressure reaches 240 kPa (35 psi), deflate the assembly, reposition the tire on the rim, lubricate both parts and re-inflate. Inflation pressure beyond 240 kPa (35 psi) with unseated beads may break the bead or rim with explosive force sufficient to cause death or serious injury.
- After seating the beads, adjust the inflation pressure to the recommended operating pressure.
- Do not weld, braze or otherwise attempt to repair and use a damaged rim.

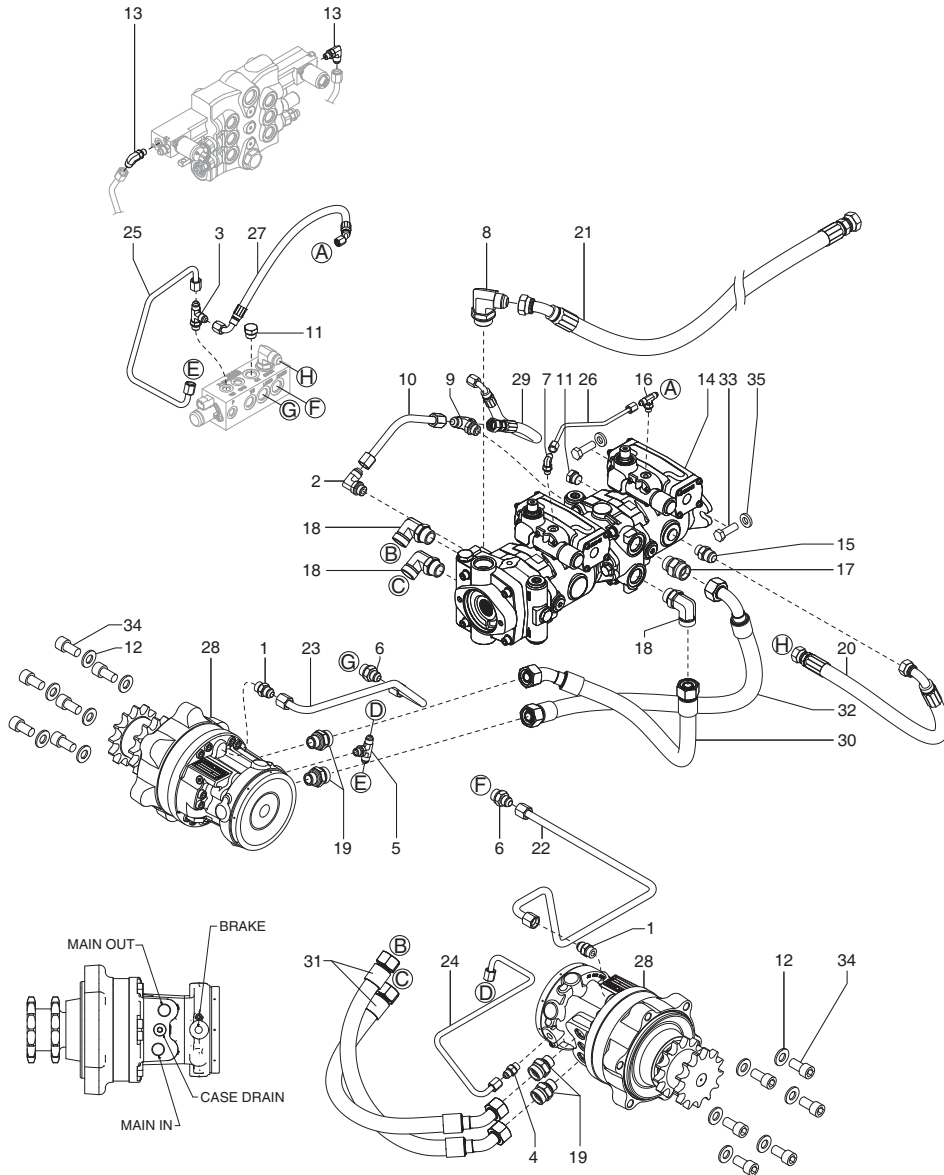
Checking Tire Pressure

Table 18: Tire Inflation Pressures

Tire Size	Inflation Pressure	
	psi	kPa
10.00 x 16.5 10-Ply Severe Duty	65	450
10.00 x 16.5 8-Ply Flotation	60	414
12.00 x 16.5 10-Ply Flotation	65	450
27 x 10.50 x 15 8-Ply	65	450

Hydrostatic System

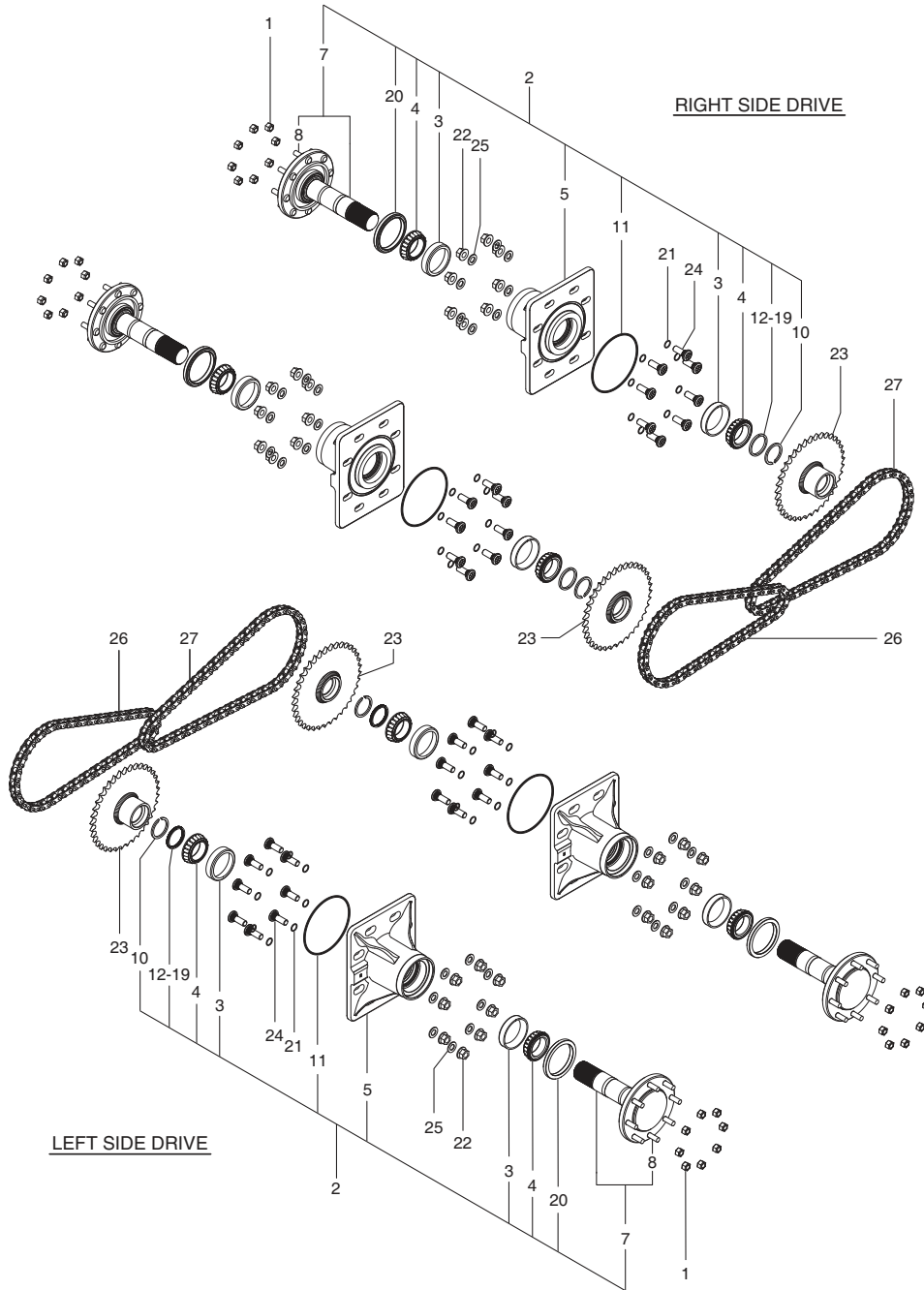
Hydrostatic Components - T-Bar/Hand-Foot Controls - Single-Speed R165/1650R



1	Straight Fitting
2	90° Fitting
3	Tee Fitting
4	Straight Fitting
5	Tee Fitting
6	Straight Fitting
7	90° Fitting
8	90° Fitting
9	Tee Fitting
10	Charge Tube
11	Plug
12	Washer
13	90° Fitting
14	Tandem Pump
15	Straight Fitting
16	Tee Fitting
17	Straight Fitting
18	90° Fitting
19	Straight Fitting
20	Hose
21	Hose
22	Tube
23	Tube
24	Tube
25	Tube
26	Tube
27	Hose
28	Drive Motor
29	Hose
30	Hose
31	Hose
32	Hose
33	Screw
34	Screw
35	Washer

Drive System

Wheel Drive Components - R150/1500R



1	Wheel Nut
2	Axle Assy
3	Bearing Cup
4	Bearing Cone
5	Axle Housing
7	Axle w/Studs
8	Wheel Screw
10	Snap Ring
11	O-Ring
12	Washer
13	Washer
14	Washer
15	Washer
16	Washer
17	Washer
18	Washer
19	Washer
20	Axle Seal
21	O-Ring
22	Flange Nut
23	Sprocket
24	Axle Bolt
25	Washer
26	Roller Chain
27	Roller Chain

Drive System

Drive Chain Removal and Installation

Drive Chain Removal

WARNING

BEFORE beginning this service procedure, shut down the machine according to “Mandatory Safety Shutdown Procedure” on page 18.

Raise and securely block the machine so all four tires are off the ground according to “Lifting the Machine” on page 102.

1. Remove the wheels and tires on the side of the machine to be serviced.
2. Drain the oil from the chaincase according to “Changing Chaincase Oil” on page 118.
3. Remove the nuts securing the chaincase cover (between wheels) and remove the cover.
4. For each drive chain: Loosen the locknuts on axle assembly attached to the chain. Slide the axle assembly in its slots to loosen chain tension.
5. Attach appropriate lifting device of adequate capacity and a positive locking mechanism able to support the axle. Remove the eight locknuts and washers attaching the axle housing to the chassis. Pull axle housing away from the chassis, allowing the axle housing sprocket to drop inside the chaincase.
6. Slip the drive chain off the axle housing sprocket; slip the drive chain off the drive motor sprocket.
7. Remove the drive chain from the chaincase.

