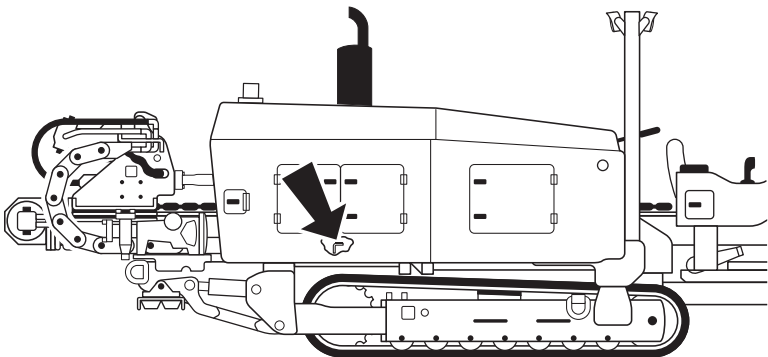


SERVICE

SERIAL NUMBER

Record the serial numbers and date of purchase of your equipment in the spaces below.



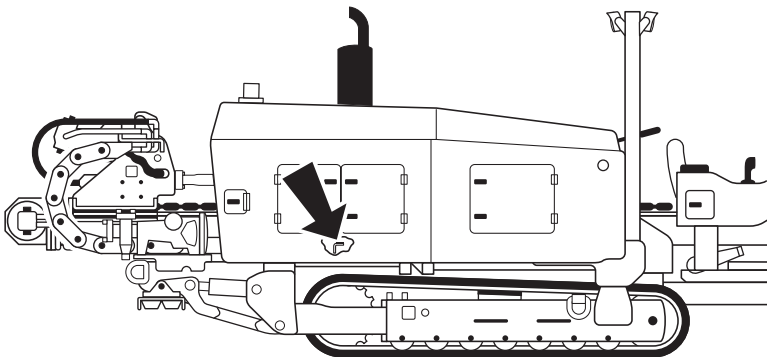
om0278c.eps

Date of Manufacture:	
Date of Purchase:	
Drilling Unit Serial Number:	

SERVICE

SERIAL NUMBER

Record the serial numbers and date of purchase of your equipment in the spaces below.



om0278c.eps

Date of Manufacture:	
Date of Purchase:	
Drilling Unit Serial Number:	

SUPPORT PROCEDURE

Notify your dealer immediately of any malfunction or failure of Ditch Witch equipment.

Always give model, serial number, and approximate date of your equipment purchase. This information should be recorded and placed on file by the owner at the time of purchase.

Return damaged parts to dealer for inspection and warranty consideration if in warranty time frame.

Order genuine Ditch Witch replacement or repair parts from your authorized Ditch Witch dealer. Use of another manufacturer's parts may void warranty consideration.

RESOURCES

Publications

Contact your Ditch Witch dealer for publications and videos covering safety, operation, service, and repair of your equipment.

Ditch Witch Training Center

For information about on-site, individualized training, contact your Ditch Witch dealer.

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FOREWORD

This manual is an important part of your equipment. It provides safety information and operation instructions to help you use and maintain your Ditch Witch equipment.

Read this manual before using your equipment. Keep it with the equipment at all times for future reference. If you sell your equipment, be sure to give this manual to the new owner.

If you need a replacement copy, contact your Ditch Witch dealer. If you need assistance in locating a dealer, visit our website at **www.ditchwitch.com** or write to the following address:

The Charles Machine Works, Inc.
Attn: Marketing Department
PO Box 66
Perry, OK 73077-0066
USA

The descriptions and specifications in this manual are subject to change. The Charles Machine Works, Inc. reserves the right to improve equipment. Some product improvements may have taken place after this manual was published. For the latest information on Ditch Witch equipment, see your Ditch Witch dealer.

Thank you for buying and using Ditch Witch equipment.

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**Operator's Manual
JT4020 Mach 1**

Issue No. 1.3/OP-11/03
Part Number 054-074

Copyright 2001, 2003
by The Charles Machine Works, Inc.,
Perry, Oklahoma



, Ditch Witch, CMW, AutoCrowd, Modularmatic, Jet Trac, Roto Witch, Subsite, Fluid Miser, Perma-Soil, Power Pipe, Super Witch, Super Witch II, Pierce Airrow, The Underground, and The Underground Authority Worldwide are registered trademarks of The Charles Machine Works, Inc.

This product is covered by one or more of the following patents:

U.S. B1 4,858,704; 4,953,638; 5,148,880; 5,242,026; 5,341,887; 5,490,569; 5,544,712; 5,546,833; 5,682,956; 5,684,466; 5,713,423; 5,794,719; 5,880,680; 5,941,322; 6,085,852; 6,109,371; 6,179,065; 6,216,803; 6,250,403; 6,250,404; 6,290,606; 6,311,790; 6,411,094; 6,543,551; 6,550,547; RE37,450; RE37,450; RE37,923; RE37,975; **Germany** 694 17 019; 695 26 634; **France** 683,845; 674,093; **Australia** 684,595; 689,533; 718,034; 706,544; 755,862; **UK** 2,309,239; 2,312,006; EP683,845; EP674,093 ; other U.S. and foreign patents pending.

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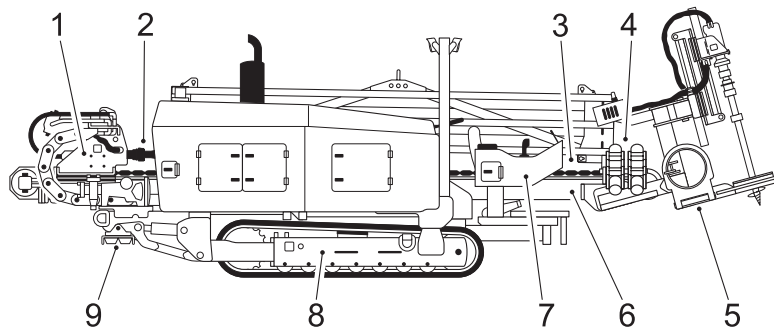
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OVERVIEW

The JT4020 Mach 1 directional drilling unit is a self-contained unit.

The JT4020 Mach 1 features rubber tracks, genuine Ditch Witch drill pipe, a pipeloader and pipe box, onboard anchoring system, onboard fluid system, cold start kit, Subsite 750 Display integrated into the control console, and simple, precise controls. Optional equipment includes a spindle brake and two sizes of pipe boxes.

The JT4020 Mach 1 directional drilling unit can be used with Ditch Witch drilling fluid units and Subsite locating equipment.



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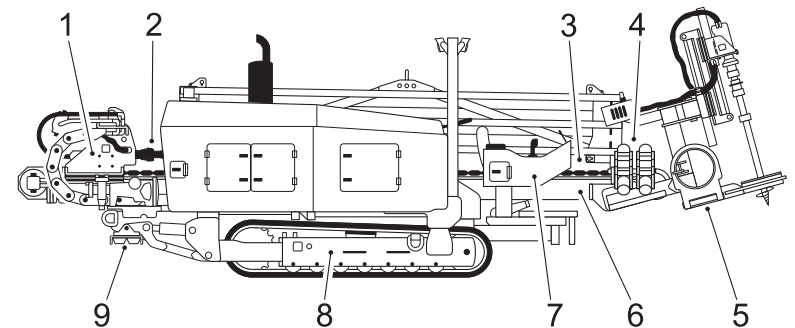
- | | |
|---------------------|-----------------------|
| 1. Carriage | 6. Drill frame |
| 2. Spindle | 7. Operator's station |
| 3. Pipeloader | 8. Tracks |
| 4. Vise wrenches | 9. Stabilizer |
| 5. Anchoring system | |

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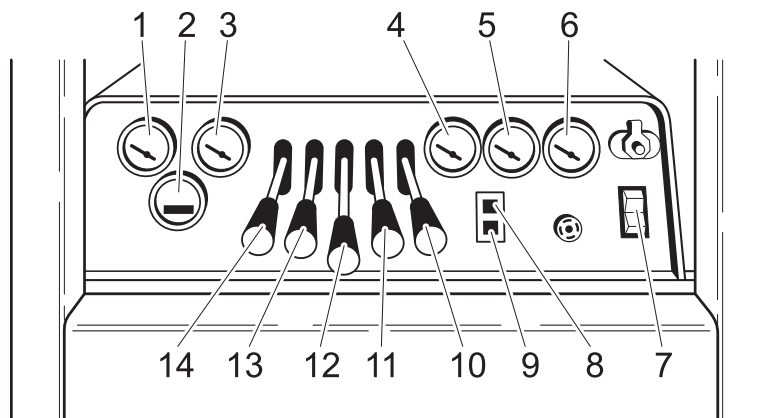