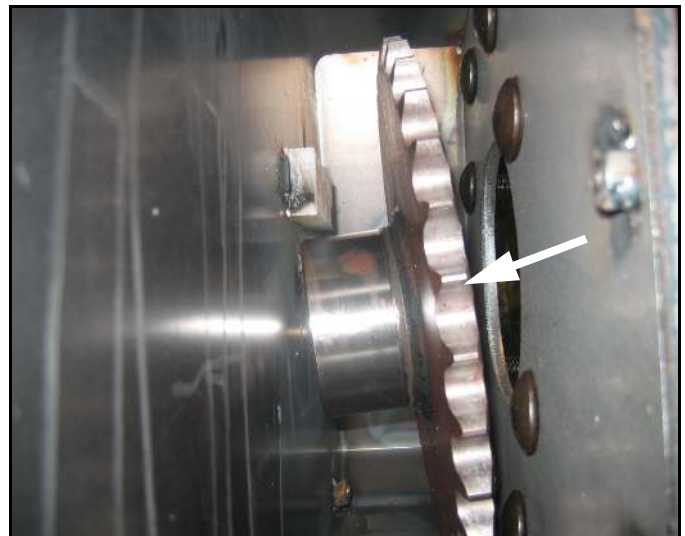


Fig. 143 – Axle Housing Sprocket

Drive Chain Removal - Connecting Link Accessible

1. Drain the oil from the chaincase according to “Changing Chaincase Oil” on page 118.
2. Remove the nuts securing the chaincase cover (between tires), and remove the cover.
3. Rotate the tires to access the connecting link in the drive chain.
4. Remove two cotter pins securing the connecting link to the drive chain and disconnect the link.



Fig. 144 – Connecting Link Cotter Pins

5. Slip the drive chain off the axle housing sprocket; slip the drive chain off the drive motor sprocket.
6. Remove the drive chain from the chaincase.

Controls

- c. When adjustment is complete, hold adjustment stud (V) in place and tighten locknut).
10. Remove pressure gauges from the ports and replace plugs. Tighten plugs securely.
11. Repeat steps 7 through 10 for ports (H and J, Fig. 148). Adjust pressures using adjustment stud (W, Fig. 148).
12. When adjustment is complete:
 - a. Stop the engine.
 - b. Remove plugs and connect high-pressure hoses (Z, Fig. 148). Tighten securely.

NOTE: Ensure hoses (Z) are connected to the same ports they were removed from.

- c. Disconnect hoses (A and B, Fig. 148) from each other. Remove plugs and connect hoses (A and B, Fig. 148) to the top of the pump. Tighten securely.

NOTE: Ensure hoses (A and B) are connected to the same ports they were removed from.

13. Start the machine and check for leaks. Tighten/repair as necessary.

Control Handle Position Adjustment



BEFORE beginning this service procedure:

- If necessary, remove the attachment from lift arm.

- Raise and block the machine so the tires are off the ground according to “Lifting the Machine” on page 102 and raise the lift arm and engage the lift arm support device according to “Engage Lift Arm Support” on page 35.

- Tilt back ROPS/FOPS until lock engages.

1. Left Control Handle Grip: Adjust the lengths of rods (E, Fig. 149) connected to the pivot assembly, so that bracket (F) on the control lever is oriented 90° to the chassis.

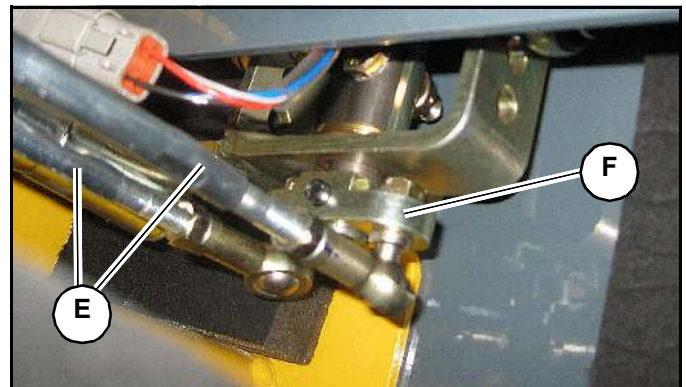


Fig. 149 – Left T-Bar Control Pivot

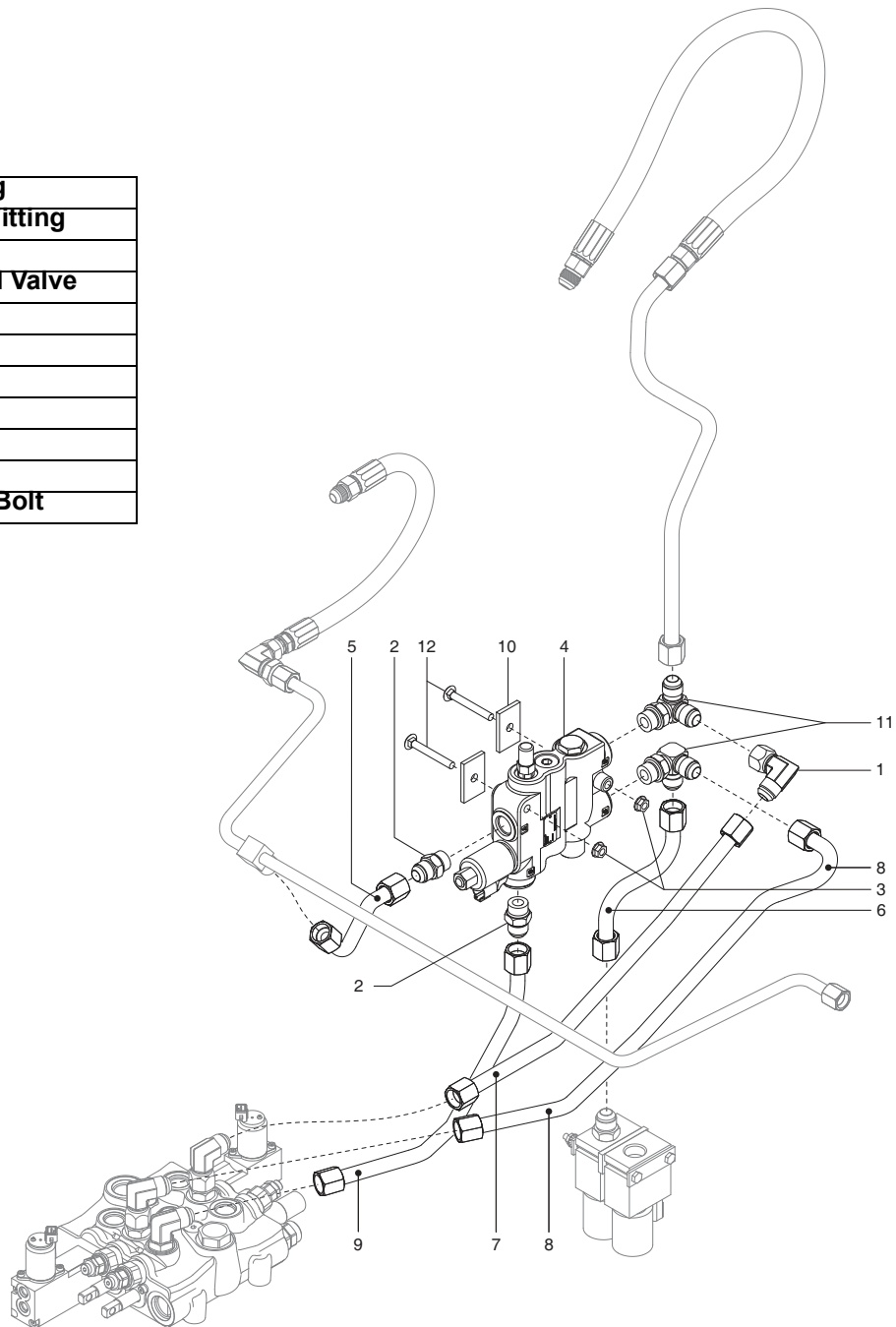
2. Left Control Handle Vertical Orientation: Adjust control rods (E, Fig. 149) at pivot assembly (F) so the left T-bar control lever is tilted 8° forward from vertical.
3. Right Control Handle Grip: Adjust the length of attachment tilt control rod (J, Fig. 150) until the rod end pin that passes through control lever (G) is oriented 90° to the chassis.

IMPORTANT: After adjustment, twist the right T-bar control grip fully in both directions and check for full activation of the control valve in both directions.

Hydraulic System

Self-Leveling Hydraulics - R135/1350R

1	90° Fitting
2	Straight Fitting
3	Locknut
4	Self-Level Valve
5	Tube
6	Tube
7	Tube
8	Tube
9	Tube
10	Spacer
11	Carriage Bolt



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Hydraulic System

2. Remove cap (B, Fig. 155) on relief valve adjuster screw (C).

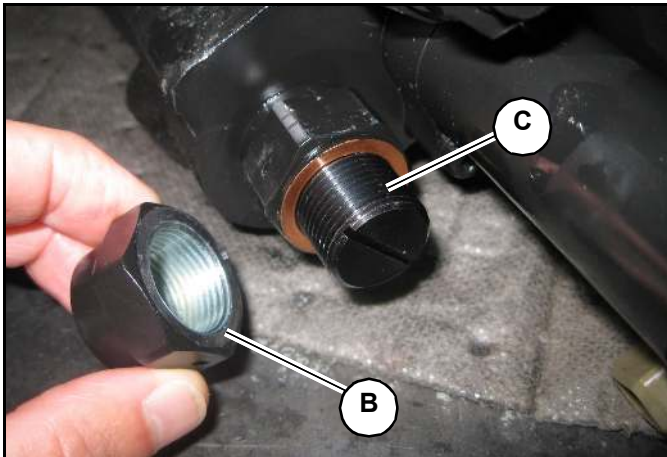


Fig. 155 – Pressure Relief Adjuster

3. Using a flat-blade screwdriver, turn the adjuster screw IN to increase pressure or OUT to reduce pressure.
4. Lower the ROPS/FOPS according to “Lowering the ROPS/FOPS” on page 102. Restart the engine and perform a pressure test according to “Pressure Test” on page 177.
5. After the pressure is within the correct range, replace the cap over the adjuster screw.
6. If, after adjustment, there is no change in the pressure reading, this indicates either a defective auxiliary pump or relief valve cartridge (on the control valve). To determine which is the cause, first replace the relief valve cartridge. If the pressure reading still does not change, the auxiliary (gear) pump should be repaired or replaced.

Tilt Cylinder Test

Tilt Cylinder Drift Test

1. Connect a bucket or attachment to the attachment hitch.
2. Sit in the operator's seat, lower the restraint bar and turn the ignition key to the ON position.

If the bucket (or attachment) drifts down with the tilt control in the NEUTRAL position, Check the tilt cylinders for external leakage. If external leakage is evident, replace the leaking cylinder(s) seals. If no external leakage is evident, check the tilt cylinders for internal leakage according to “Tilt Cylinder Internal Leakage Test” on page 179.

NOTE: *Maximum allowable tilt cylinder circuit drifting with a loaded bucket is 0.4" (10 mm) of cylinder extension within 15 minutes.*

Tilt Cylinder Internal Leakage Test

IMPORTANT: *This procedure requires two people.*



WARNING

BEFORE beginning this service procedure, perform the following **SAFETY** procedures:

- If necessary, remove the attachment from the lift arm.
- Tilt the attachment hitch in towards the machine until the tilt cylinders bottom out.
- Shut off the engine.
- Relieve hydraulic system pressure.

Refer to “Mandatory Safety Shutdown Procedure” on page 18.

IMPORTANT: *To prevent contamination, ALWAYS clean the area around hydraulic fittings before disconnecting hydraulic hoses or tubes.*

Hydraulic System

4. Use a chain clamp (B, Fig. 172) to remove the collar from the cylinder tube.

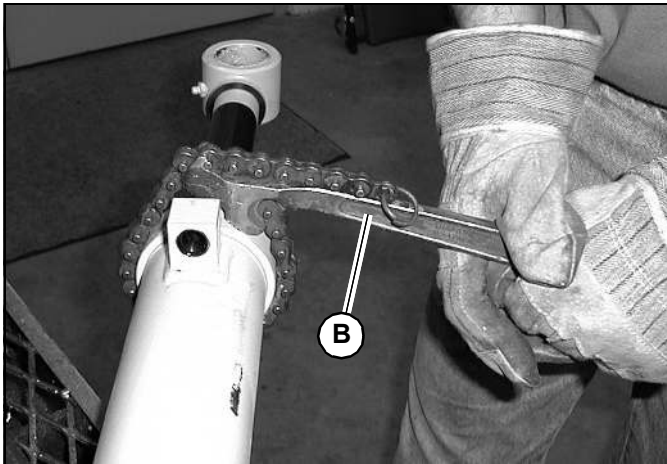


Fig. 172 – Collar Removal

5. Remove the rod assembly (C, Fig. 173) and inspect both the cylinder rod and the tube for dents or nicks that may cause damage to the O-rings and seals.

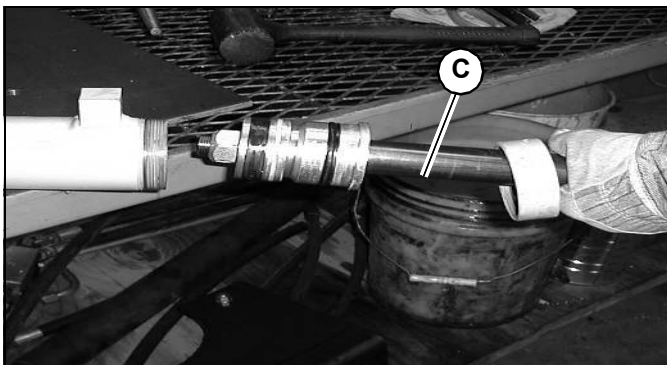


Fig. 173 – Cylinder Rod Assembly Removal

6. Loosen and remove locknut (D, Fig. 174) securing the head gland, seal kit and piston on the cylinder rod.

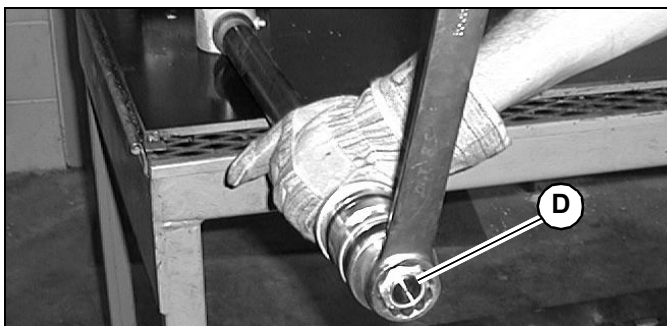


Fig. 174 – Cylinder Rod Locknut Removal

7. Remove piston assembly (E, Fig. 175) from the cylinder rod.

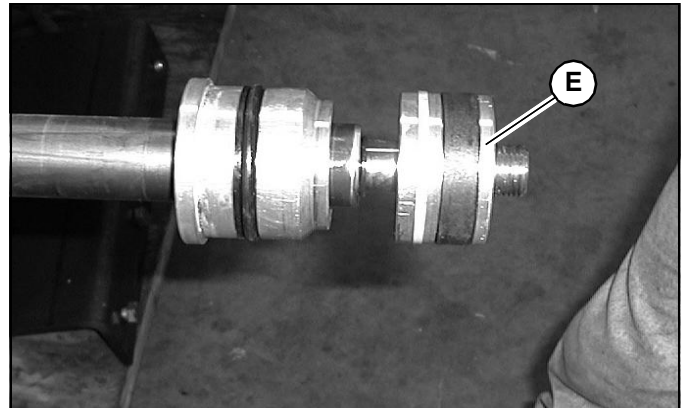


Fig. 175 – Piston/Head Gland Removal

8. Slide the head gland, seals, and o-rings off the cylinder rod and inspect them for wear.

9. Change the seals as needed.

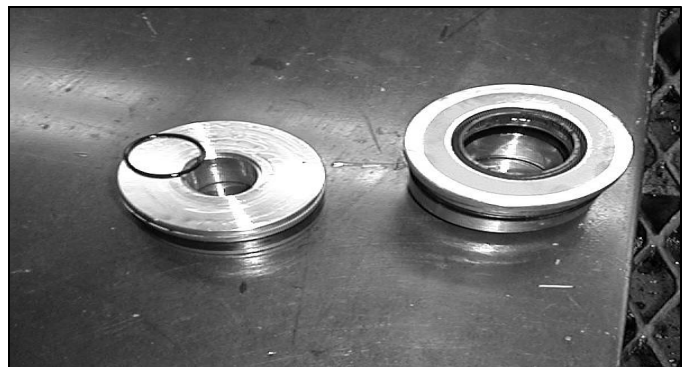


Fig. 176 – Cylinder Seals/O-Rings

Electrical System

WARNING

Inspect and check the machine's electrical equipment at regular intervals. Defects, such as loose connections or scorched cables must be repaired before using the machine.

Only use correct, original equipment fuses with the specified current rating. Immediately turn the machine off if there are any problems with the electrical system.

Work on the electrical system must be performed only by a trained technician.

Power Distribution

Electrical circuitry is protected from overloading and short circuits by a combination of fuses and relays contained in the power distribution modules located inside the engine compartment on the right. Fuses protect electrical circuits and relays provide switched power to the circuits.



Fig. 183 – Power Distribution Modules

Fuses/Relays/Diodes

Decals on the power distribution modules identify fuses and relays contained within the module. Refer to “Fuses, Relays and Diodes” on page 120 for fuse, relay and diode location, circuit, rating and function information.

Power Distribution Module Fuse Test

WARNING

BEFORE beginning this service procedure, shut down the machine according to “Mandatory Safety Shutdown Procedure” on page 18.

Using a volt/ohm multimeter or a test lamp, measure between test points and the chassis ground for 12V, with the wiring connected and power applied to the selected circuit. 12V should be present on both sides of the fuses.

Main Power Relay

The main power relay is located in the engine compartment outside of the power distribution modules.

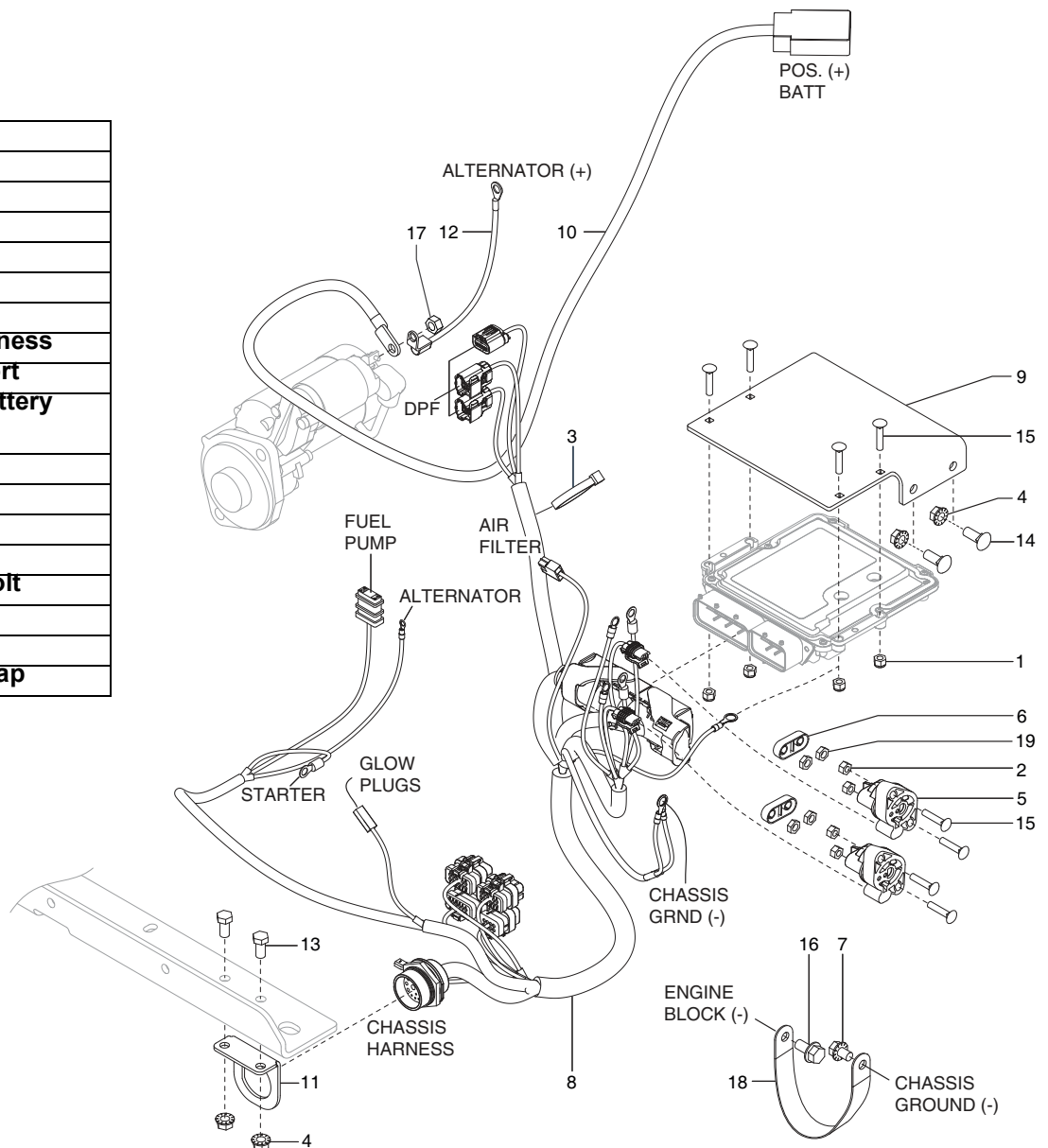


Fig. 184 – Main Power Relay

Electrical System

Engine Electrical - R135/1350R

1	Locknut
2	Locknut
3	Cable tie
4	Locknut
5	Solenoid
6	Cover
7	Screw
8	Engine Harness
9	ECU Support
10	Positive Battery Cable
11	Bracket
12	Cable
13	Screw
14	Screw
15	Carriage Bolt
16	Screw
17	Nut
18	Ground Strap