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CONTROLS

SET-UP CONSOLE OVERVIEW

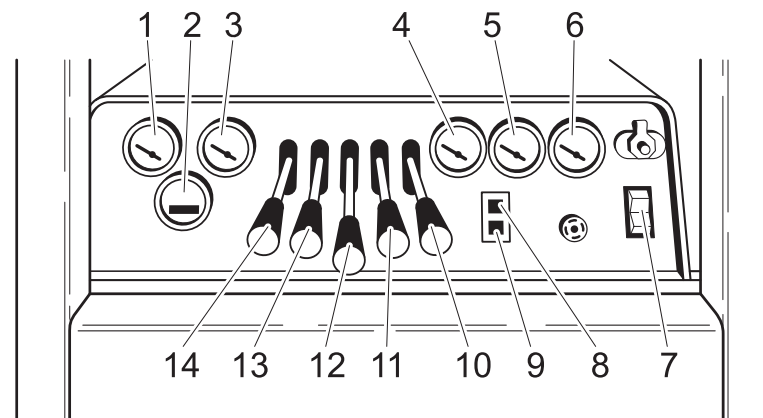


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- | | |
|-------------------------------------|---|
| 1. Fuel gauge | 8. Hydraulic oil temperature indicator |
| 2. Hourmeter | |
| 3. Voltmeter | 9. Hydraulic oil filter service indicator |
| 4. Engine coolant temperature gauge | 10. Front frame tilt control |
| 5. Engine oil pressure gauge | 11. Back frame tilt control |
| 6. Tachometer | 12. Shuttle stop control |
| 7. Light switch | 13. Left stabilizer control |
| | 14. Right stabilizer control |

CONTROLS

SET-UP CONSOLE OVERVIEW



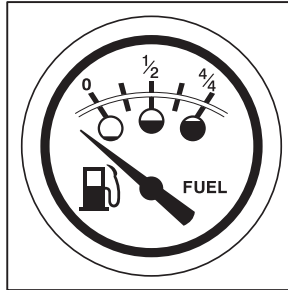
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SET-UP CONSOLE DESCRIPTIONS

Fuel Gauge

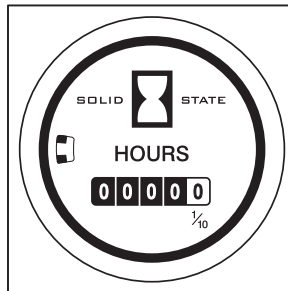
This gauge indicates fuel level in tank. Use #2 diesel fuel in most cases. If temperature drops below 40°F (4°C), use #1 diesel fuel. Tank holds 55 gal (208 L).



ic1301a.eps

Hourmeter

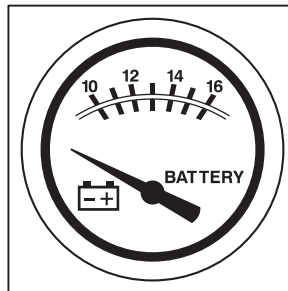
This gauge records engine operating time. Use these times to schedule lubrication and maintenance.



ic1274a.eps

Voltmeter

This gauge measures voltage in electric system. Reading should be 13-14 volts with engine running. If not, stop engine and investigate.

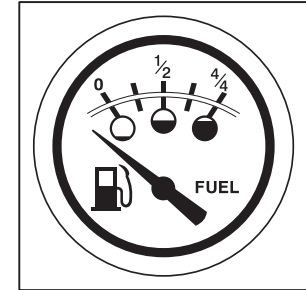


ic1302a.eps

SET-UP CONSOLE DESCRIPTIONS

Fuel Gauge

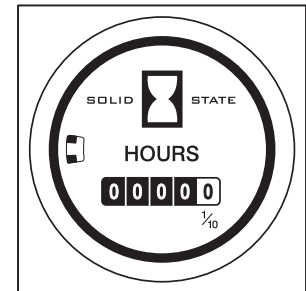
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ic1301a.eps

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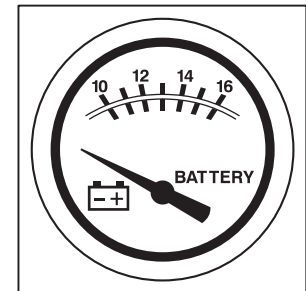
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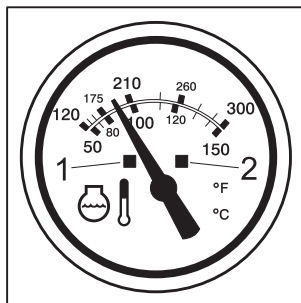


ic1302a.eps

Engine Coolant Temperature Gauge

This gauge displays engine coolant temperature.

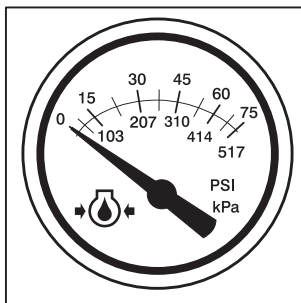
- If alert light (1) comes on, modify operating method and check radiator.
- If shutdown light (2) comes on and buzzer sounds, shut down unit, clean radiator, and check coolant.



ic0098c.eps

Engine Oil Pressure Gauge

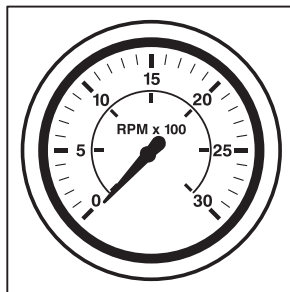
This gauge displays engine oil pressure. At full load, reading should be 35-65 psi (2.4-4.5 bar). At idle, reading should not drop below 15 psi (1 bar).



ic0099c.eps

Tachometer

This gauge displays engine rpm. At full load, reading should be 2200-2400 rpm. Full-load reading of less than 2100 rpm can cause overheating.

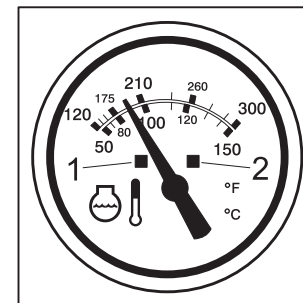


ic1265a.eps

Engine Coolant Temperature Gauge

This gauge displays engine coolant temperature.

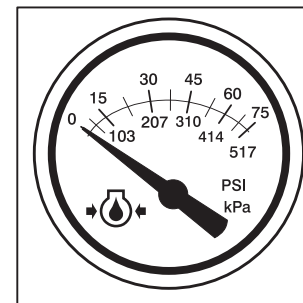
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ic0098c.eps

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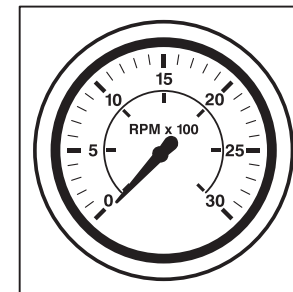
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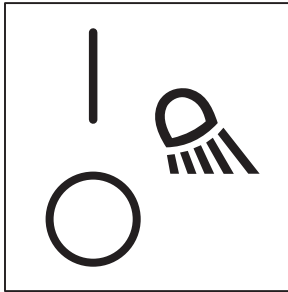


ic1265a.eps

Light Switch

This switch controls work lights.

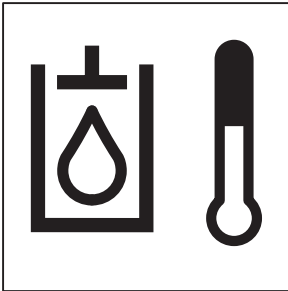
- Press top to turn on.
- Press bottom to turn off.



ic1355a.eps

Hydraulic Oil Temperature Indicator

This indicator lights if hydraulic oil overheats.

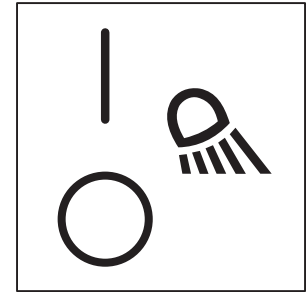


ic1295a.eps

Light Switch

This switch controls work lights.