Electrical System

Table 24: Controller Area Network (CAN) Functional Detail

Function	Inputs/Conditions	Outputs/Actions	Malfunction Indicators
Stop Engine	<ul style="list-style-type: none"> Ignition switch in OFF position. 	Stops fuel flow.	<ul style="list-style-type: none"> Ignition switch malfunction. Electrical fault (switch, components, connections or battery). Solenoid or other component malfunction.
Throttle Speed Adjust	<ul style="list-style-type: none"> Engine is running (engine oil pressure detected). Throttle speed analog input value is between 0.425-3.35 VDC. 	<p>Throttle speed CAN message is sent to the engine ECU. Throttle speed is set to the highest of the two values between the hand and foot throttles.</p> <p>NOTE: If the throttle speed analog input value is out-of-range, a CAN error code is generated.</p>	<ul style="list-style-type: none"> Throttle control malfunction. Electrical fault (switch / components / connections). Component malfunction. CAN communication error.
Release Park Brake	<ul style="list-style-type: none"> Engine is running (engine oil pressure detected). Seat switch CLOSED (seat occupied). Restraint bar switch CLOSED (restraint bar down). Parking brake button on the control keypad is pushed. 	<p>Parking brake output (release brake) is turned on and the parking brake indicator light is turned off. Repeated pressing of parking brake button toggles the parking brake, and parking brake indicator light, on/off.</p> <p>If the engine is running and the seat switch and/or the restraint bar switch is opened for more than 0.5 seconds, the parking brake is set and the parking brake indicator light turns on.</p>	<ul style="list-style-type: none"> Electrical fault (switch / components / connections). Component / safety interlock system malfunction.

Electrical System

Table 24: Controller Area Network (CAN) Functional Detail

Function	Inputs/Conditions	Outputs/Actions	Malfunction Indicators
Activate Front Wiper (optional door installed)	<ul style="list-style-type: none"> Ignition switch in ON / RUN or START position. Windshield wiper button pressed. 	<p>Activates/deactivates windshield wiper:</p> <ul style="list-style-type: none"> One press turns on the windshield wiper continuously and turns on all three indicator LEDs. A second press activates a three second delay; turns on only two indicator LEDs. A third press activates a six second delay; turns on only one indicator LED. A fourth press turns off the windshield wiper and turns off the LEDs. 	<ul style="list-style-type: none"> Electrical/mechanical fault (components, connections or battery).
Activate Front Washer (optional door installed)	<ul style="list-style-type: none"> Ignition switch in ON / RUN or START position. Windshield washer button pressed continuously. 	<p>Activates the front windshield washer and wiper continuously while windshield washer button is pressed.</p> <p>When button is released, washer stops immediately and wiper stops after five seconds.</p>	<ul style="list-style-type: none"> Electrical/mechanical fault (components, connections or battery).
Activate Rear Wiper (optional rear wiper installed)	<ul style="list-style-type: none"> Ignition switch in ON / RUN or START position. Rear window wiper button pressed continuously. 	<p>Activates/deactivates rear wiper:</p> <ul style="list-style-type: none"> One press turns on the rear wiper continuously and turns on all three indicator LEDs. A second press activates a three second delay; turns on only two indicator LEDs. A third press activates a six second delay; turns on only one indicator LED. A fourth press turns off the rear wiper and turns off the LEDs. 	<ul style="list-style-type: none"> Electrical/mechanical fault (components, connections or battery).
Activate Rear Washer	<ul style="list-style-type: none"> Ignition switch in ON / RUN or START position. Rear window washer button pressed continuously. 	<p>Activates the rear windshield washer and wiper continuously while rear window washer button is pressed.</p> <p>When button is released, washer stops immediately and wiper stops after five seconds.</p>	<ul style="list-style-type: none"> Electrical/mechanical fault (components, connections or battery).

Lift Arms and ROPS/FOPS

R150/1500R, R165/1650R Lift Cylinder Installation

WARNING

Be sure the lock is securely engaged when the ROPS/FOPS is raised. Properly support the ROPS/FOPS when unlatching the lock mechanism and lowering the ROPS/FOPS.

1. Raise the ROPS/FOPS according to “Raising the ROPS/FOPS” on page 101.

NOTE: Perform steps 2 through 8 on both lift cylinders.

2. Using an appropriate lifting device, position lift cylinder rod end (A, Fig. 210) to lift arm (B) and install pivot pin (C).

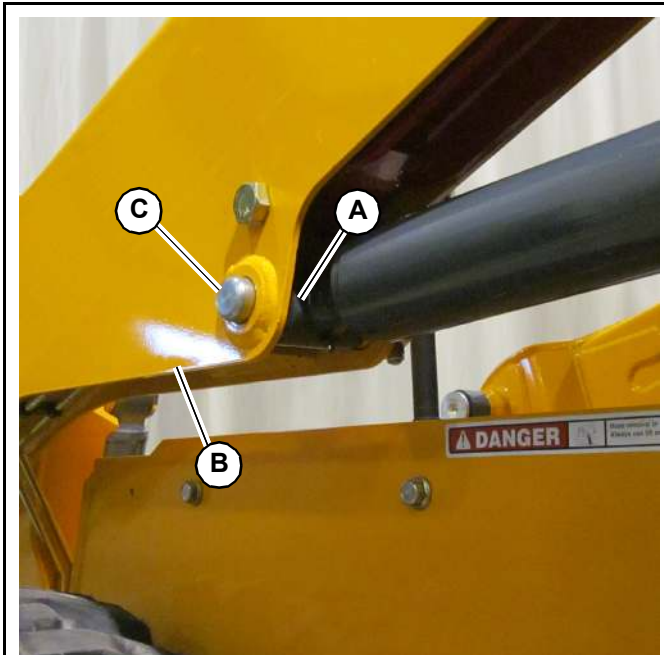


Fig. 210 – Rod End Pivot Pin

3. Install cap screw (D, Fig. 211) and locknut (E).

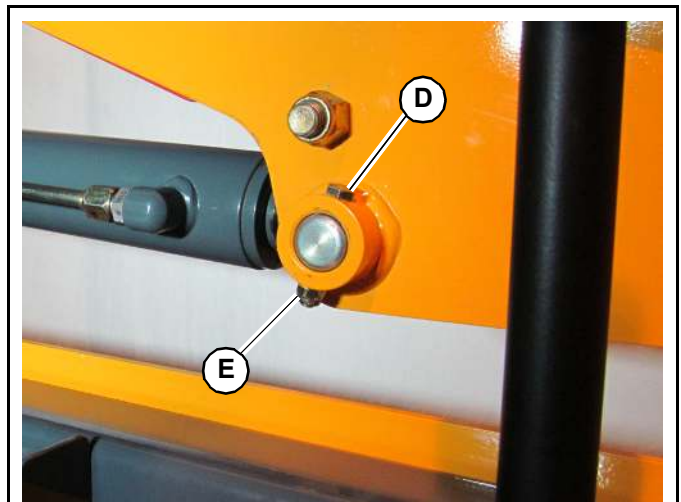


Fig. 211 – Rod End Pivot Pin, Cap Screw, and Locknut

4. Position lift cylinder (F, Fig. 212) to chassis pivot pin opening and install base end pivot pin (G).

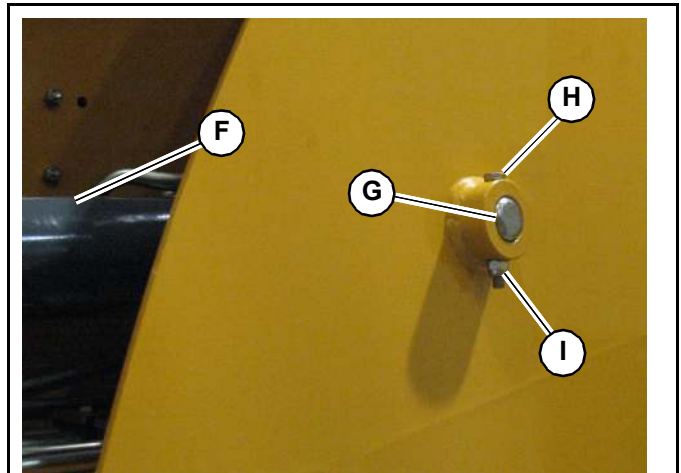


Fig. 212 – Base End Pivot Pin

5. Install cap screw (H) and locknut (I).
6. Lower the ROPS/FOPS according to “Lowering the ROPS/FOPS” on page 102.

Lift Arms and ROPS/FOPS

R150/1500R, R165/1650R ROPS/ FOPS Removal/Installation

R150/1500R, R165/1650R ROPS/FOPS Removal

1. Remove attachments. See “Disconnecting Attachments” on page 82.
2. Engage the lift arm support and raise the lift arm according to “Engage Lift Arm Support” on page 35.
3. Shut down the machine according to “Mandatory Safety Shutdown Procedure” on page 18.
4. Open the engine compartment according to “Engine Access” on page 103.
5. Disconnect the ground strap from the negative (-) battery terminal. Secure the ground strap safely away from the battery.

IMPORTANT: *Dispose of waste coolant according to environmental laws. DO NOT pour coolant onto the ground or down a drain.*

NOTE: *The capacity of the cooling system is approximately 14.4 L (3.8 gal.) for models R165/1650R and 9.5 L (2.5 gal.) for models R150/1500R.*

6. Drain the cooling system according to “Draining/Flushing Cooling System” on page 112.

NOTE: *Coolant leakage will occur. Collect coolant and dispose of properly.*

7. Loosen hose clamps and disconnect heater hoses (A and B, Fig. 242) from the heater control valve (C). Cap and plug hoses and valve openings to prevent contamination entering cooling system.

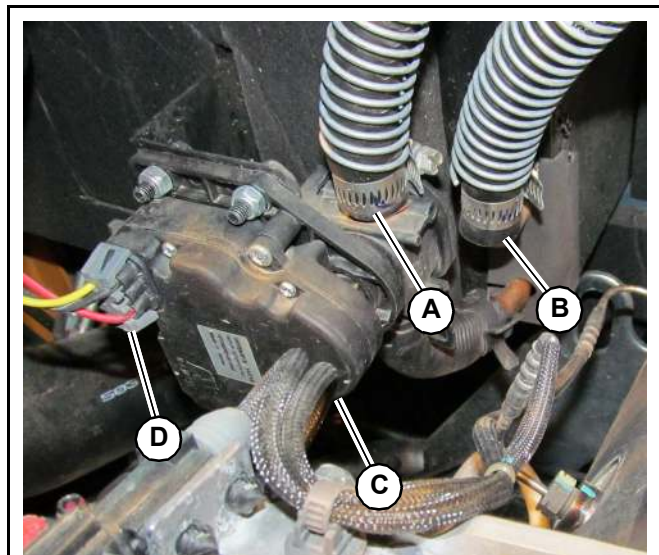


Fig. 242 – Heater Control Valve

8. Disconnect wiring connector (D) from heater control valve (C).
9. Close the engine compartment according to “Engine Access” on page 103.