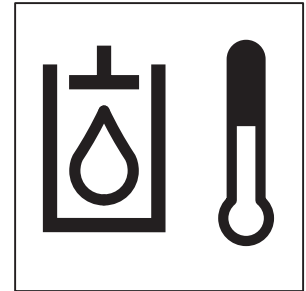
- Press top to turn on.
- Press bottom to turn off.



ic1355a.eps

Hydraulic Oil Temperature Indicator

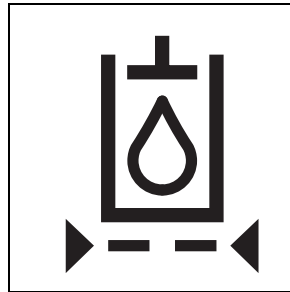
This indicator lights if hydraulic oil overheats.



ic1295a.eps

Hydraulic Oil Filter Service Indicator

This indicator lights when hydraulic oil filter needs to be replaced.

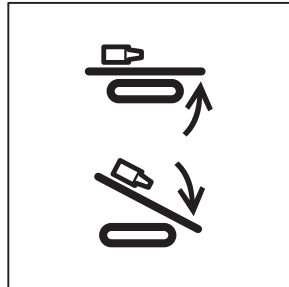


Front Frame Tilt Control

This lever raises or lowers front end of drill frame.

- Push to raise.
- Pull to lower.

IMPORTANT: To ensure a stable platform for drilling, use front and back tilt controls together to set frame at desired pitch without raising tracks off the ground.



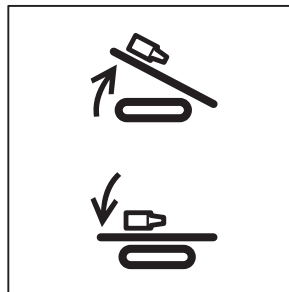
ic1342a.eps

Back Frame Tilt Control

This lever raises or lowers back end of drill frame.

- Push to raise.
- Pull to lower.

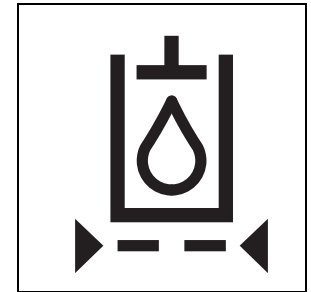
IMPORTANT: To ensure a stable platform for drilling, use front and back tilt controls together to set frame at desired pitch without raising tracks off the ground.



ic1343a.eps

Hydraulic Oil Filter Service Indicator

This indicator lights when hydraulic oil filter needs to be replaced.

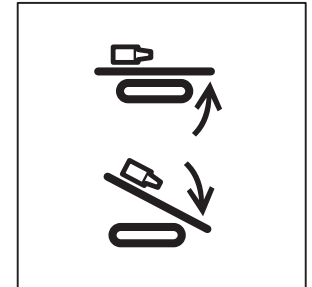


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- Pull to lower.

IMPORTANT: To ensure a stable platform for drilling, use front and back tilt controls together to set frame at desired pitch without raising tracks off the ground.



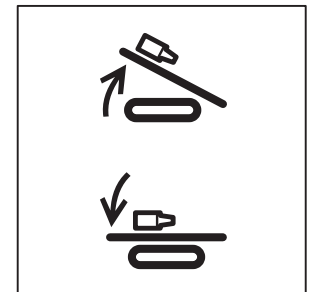
ic1342a.eps

Back Frame Tilt Control

This lever raises or lowers back end of drill frame.

- Push to raise.
- Pull to lower.

IMPORTANT: To ensure a stable platform for drilling, use front and back tilt controls together to set frame at desired pitch without raising tracks off the ground.



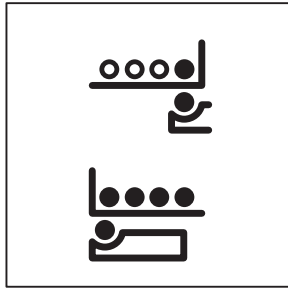
ic1343a.eps

Shuttle Stop Control

This lever controls shuttle stop position.

- Push to lower shuttle stop.
- Pull to raise shuttle stop.

IMPORTANT: Refer to row indicator located on drill frame when selecting pipelader row.



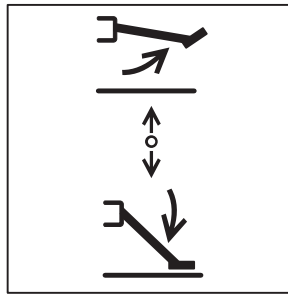
ic0253h.eps

Left Stabilizer Control

This lever controls left rear stabilizer.

- Push to raise.
- Pull to lower.

Lower left and right stabilizers to the ground together, then adjust individually.



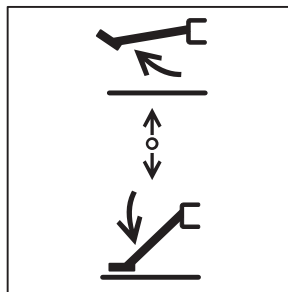
ic1344a.eps

Right Stabilizer Control

This lever controls right rear stabilizer.

- Push to raise.
- Pull to lower.

Lower left and right stabilizers to the ground together, then adjust individually.



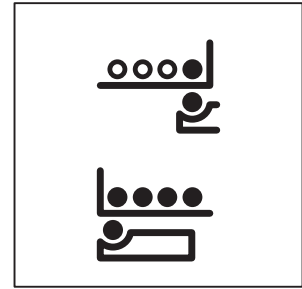
ic1345a.eps

Shuttle Stop Control

This lever controls shuttle stop position.

- Push to lower shuttle stop.
- Pull to raise shuttle stop.

IMPORTANT: Refer to row indicator located on drill frame when selecting pipelader row.



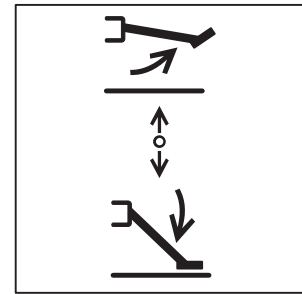
ic0253h.eps

Left Stabilizer Control

This lever controls left rear stabilizer.

- Push to raise.
- Pull to lower.

Lower left and right stabilizers to the ground together, then adjust individually.



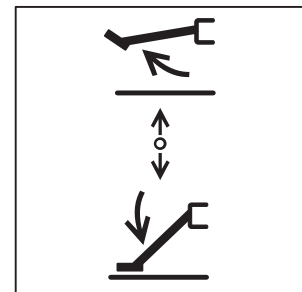
ic1344a.eps

Right Stabilizer Control

This lever controls right rear stabilizer.

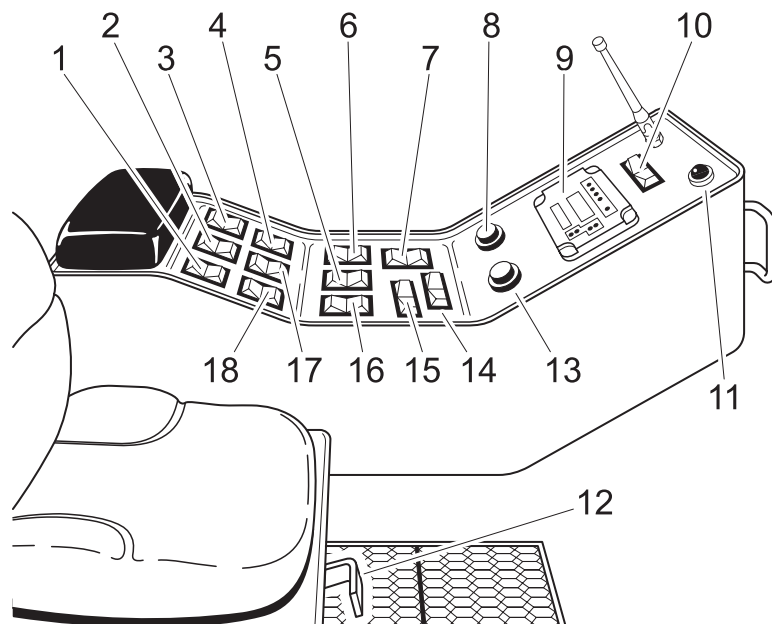
- Push to raise.
- Pull to lower.

Lower left and right stabilizers to the ground together, then adjust individually.



ic1345a.eps

LEFT CONTROL CONSOLE OVERVIEW

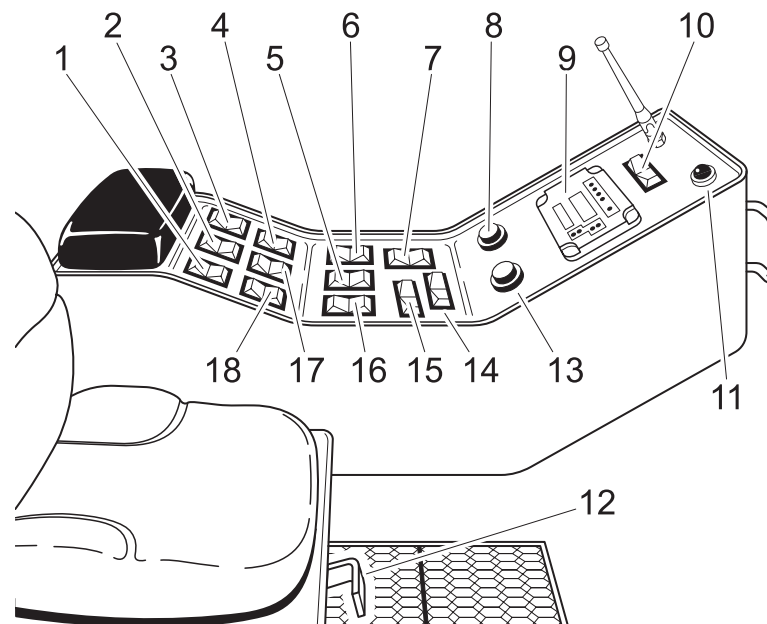


om0263c.eps

- | | |
|---------------------------------------|--------------------------------------|
| 1. Engine throttle switch | 10. Operator's station pivot switch |
| 2. Spindle brake (optional) | 11. Horn |
| 3. Add pipe/manual/remove pipe switch | 12. Operator's station pivot lock |
| 4. Pipe lift switch | 13. Fluid flow control |
| 5. Rear wrench clamp switch | 14. Drill/park/drive selector switch |
| 6. Rear wrench rotation switch | 15. Pipe lubricator control |
| 7. Set/resume switch | 16. Front wrench clamp switch |
| 8. Rotation speed control | 17. Pipe gripper switch |
| 9. ESID* | 18. Pipe shuttle switch |

* Called out later in chapter

LEFT CONTROL CONSOLE OVERVIEW



om0263c.eps

- | | |
|---------------------------------------|--------------------------------------|
| 1. Engine throttle switch | 10. Operator's station pivot switch |
| 2. Spindle brake (optional) | 11. Horn |
| 3. Add pipe/manual/remove pipe switch | 12. Operator's station pivot lock |
| 4. Pipe lift switch | 13. Fluid flow control |
| 5. Rear wrench clamp switch | 14. Drill/park/drive selector switch |
| 6. Rear wrench rotation switch | 15. Pipe lubricator control |
| 7. Set/resume switch | 16. Front wrench clamp switch |
| 8. Rotation speed control | 17. Pipe gripper switch |
| 9. ESID* | 18. Pipe shuttle switch |

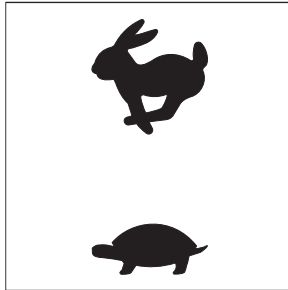
* Called out later in chapter

LEFT CONTROL CONSOLE DESCRIPTIONS

Engine Throttle Switch

This switch controls engine speed.

- Press top to increase speed.
- Press bottom to decrease speed.
- Press switch additional times to further increase or decrease engine speed.

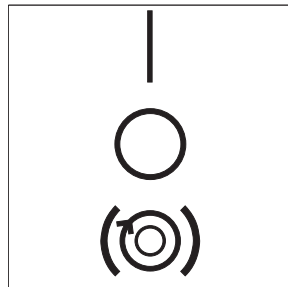


lc0095c.eps

Spindle Brake Switch

This switch engages or disengages spindle brake.

- Press top to engage.
- Press bottom to disengage.

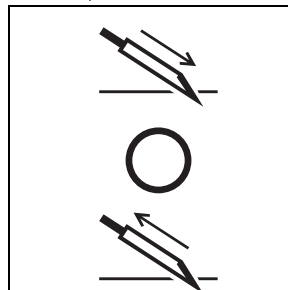


lc0094c.eps

Add Pipe/Manual/Remove Pipe Switch

This switch selects pipeloader control functions.

- Press top to select "add pipe" function.
- Move to center to use manual pipeloader controls.
- Press bottom to select "remove pipe" function.

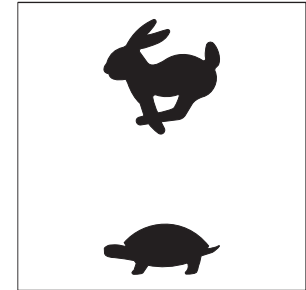


LEFT CONTROL CONSOLE DESCRIPTIONS

Engine Throttle Switch

This switch controls engine speed.

- Press top to increase speed.
- Press bottom to decrease speed.
- Press switch additional times to further increase or decrease engine speed.

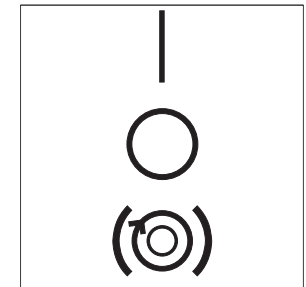


lc0095c.eps

Spindle Brake Switch

This switch engages or disengages spindle brake.

- Press top to engage.
- Press bottom to disengage.

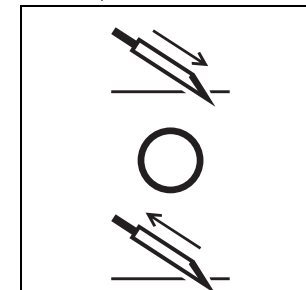


lc0094c.eps

Add Pipe/Manual/Remove Pipe Switch

This switch selects pipeloader control functions.

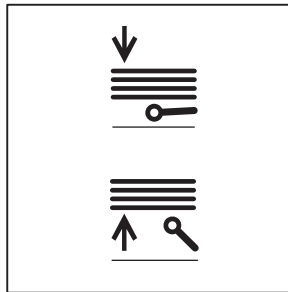
- Press top to select "add pipe" function.
- Move to center to use manual pipeloader controls.
- Press bottom to select "remove pipe" function.



Pipe Lift Switch

This switch raises and lowers all rows in pipe box.

- Press top to lower.
- Press bottom to raise.

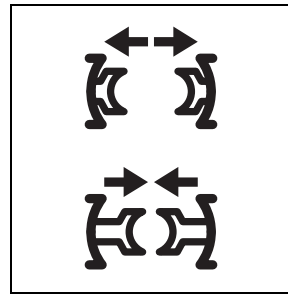


ic1277a.eps

Rear Wrench Clamp Switch

This switch controls rear wrench clamp.

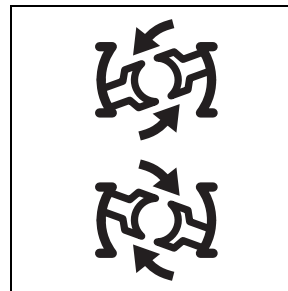
- Press top to disengage (unclamp).
- Press bottom to engage (clamp).



Rear Wrench Rotation Switch

This switch rotates rear wrench clockwise or counterclockwise.

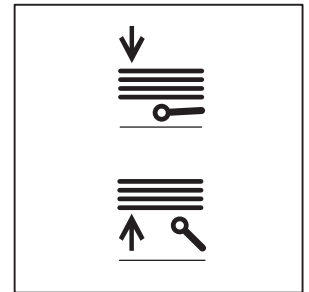
- Press top to rotate counterclockwise (breakout).
- Press bottom to rotate clockwise (makeup).
- Release to stop rotation.



Pipe Lift Switch

This switch raises and lowers all rows in pipe box.

- Press top to lower.
- Press bottom to raise.