WARNING

Be sure the lock is securely engaged when the ROPS/FOPS is raised. Properly support the ROPS/FOPS when unlatching the lock mechanism and lowering the ROPS/FOPS.

10. Raise the ROPS/FOPS according to “Raising the ROPS/FOPS” on page 101.

NOTE: *Label all wires and wiring connectors. Reference their locations before disconnecting to ensure correct installation.*

Lift Arms and ROPS/FOPS

NOTE: Repeat the next step for both ROPS/FOPS support strut.

17. Remove cap screw (R, Fig. 269) and flat washer (S). Lower support strut to fender.

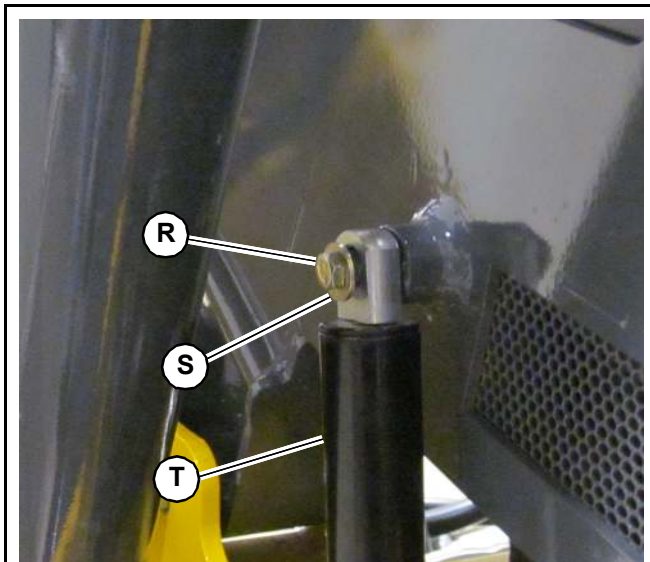


Fig. 269 – ROPS/FOPS Support Strut—Top



WARNING

Use the lifting device to lower the ROPS/FOPS with the support struts removed. With the support struts removed, the ROPS/FOPS is very heavy and must be handled using an appropriate lifting device and not by hand.

18. Lower the ROPS/FOPS using the lifting device according to “Lowering the ROPS/FOPS” on page 102.

NOTE: Leave the lifting device attached to the ROPS/FOPS for use during step 23.

19. Remove three cap screws (U, Fig. 270) and access panel (V) from the bottom of the machine.

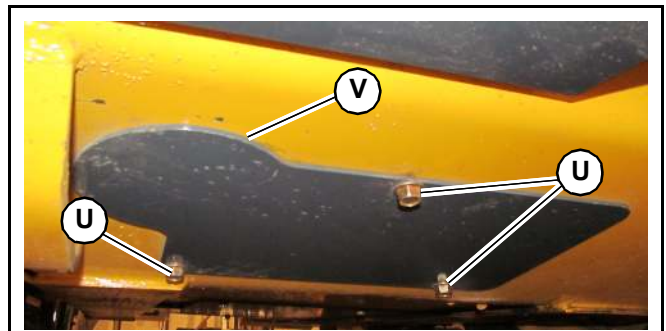


Fig. 270 – Bottom Access Panel

20. Disconnect wiring connector (W, Fig. 271) from washer pump (X).

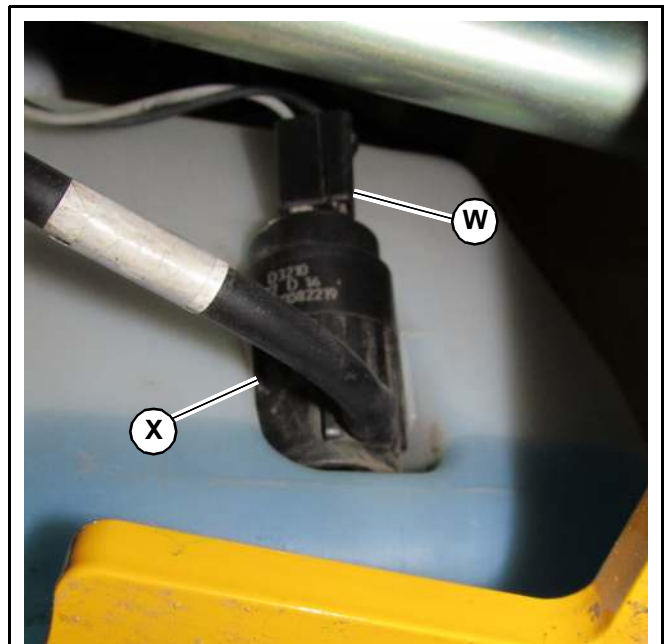


Fig. 271 – Washer Pump Wiring Connector

Models R165/1650R Tier 4 Engine Removal/Installation

21. Remove two locknuts (S, Fig. 299), two clamps with fuel hoses (T), and two carriage bolts (R) from the top of the fan shroud and two shroud brackets.

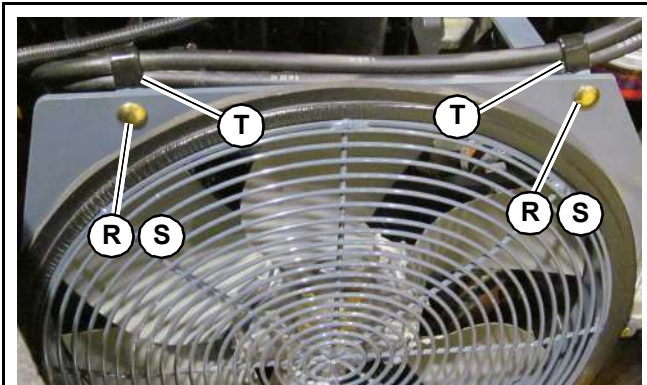


Fig. 299 – Disconnect Fan Shroud and Fuel Lines

22. Remove two locknuts (U, Fig. 300), two cap screws (V), and fuel cooler (W) from the fan shroud (X). Remove fuel cooler and fuel hoses from the machine.

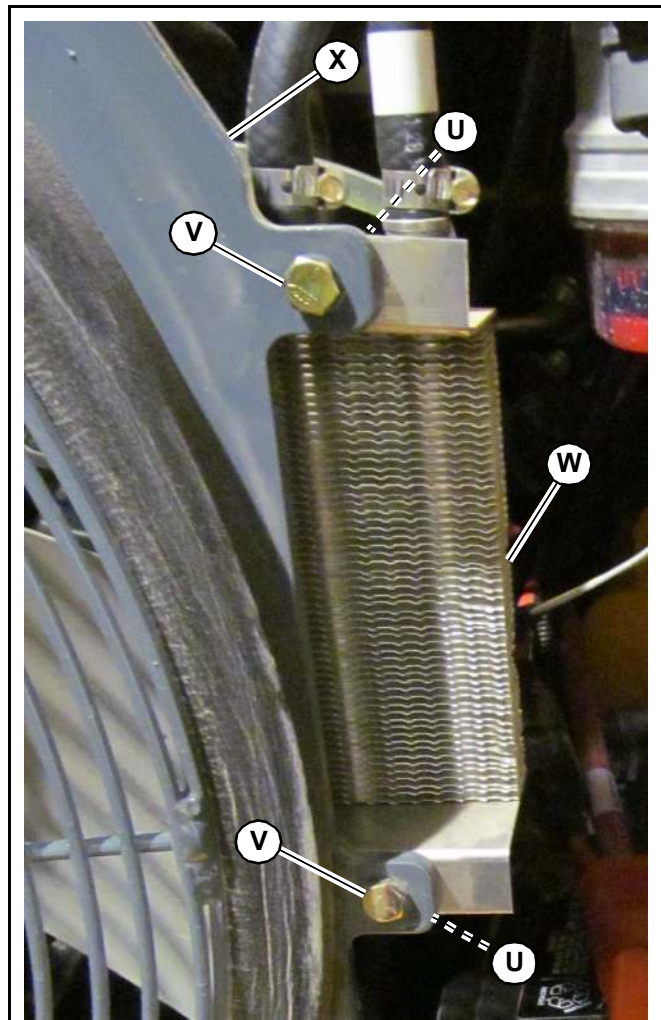


Fig. 300 – Remove Fuel Cooler

23. Remove two locknuts (Y, Fig. 301), two carriage bolts (Z), and fan shroud (A) from the rear engine mounts.

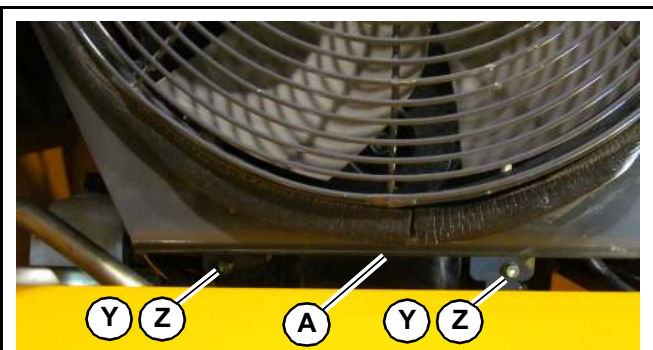


Fig. 301 – Disconnect Lower Fan Shroud

Models R165/1650R Tier 4 Engine Removal/Installation

17. Install air cleaner bracket (G, Fig. 331) and secure using three locknuts (H).

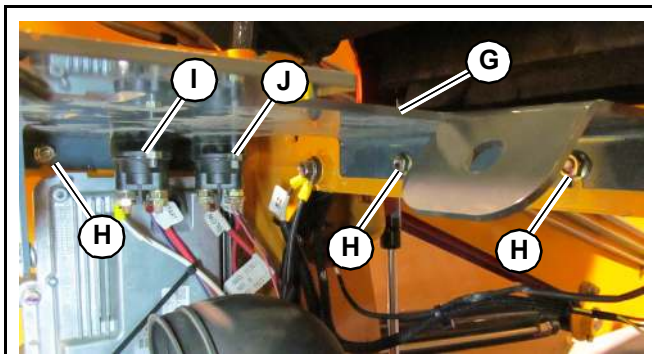


Fig. 331 – Connect Wiring to Solenoids

18. Connect wiring to solenoids (I and J) located on the bottom of air cleaner bracket (G).
19. Install washer bottle filler neck (K, Fig. 332) to air cleaner plate (L) and secure using two locknuts (M) and two carriage bolts (N).