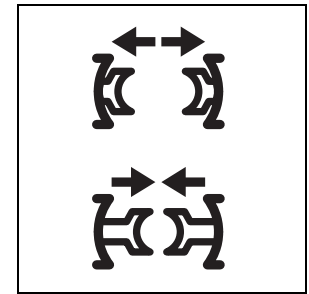


ic1277a.eps

Rear Wrench Clamp Switch

This switch controls rear wrench clamp.

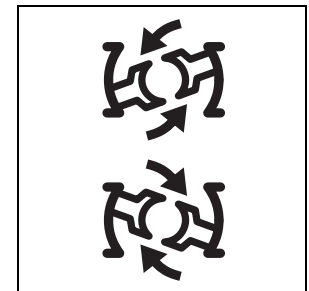
- Press top to disengage (unclamp).
- Press bottom to engage (clamp).



Rear Wrench Rotation Switch

This switch rotates rear wrench clockwise or counterclockwise.

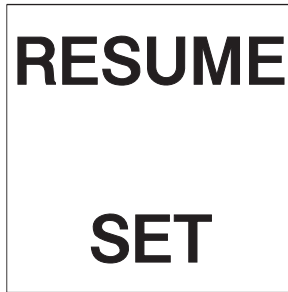
- Press top to rotate counterclockwise (breakout).
- Press bottom to rotate clockwise (makeup).
- Release to stop rotation.



Set/Resume Switch

This switch enables cruise control operation over thrust and rotation. It is also used during automated pipeloading.

- Press top to resume operation or increase operation levels.
- Press bottom to set operating conditions or reduce operation levels.



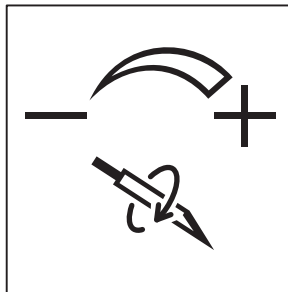
lc0091c.eps

For more information on this control function, see "Operate Cruise Control" in **OPERATION**.

Rotation Speed Control

This knob controls maximum rotation speed.

- Turn clockwise to increase rotation speed.
- Turn counterclockwise to decrease rotation speed.

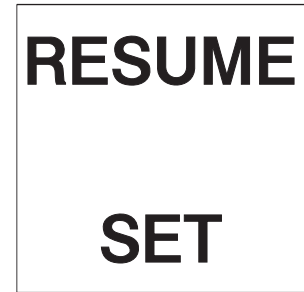


ic1281a.eps

Set/Resume Switch

This switch enables cruise control operation over thrust and rotation. It is also used during automated pipeloading.

- Press top to resume operation or increase operation levels.
- Press bottom to set operating conditions or reduce operation levels.



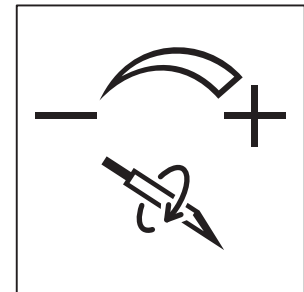
lc0091c.eps

For more information on this control function, see "Operate Cruise Control" in **OPERATION**.

Rotation Speed Control

This knob controls maximum rotation speed.

- Turn clockwise to increase rotation speed.
- Turn counterclockwise to decrease rotation speed.

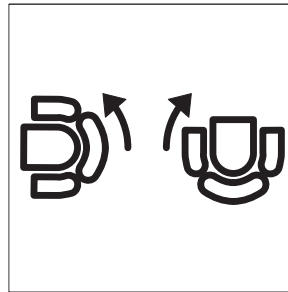


ic1281a.eps

Operator's Station Pivot Control Switch

This switch controls operator's station position.

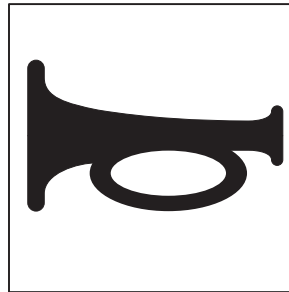
- While lifting pivot lock, press left side to pivot into drilling position.
- While lifting pivot lock, press right side to pivot into driving position.



lc0108c.eps

Horn

This button sounds horn.



ic1276a.eps

Operator's Station Pivot Lock

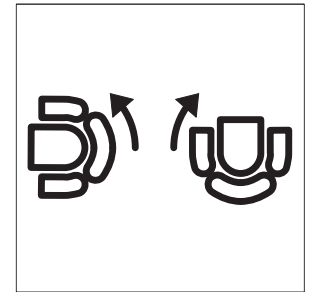
This control allows operator's station to pivot, or it locks operator's station in drive position.

- Lift to unlock. Hold up while pivoting operator's station.
- Control will return to locked position when operator's station reaches drive position.

Operator's Station Pivot Control Switch

This switch controls operator's station position.

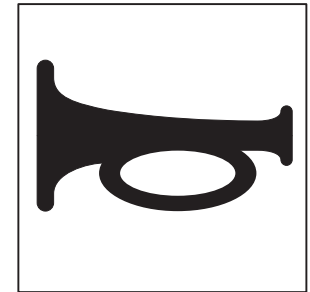
- While lifting pivot lock, press left side to pivot into drilling position.
- While lifting pivot lock, press right side to pivot into driving position.



lc0108c.eps

Horn

This button sounds horn.



ic1276a.eps

Operator's Station Pivot Lock

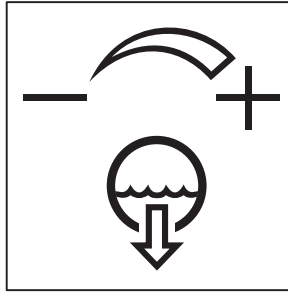
This control allows operator's station to pivot, or it locks operator's station in drive position.

- Lift to unlock. Hold up while pivoting operator's station.
- Control will return to locked position when operator's station reaches drive position.

Fluid Flow Control

This knob adjusts drilling fluid flow rate from zero to maximum.

- Turn clockwise for greater flow.
- Turn counterclockwise for less flow.

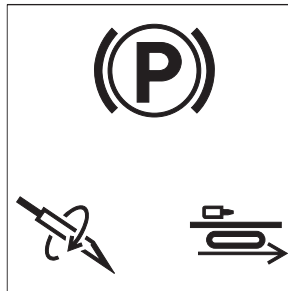


lc1289a.eps

Drill/Park/Drive Selector Switch

This switch selects joystick control mode.

- Press left side to drill.
- Move to center to set parking brake.
- Press right side to drive.

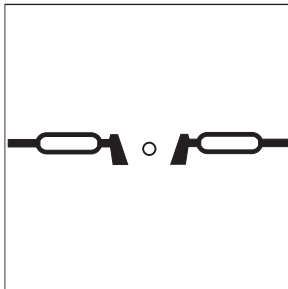


lc0092c.eps

Pipe Lubricator Control

This switch controls pipe thread lubricator.

- Press left side to fill applicator at back of pipeloader.
- Press right side to apply joint compound to threads at wrenches.

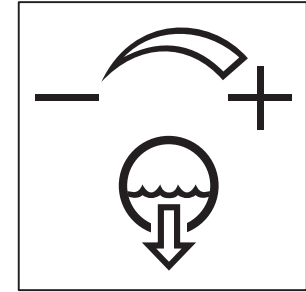


lc0107c.eps

Fluid Flow Control

This knob adjusts drilling fluid flow rate from zero to maximum.

- Turn clockwise for greater flow.
- Turn counterclockwise for less flow.

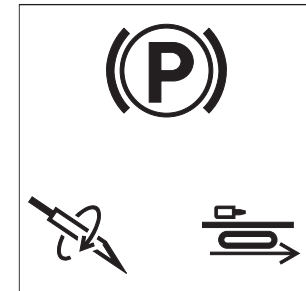


lc1289a.eps

Drill/Park/Drive Selector Switch

This switch selects joystick control mode.

- Press left side to drill.
- Move to center to set parking brake.
- Press right side to drive.

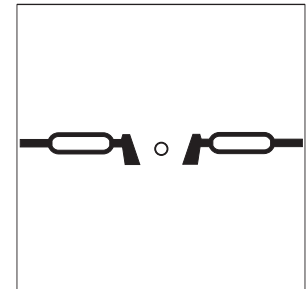


lc0092c.eps

Pipe Lubricator Control

This switch controls pipe thread lubricator.

- Press left side to fill applicator at back of pipeloader.
- Press right side to apply joint compound to threads at wrenches.