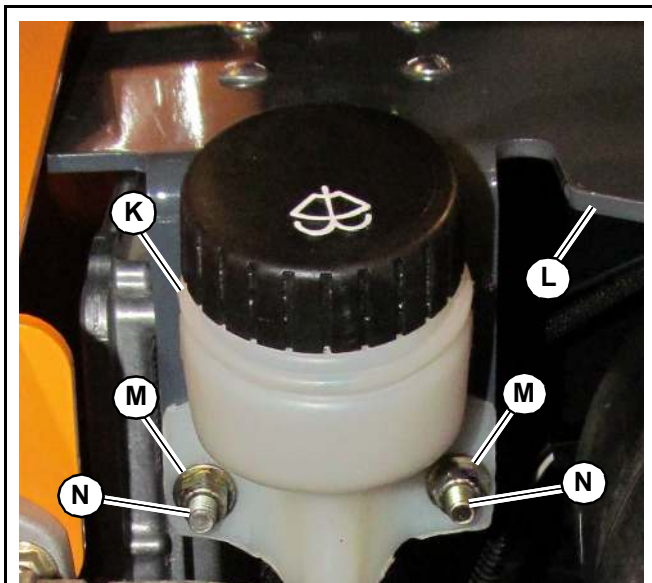


Fig. 332 – Install Washer Bottle Fill Neck

20. Secure air cleaner assembly (O, Fig. 333) to the air cleaner bracket using two locknuts (P) and two cap screws (Q).

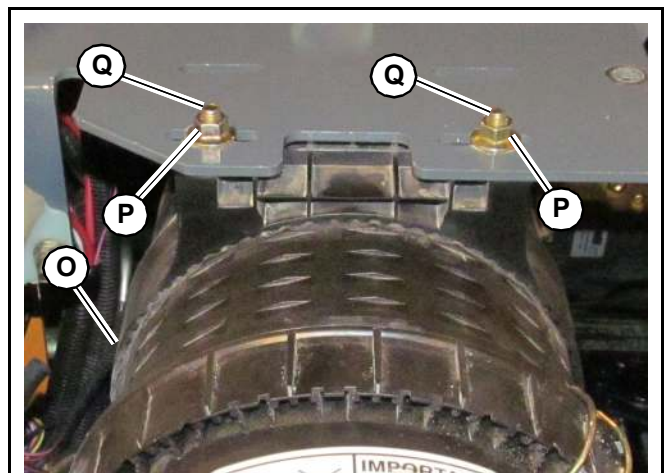


Fig. 333 – Install Air Cleaner Assembly

21. Secure air cleaner (S, Fig. 334) to intake tube (T) with hose clamp (R). Tighten securely.

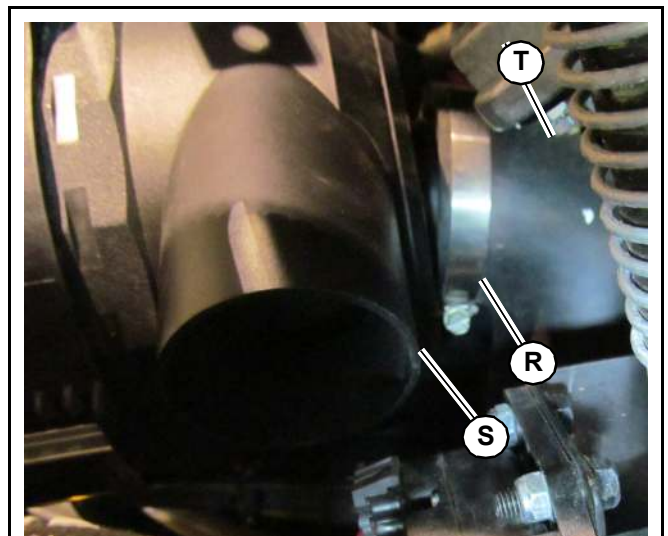


Fig. 334 – Connect Air Cleaner Hose Clamp

22. Install fan shroud (W, Fig. 335) to rear engine mounts using two locknuts (U) and two carriage bolts (V). Tighten securely.

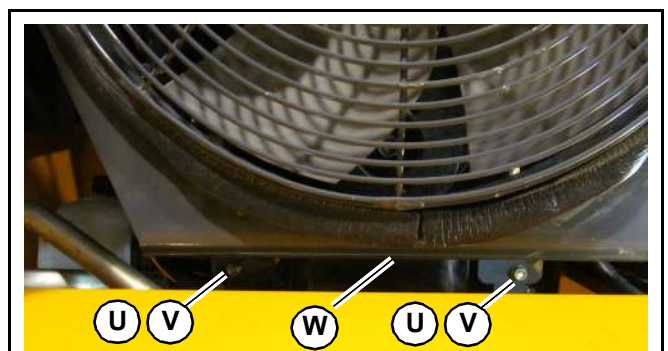


Fig. 335 – Connect Lower Fan Shroud

Models R135/1350R/R150/1500R Tier 4 Engine Removal/Installation

27. Disconnect wiring connectors (T and U, Fig. 365) from ECU (X).

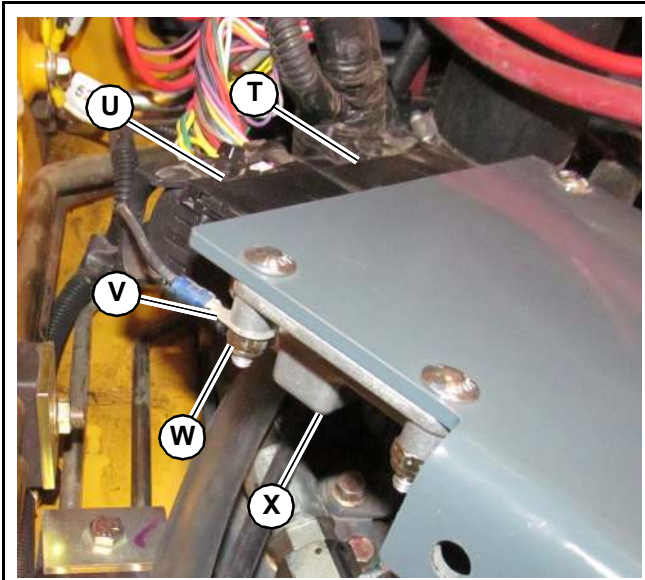


Fig. 365 – Disconnect ECU Wiring Connectors

28. Remove locknut (W) and disconnect wiring connector (V) from ECU (X).

NOTE: To prevent hydraulic oil contamination, cap/plug all openings.

29. Remove nut and washer (Y, Fig. 366). Disconnect wiring connector (Z).

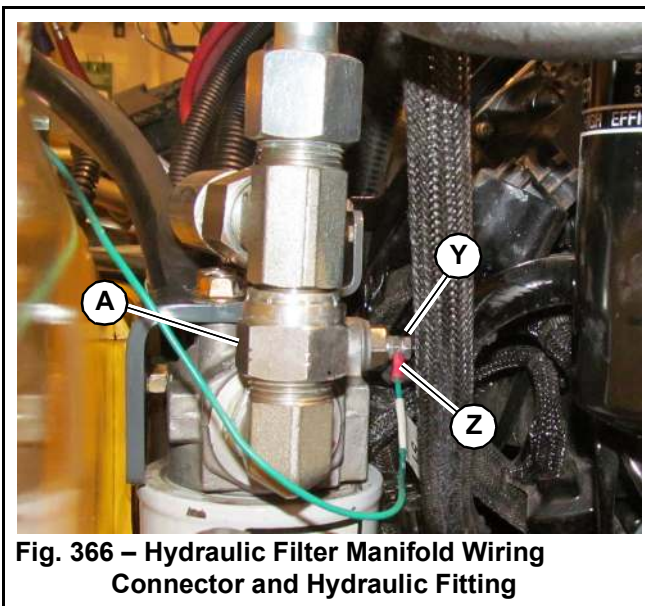


Fig. 366 – Hydraulic Filter Manifold Wiring Connector and Hydraulic Fitting

30. Disconnect hydraulic fitting (A) from the hydraulic filter manifold.

31. Disconnect fitting (B, Fig. 367) and two hose clamps (C) from the hydraulic filter manifold.

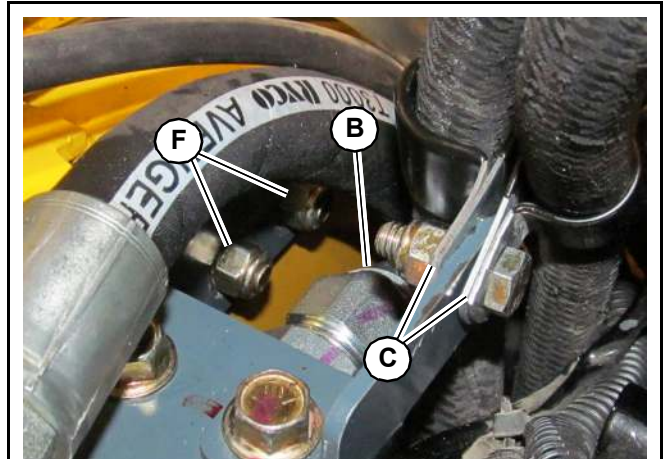


Fig. 367 – Disconnect Hydraulic Line and Hose Bracket from Hydraulic Filter Manifold

32. Remove two locknuts and two carriage bolts (F). Remove the hydraulic filter manifold.

33. Label and disconnect wiring connectors from solenoids (G and H, Fig. 368).

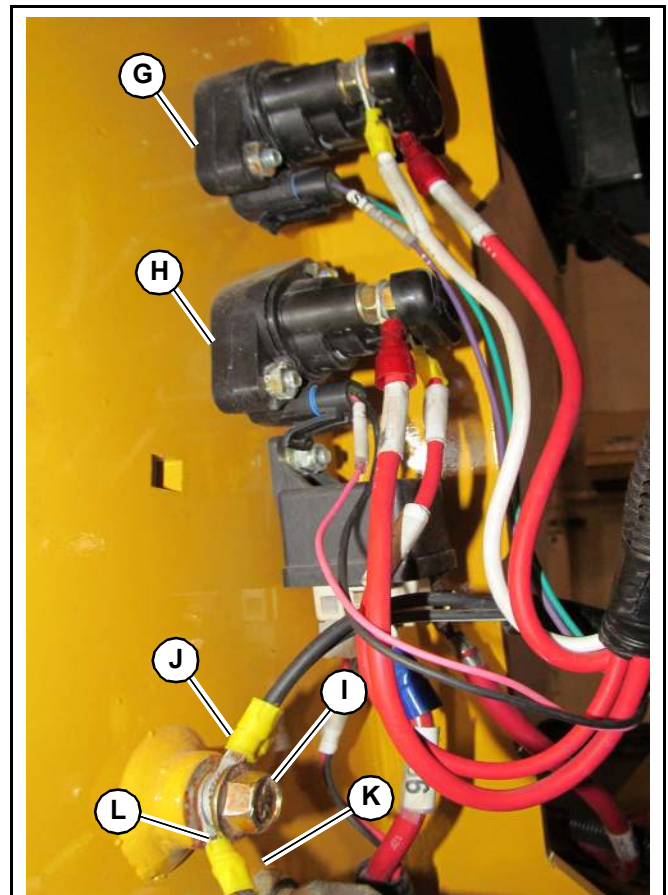
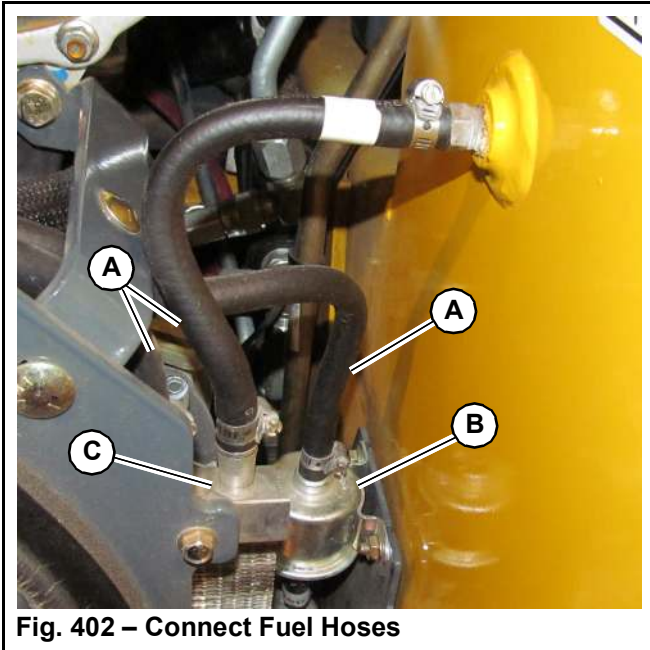