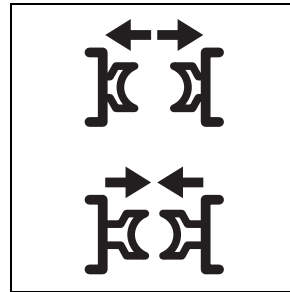


lc0107c.eps

Front Wrench Clamp Switch

This switch controls front wrench clamp.

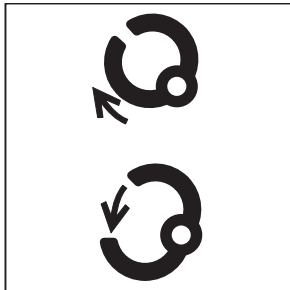
- Press top to disengage (unclamp).
- Press bottom to engage (clamp).



Pipe Gripper Switch

This switch controls loader grippers.

- Press top to close.
- Press bottom to open.

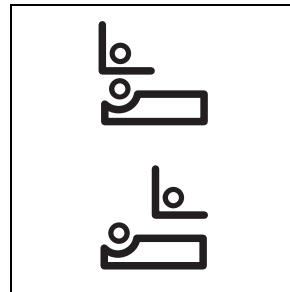


ic1279a.eps

Pipe Shuttle Switch

This switch moves shuttle to and from pipe box.

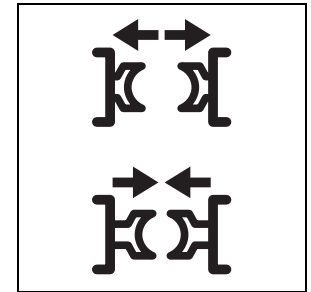
- Press top to move toward pipe box.
- Press bottom to move toward spindle.



Front Wrench Clamp Switch

This switch controls front wrench clamp.

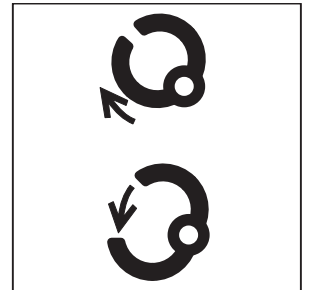
- Press top to disengage (unclamp).
- Press bottom to engage (clamp).



Pipe Gripper Switch

This switch controls loader grippers.

- Press top to close.
- Press bottom to open.

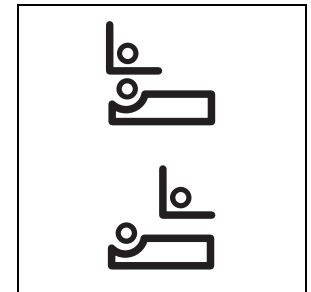


ic1279a.eps

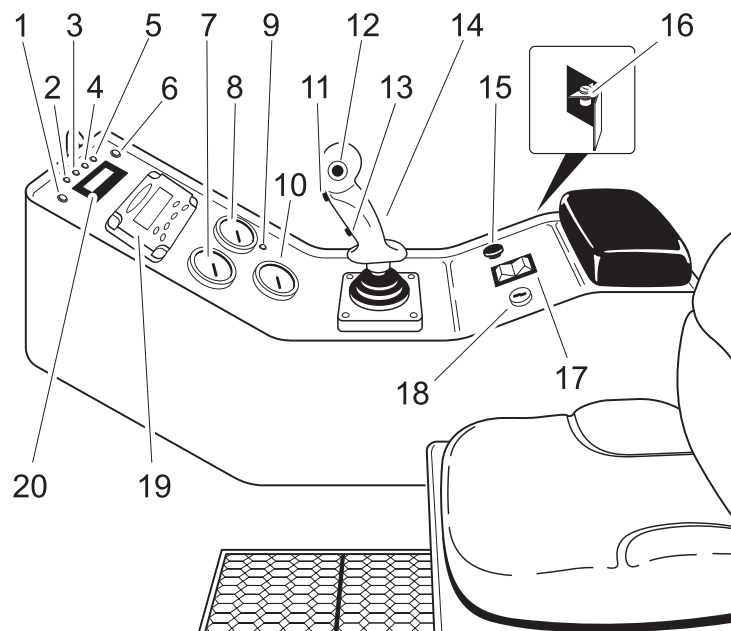
Pipe Shuttle Switch

This switch moves shuttle to and from pipe box.

- Press top to move toward pipe box.
- Press bottom to move toward spindle.



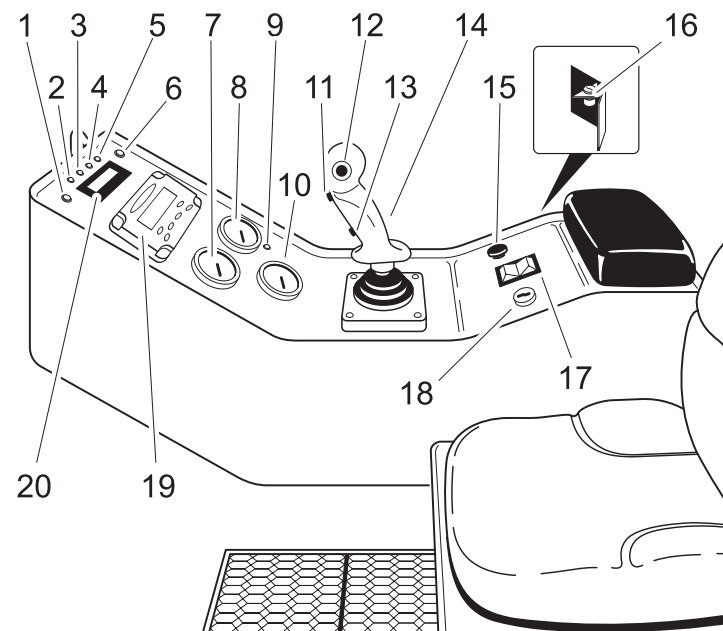
RIGHT CONTROL CONSOLE OVERVIEW



om0262c.eps

- | | |
|-------------------------------------|--|
| 1. Diagnostic light | 11. Dual speed carriage/two-speed ground drive control |
| 2. Rear home status light | 12. Drilling fluid quick fill switch |
| 3. Shuttle home status light | 13. Drilling fluid pump switch |
| 4. Front home status light | 14. Track and carriage control |
| 5. Front wrench status light | 15. Remote engine stop switch |
| 6. Control cycle light | 16. Tracker control key |
| 7. Thrust pressure gauge | 17. Cold start switch |
| 8. Drilling fluid pressure gauge | 18. Ignition |
| 9. Drilling fluid pump status light | 19. Subsite 750 Display * |
| 10. Rotation pressure gauge | 20. Drilling fluid flowmeter |
- * Called out later in this chapter

RIGHT CONTROL CONSOLE OVERVIEW



om0262c.eps

- | | |
|-------------------------------------|--|
| 1. Diagnostic light | 11. Dual speed carriage/two-speed ground drive control |
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| 6. Control cycle light | 16. Tracker control key |
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| 8. Drilling fluid pressure gauge | 18. Ignition |
| 9. Drilling fluid pump status light | 19. Subsite 750 Display * |
| 10. Rotation pressure gauge | 20. Drilling fluid flowmeter |
- * Called out later in this chapter

RIGHT CONTROL CONSOLE DESCRIPTIONS

Diagnostic Light

This light displays the status of the machine's diagnostic system.

- Light off indicates system is OK.
- Light on indicates system may not be getting power.
- Constant flashing indicates a non-essential diagnostic code.
- Flashing on for three seconds and off for half a second indicates an essential diagnostic code.



lc0083c.eps

For more information on this control function, see "Troubleshooting Drilling Unit" in **MAINTENANCE**.

Rear Home Status Light

This light shows the status of rear home proximity switch.

- When carriage is at rear of drill frame, light should be on.
- When carriage is away from rear of drill frame, light should be off.



lc0085c.eps

RIGHT CONTROL CONSOLE DESCRIPTIONS

Diagnostic Light

This light displays the status of the machine's diagnostic system.

- Light off indicates system is OK.
- Light on indicates system may not be getting power.
- Constant flashing indicates a non-essential diagnostic code.
- Flashing on for three seconds and off for half a second indicates an essential diagnostic code.



lc0083c.eps

For more information on this control function, see "Troubleshooting Drilling Unit" in **MAINTENANCE**.

Rear Home Status Light

This light shows the status of rear home proximity switch.

- When carriage is at rear of drill frame, light should be on.
- When carriage is away from rear of drill frame, light should be off.



lc0085c.eps

Shuttle Home Status Light

This light shows the status of shuttle home proximity switch.

- When shuttle is retracted, light should be on.
- When shuttle is extended, light should be off.

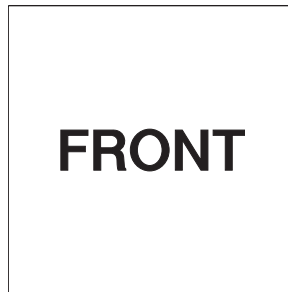


lc0086c.eps

Front Home Status Light

This light shows the status of front home proximity switch.

- When carriage is at front of drill frame, light should be on.
- When carriage is away from front of drill frame, light should be off.



lc0087c.eps

Front Wrench Status Light

This light shows the status of front wrench pressure switch.

- When front wrench is closed and pressured up, light should be on.
- When front wrench is open, light should be off.



lc0088c.eps

Shuttle Home Status Light

This light shows the status of shuttle home proximity switch.

- When shuttle is retracted, light should be on.
- When shuttle is extended, light should be off.

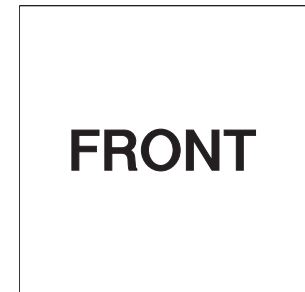


lc0086c.eps

Front Home Status Light

This light shows the status of front home proximity switch.

- When carriage is at front of drill frame, light should be on.
- When carriage is away from front of drill frame, light should be off.



lc0087c.eps

Front Wrench Status Light

This light shows the status of front wrench pressure switch.

- When front wrench is closed and pressured up, light should be on.
- When front wrench is open, light should be off.

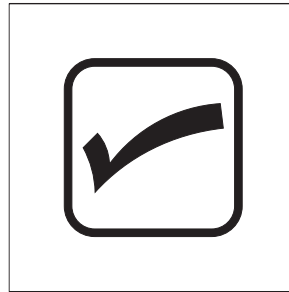


lc0088c.eps

Control Cycle Light

This light displays the status of machine's control cycles.

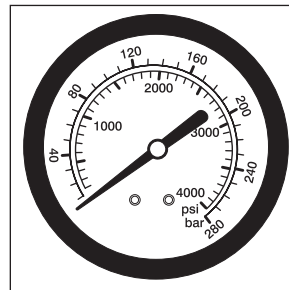
- Light off indicates nothing is currently being controlled.
- "Flash, pause" light cycle indicates system is waiting for an action before starting cycle.
- Light on indicates something is currently being controlled.
- "Flash, pause, flash, longer pause" light cycle indicates a control cycle has been interrupted.



lc0084c.eps

Thrust Pressure Gauge

This gauge displays hydraulic fluid pressure to thrust motors during thrust and pullback.

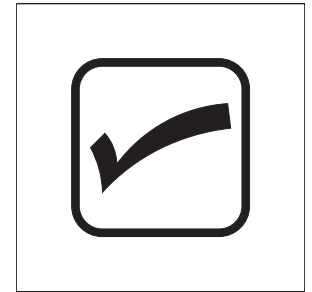


ic0105c.eps

Control Cycle Light

This light displays the status of machine's control cycles.

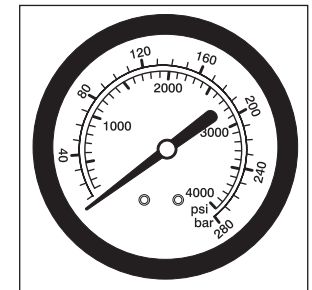
- Light off indicates nothing is currently being controlled.
- "Flash, pause" light cycle indicates system is waiting for an action before starting cycle.
- Light on indicates something is currently being controlled.
- "Flash, pause, flash, longer pause" light cycle indicates a control cycle has been interrupted.



lc0084c.eps

Thrust Pressure Gauge

This gauge displays hydraulic fluid pressure to thrust motors during thrust and pullback.

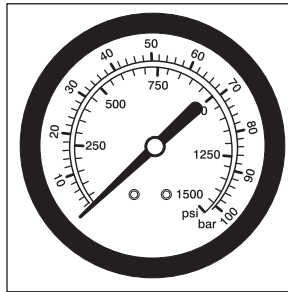


ic0105c.eps

Drilling Fluid Pressure Gauge

This gauge displays pressure in drilling fluid hard line.

IMPORTANT: Monitor this gauge and drilling fluid flowmeter carefully to see if values are rising or falling at the same time. If they are not, nozzle might be plugged.

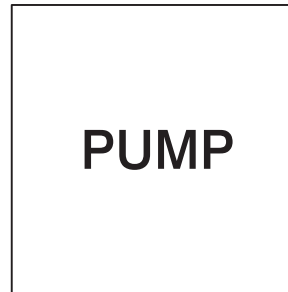


ic0106c.eps

Drilling Fluid Pump Status Light

This light shows the status of drilling fluid pump.

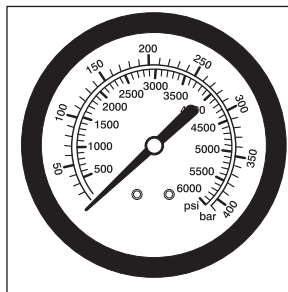
- When pump is on, light should be on.
- When pump is off, light should be off.



ic1353a.eps

Rotation Pressure Gauge

This gauge displays hydraulic fluid pressure to rotation motor when spindle is turned clockwise.

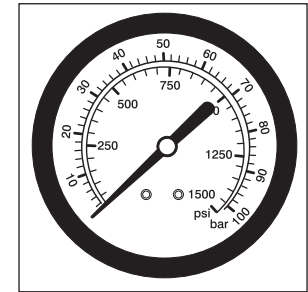


ic0104c.eps

Drilling Fluid Pressure Gauge

This gauge displays pressure in drilling fluid hard line.

IMPORTANT: Monitor this gauge and drilling fluid flowmeter carefully to see if values are rising or falling at the same time. If they are not, nozzle might be plugged.

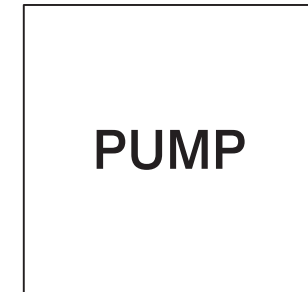


ic0106c.eps

Drilling Fluid Pump Status Light

This light shows the status of drilling fluid pump.

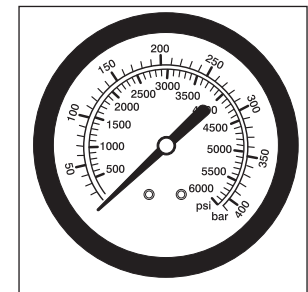
- When pump is on, light should be on.
- When pump is off, light should be off.



ic1353a.eps

Rotation Pressure Gauge

This gauge displays hydraulic fluid pressure to rotation motor when spindle is turned clockwise.



ic0104c.eps

Dual Speed Carriage Travel/ Two-Speed Ground Drive Control

This button increases carriage travel speed or ground drive speed.

Carriage Travel Speed

IMPORTANT: Drill/park/drive selector must be in **drill** position.

Use during bore or pullback **when no pipe is in spindle** to save time.

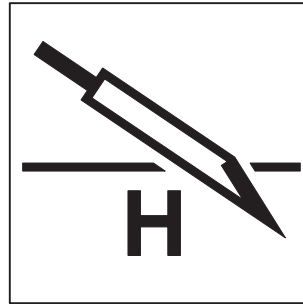
- Push to increase carriage travel speed.
- Release to return to normal carriage travel speed.

Ground Drive Speed

IMPORTANT: Drill/park/drive selector must be in **drive** position.

Use during driving **when driving straight**. Unit will be in low speed mode each time unit is started.

- Push for high ground drive speed.
- Push again for low ground drive speed.



ic0101c.eps

Dual Speed Carriage Travel/ Two-Speed Ground Drive Control

This button increases carriage travel speed or ground drive speed.

Carriage Travel Speed

IMPORTANT: Drill/park/drive selector must be in **drill** position.