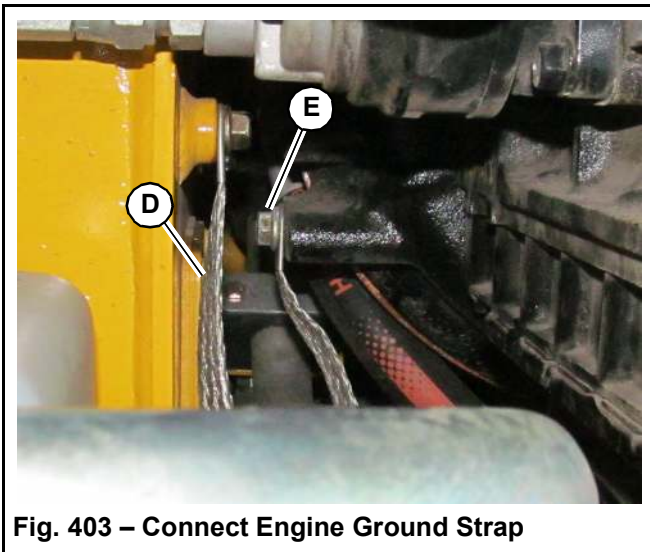
Fig. 368 – Solenoid Wiring Connectors and Ground Wires

Models R135/1350R/R150/1500R Tier 4 Engine Removal/Installation

23. Connect fuel lines (A, Fig. 402) to fuel filter pump (B) and fuel cooler (C) and secure using hose clamps. Tighten hose clamps securely.

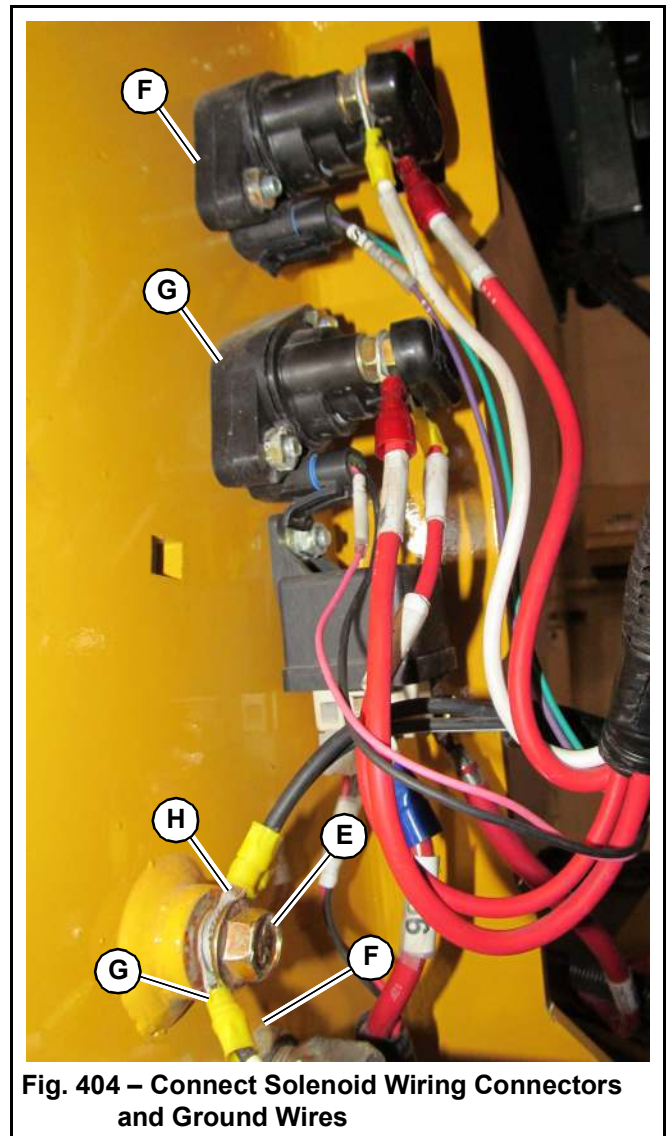


24. Secure ground strap (D, Fig. 403) to the engine using cap screw (E). Tighten securely.



25. Connect wiring connectors to solenoids (F and G, Fig. 404).

NOTE: Wiring connections to solenoids (F and G) were labeled and removed during step Fig. 33 on page 289.



26. Secure ground wiring connectors (F—H) to ground point using cap screw (E). Tighten securely.
27. Secure the hydraulic filter manifold to the chassis using two cap screws and two locknuts (I, Fig. 405). Tighten securely.

Troubleshooting

Table 28: Hydraulic System Troubleshooting

Problem	Possible Cause	Corrective Action
Hydraulic cylinder action slow for lift/tilt function	Bleed orifice plugged.	Remove orifice and clean.
	Incorrect settings on pump valve.	Adjust the pump valve.
	Low engine speed.	Operate engine at higher speeds.
	Hydraulic oil viscosity too heavy.	Allow longer warm-up or replace existing oil with proper viscosity oil.
	Hydraulic oil leaking past cylinder piston seals.	Replace cylinder seals and O-rings as needed.
	Hydraulic oil level low.	Check oil level in reservoir. If oil is low, check for an external leak. Repair and add oil.
	Lift or tilt solenoid lock valve malfunctioning or one of two cartridges on solenoid valve malfunctioning.	Check electrical connections to pilot solenoid. Replace as needed.
	Control linkage is restricted.	Check control linkage, readjust for full spool travel.
	Inadequate pilot supply oil pressure to joystick or foot controls.	Check pilot supply oil pressure.
	Inadequate pilot signal from control to the main control valve.	Check signal pressure.
	Pump damage.	Check pressure and flow.
Sluggish hydraulic system performance	Low hydraulic fluid level.	Top off hydraulic fluid.
	Hydraulic oil viscosity too heavy.	Replace existing oil with proper viscosity oil. See "Fluid Capacities/Lubricants" on page 345.
		Allow longer warm-up.
	Engine to pump coupling or hydraulic pump damaged.	Repair/replace as necessary.
	Pressure limiting valves set too low or damaged.	
	Hydraulic cylinder damaged.	
	Control valves damaged.	
	Oil leaking past cylinder/motor seals (internal or external).	
	Oil leaking past spools in control valve.	
	Low engine speed.	Increase engine speed.
	Engine running rough.	Poor fuel quality or incorrect grade. See "Fluid Capacities/Lubricants" on page 345 for proper fuel grade.
		Restricted fuel filter/fuel system. Replace fuel filter; remove restriction. See "Changing Fuel Filter" on page 108.
	Dirty/restricted air filter(s).	Replace filter(s).
	Air in hydraulic system.	Cycle lift and tilt cylinders to maximum stroke and maintain pressure for short time to clear air from the hydraulic system. Also check for low oil level in reservoir; top off as necessary.
Worn hydraulic pump.	Repair/replace as necessary.	
Control linkage malfunction.	Adjust/repair linkage for full spool travel.	
Solenoid valve malfunction.	Check solenoid electrical connections; repair as necessary.	

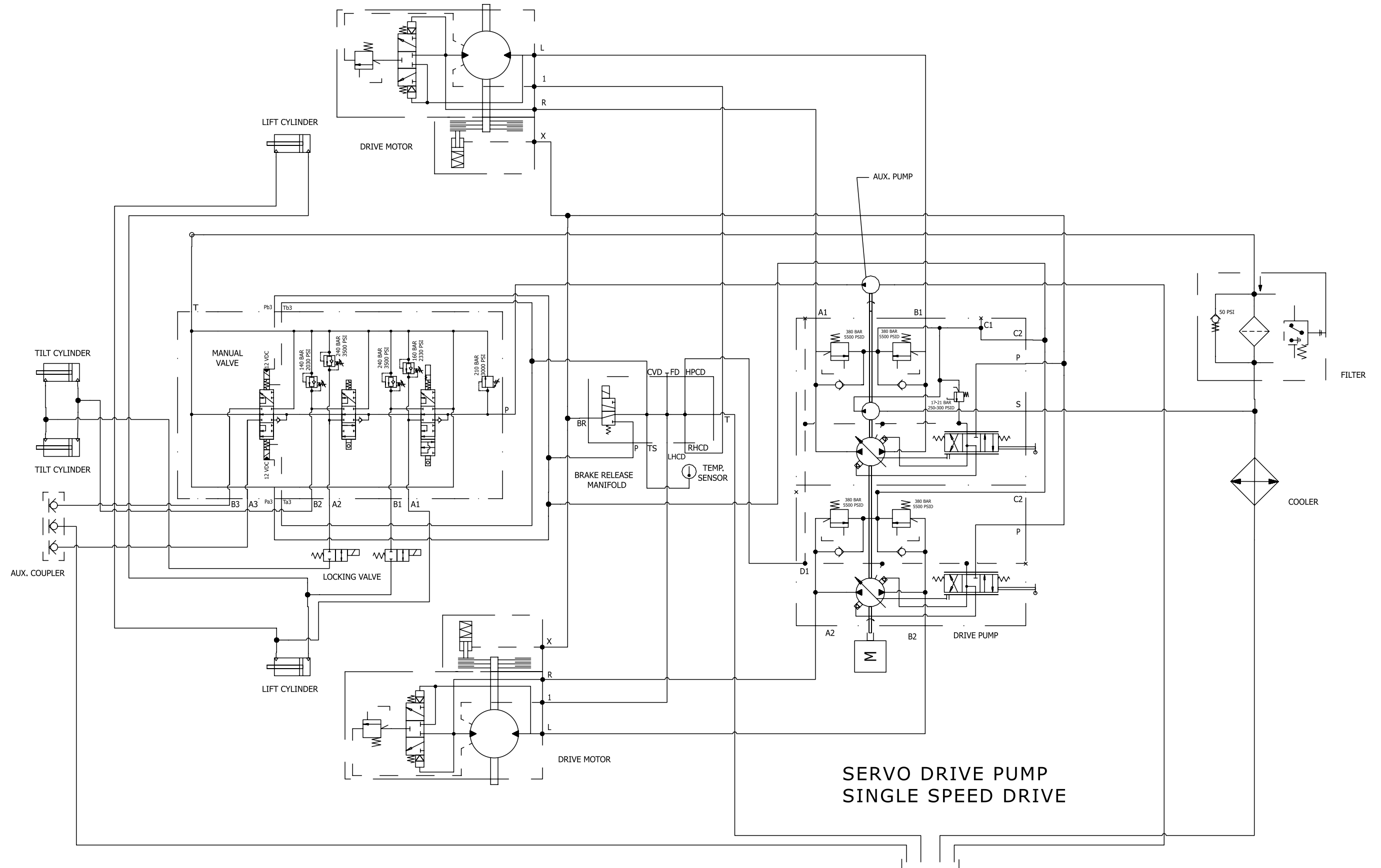
Troubleshooting

Table 31: Yanmar Engine Diagnostic Trouble Codes (DTC)

DTC			Error Item	
SPN	FMI	P-Code	Part	State
638	2	P1214	Engine	Malfunction
	3	P1213	Engine Fuel Rack Position Actuator	Shorted to high source
	4	P1212	Engine Fuel Rack Position Actuator	Shorted to low source
	7	P1211	Engine Fuel Rack Position Actuator	Mechanical malfunction
639	12	U0001	High Speed CAN	Communication fault
651	3	P1271	Injector 1 (Cylinder Number 4)	Injector 1 short-circuit
	5	P0204	Injector 1 (Cylinder Number 4)	Injector 1 open circuit (inherent location of the injector)
	6	P0271	Injector 1 (Cylinder Number 4)	Injector 1 coil short-circuit
	11	P0272	Injector 1 (Cylinder Number 4)	Injector 1 unclassified
652	3	P1262	Injector 1 (Cylinder Number 3)	Injector 1 short circuit
		P1268	Injector 4 (Cylinder Number 3)	Injector 4 short-circuit
	5	P0203	Injector 1 (Cylinder Number 3))	Injector 1 open circuit (inherent location of the Injector)
		P0203	Injector 4 (Cylinder Number 3)	Injector 4 open circuit (inherent location of the injector)
	6	P0268	Injector 1 (Cylinder Number 3)	Injector 1 coil short circuit
		P0268	Injector 4 (Cylinder Number 3)	Injector 4 coil short-circuit
	11	P1263	Injector 1 (Cylinder Number 3)	Injector 1 unclassified
		P1269	Injector 4 (Cylinder Number 3)	Injector 4 unclassified
653	3	P1265	Injector 2 (Cylinder Number 2)	Injector 2 short-circuit
	5	P0202	Injector 2 (Cylinder Number 2)	Injector 2 open circuit (inherent location of the injector)
	6	P0265	Injector 2 (Cylinder Number 2)	Injector 2 coil short-circuit
	11	P1266	Injector 2 (Cylinder Number 2)	Injector 2 unclassified
654	3	P1262	Injector 3 (Cylinder Number 1)	Injector 3 short-circuit
	5	P0201	Injector 3 (Cylinder Number 1)	Injector 3 open circuit (inherent location of the injector)
	6	P0262	Injector 3 (Cylinder Number 1)	Injector 3 coil short-circuit
	11	P1263	Injector 3 (Cylinder Number 1)	Injector 3 unclassified
1078	4	P0340	Fuel Injection Pump Speed Sensor	Shorted to low source
1079	2	P1644	Sensor 5V	Intermittent fault
	3	P0643	Sensor 5V	Shorted to high source
	4	P0642	Sensor 5V	Shorted to low source
1136	0	P0634	ECU Internal Temperature	Too high
	2	P1664	ECU Internal Temperature Sensor	Intermittent fault
	3	P0669	ECU Internal Temperature Sensor	Shorted to high source
	4	P0668	ECU Internal Temperature Sensor	Shorted to low source
1202	2	U423	Immobilizer	System fault
1209	3	P0473	EGR High Pressure Side Sensor	EGR low pressure side sensor fault (high voltage)
	4	P0472	EGR High Pressure Side Sensor	EGR low pressure side sensor fault (low voltage)
	13	P0471	EGR High Pressure Side Sensor	Abnormal learning value

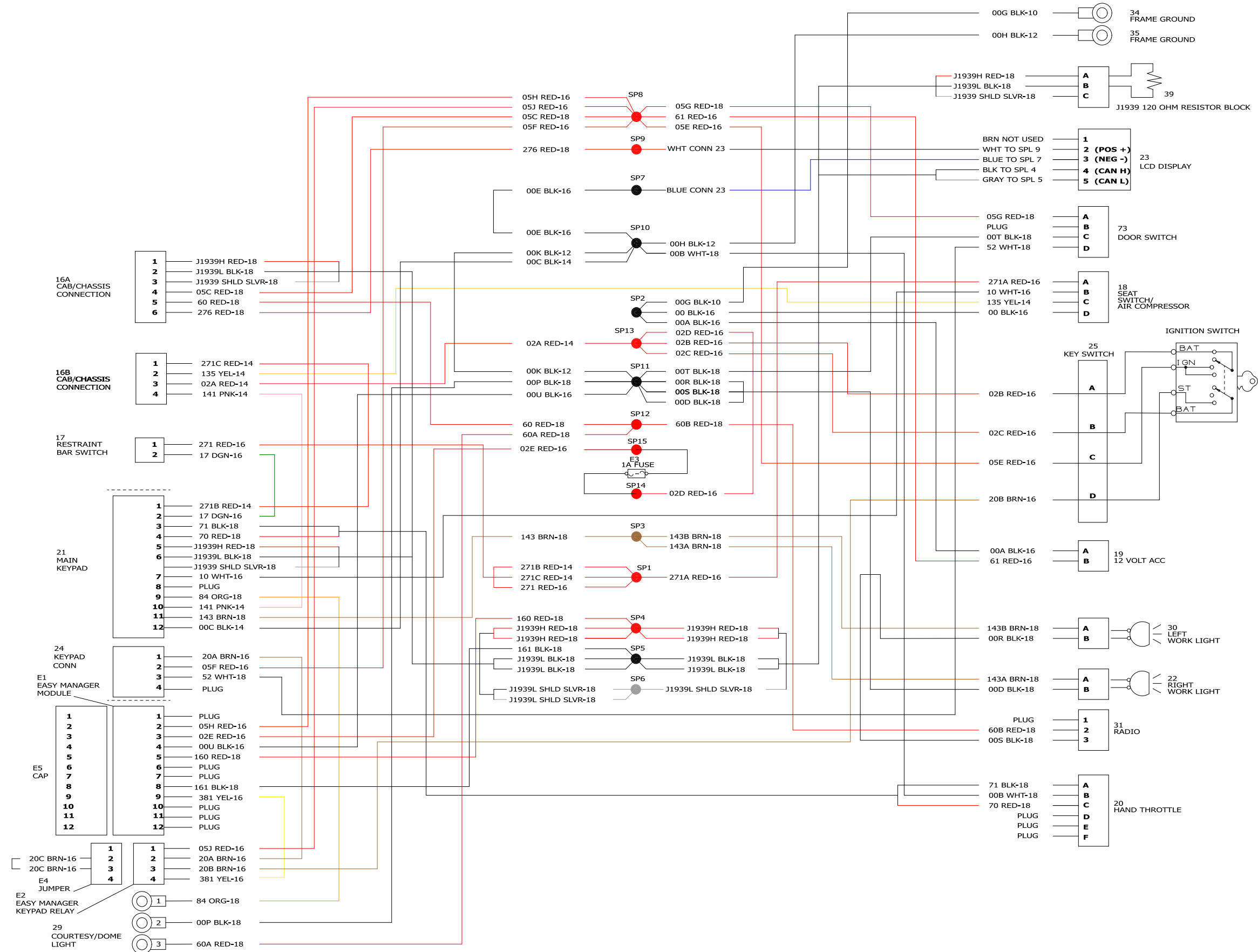
Schematics

Hydraulic Schematic – Models 165R/1650R with T-Bar or Hand/Foot Controls (Single-Speed)



Schematics

Electrical Schematic – ROPS (Page 1 of 3)



Specifications

Engine

Table 40: Engine

	R135/1350R	R150/1500R	R165/1650R
Engine Make/Model	Yanmar 4TNV88C-KMS (DPF Models)		Yanmar 4TNV98C-NMS2
	Yanmar 4TNV88-BKMSR2 (Non-DPF Models)		4TNV98-ZNMS3R (Non-DPF Models)
High/Low Idle	2830/1000 rpm		2530/1000 rpm
Design	In-line 4 cylinder, 4-stroke diesel, naturally aspirated		
Displacement	2.19 L (133.6 in ³)		3.3 L (201.4 in ³)
Bore and Stroke	88 × 90 mm		98 × 110 mm
Gross Power	34.5 kW (46.3 HP) @ 2800 rpm		52 kW (69.9 HP) @ 2800 rpm
Net Power	33 kW (44.5 HP) @ 2800 rpm		51 kW (68.4 HP) @ 2800 rpm
Peak Torque	146 Nm (107.8 ft.-lbs.) @ 1820 rpm		241 Nm (178 ft.-lbs.) @ 1625 rpm
Low/High Idle	1000 / 2830 rpm		1000 / 2530 rpm
Fuel Injection System	Direct injection with common rail injection system		
Fuel Delivery	High-pressure common rail		
Fuel Shut-off	On individual injectors		
Fuel Filtering	In-line filter cartridge with water trap and replaceable element		
Firing Order	1-3-4-2-1 (from flywheel end)		
Normal Starting Aid	Glow plugs		
Cold Starting Aid (Optional)	Engine block / Oil pan heater		
Lubrication	Forced lubrication with trochoid pump		
Crankcase Ventilation	Closed		
Max. Inclined Angle (engine still supplied with oil)	30° in all directions		
Cooling System	Water/ethylene glycol		
Permissible Coolant Temperature	110°C (230°F)		
Thermostat Rating	82° C (180°F) cracking / 95° C (203°F) full open		
Fan Type / Ratio	Pusher / 1:1		Pusher / 0.867:1
Exhaust Emission Compliance	Tier 4		
Electric Starter Motor Power	12 VDC - 2.3 kW (3.1 HP)		12 VDC - 3.0 kW (4.0 HP)
Alternator Voltage / Amperage	12-14VDC / 100 A		
Operating Range– Ambient Temperature ¹	-15°C (+5°F) – +45°C (+113°F)		

1. Operation above temperature range may result in overheating; operation below temperature range may result in hard-starting. Contact your dealer before operating the machine outside temperature range.

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