Use during bore or pullback **when no pipe is in spindle** to save time.

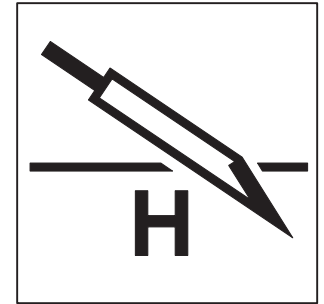
- Push to increase carriage travel speed.
- Release to return to normal carriage travel speed.

Ground Drive Speed

IMPORTANT: Drill/park/drive selector must be in **drive** position.

Use during driving **when driving straight**. Unit will be in low speed mode each time unit is started.

- Push for high ground drive speed.
- Push again for low ground drive speed.

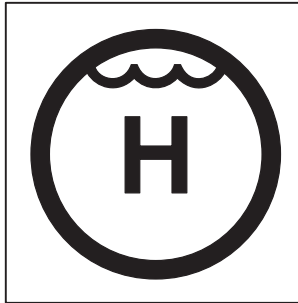


ic0101c.eps

Drilling Fluid Quick Fill Switch

This switch allows drill pipe to be filled with drilling fluid quickly.

- Press and hold for full pump flow to fill pipe with fluid.
- Release to return fluid flow to flow control setting.

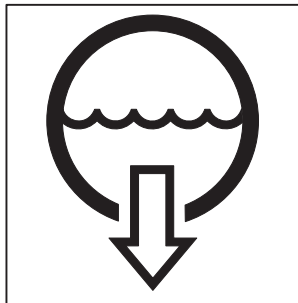


ic0100c.eps

Drilling Fluid Pump Switch

This switch controls fluid pump.

- Press once to turn on.
- Press again to turn off.

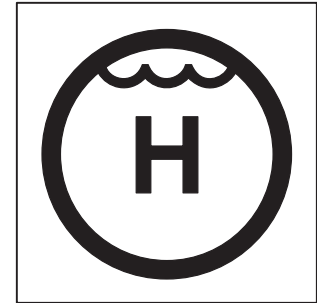


ic0102c.eps

Drilling Fluid Quick Fill Switch

This switch allows drill pipe to be filled with drilling fluid quickly.

- Press and hold for full pump flow to fill pipe with fluid.
- Release to return fluid flow to flow control setting.

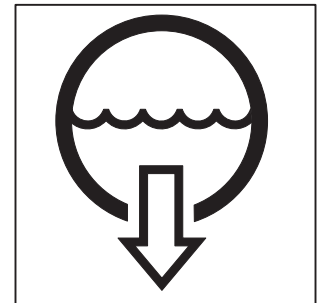


ic0100c.eps

Drilling Fluid Pump Switch

This switch controls fluid pump.

- Press once to turn on.
- Press again to turn off.



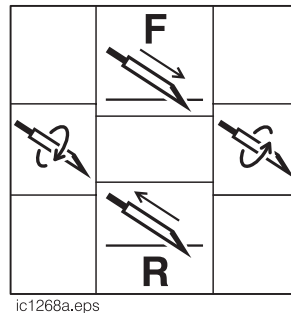
ic0102c.eps

Track and Carriage Control

This joystick controls track direction and speed and thrust/rotation direction and speed.

Track Control

With drill/drive selector switch in **drive** mode, joystick controls track direction and speed.



- Push to move forward.
- Pull to move backward.
- While moving forward or backward, move right or left to steer.

For more information on this control function, see “Operate Track Control” in **TRANSPORTATION**.

Carriage Control

With drill/drive selector switch in **drill** mode, joystick controls thrust/rotation direction and speed.

Push or pull joystick to control thrust direction.

- Push to move forward.
- Pull to move backward.

Move joystick right or left to control rotation.

- Move right to rotate counterclockwise (breakout).
- Move left to rotate clockwise (makeup).

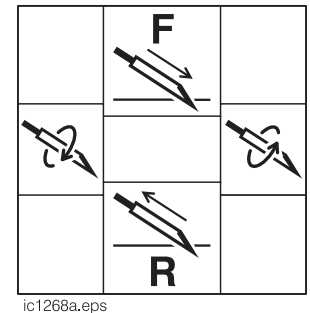
For more information on this control function, see “Operate Carriage Control” in **OPERATION**.

Track and Carriage Control

This joystick controls track direction and speed and thrust/rotation direction and speed.

Track Control

With drill/drive selector switch in **drive** mode, joystick controls track direction and speed.



- Push to move forward.
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For more information on this control function, see “Operate Track Control” in **TRANSPORTATION**.

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- Push to move forward.
- Pull to move backward.

Move joystick right or left to control rotation.

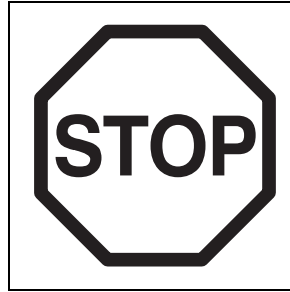
- Move right to rotate counterclockwise (breakout).
- Move left to rotate clockwise (makeup).

For more information on this control function, see “Operate Carriage Control” in **OPERATION**.

Remote Engine Stop Switch

This button stops drilling unit engine.

- Press red button on drilling unit to stop engine.
- Turn ignition switch off and then back to start to restart engine.

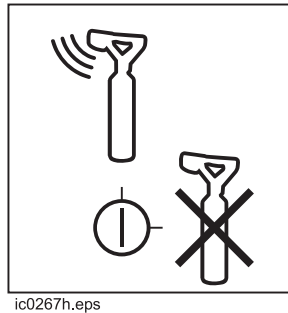


IMPORTANT: If this switch is used to stop drilling unit, be sure to turn ignition switch off if machine will be left unattended for long periods of time. Battery discharge can occur.

Tracker Control Key

This key enables and disables tracker control mode.

- Move key to enable position (up) to allow tracker operator to stop thrust and rotation. Remove key and keep in tracker operator's possession.
- Move key to disable position (right) to override tracker control mode.

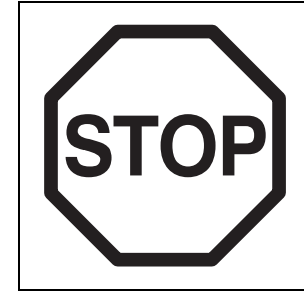


For more information on this control function, see "Operate Tracker Control Mode" in **OPERATION**.

Remote Engine Stop Switch

This button stops drilling unit engine.

- Press red button on drilling unit to stop engine.
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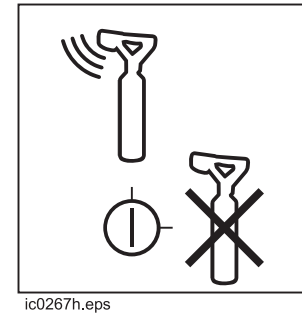


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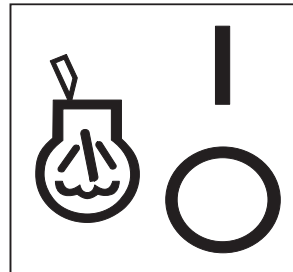


For more information on this control function, see "Operate Tracker Control Mode" in **OPERATION**.

Cold Start Switch

This switch helps start cold engine.

- Turn key to on position.
- Press top of switch for 10-20 seconds.
- Start engine.

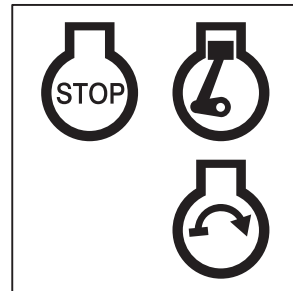


ic0137h.eps

Ignition

This switch has three positions.

- Insert key and turn all the way clockwise to start engine.
- Release when engine starts.
- Key will return to on position.
- Turn counterclockwise to STOP position to stop engine.



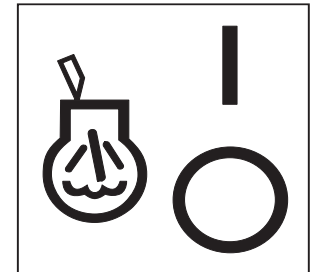
ic1271a.eps

IMPORTANT: Turn key to STOP position and then to start position to restart engine with ignition switch after it has been turned off with remote engine stop button.

Cold Start Switch

This switch helps start cold engine.

- Turn key to on position.
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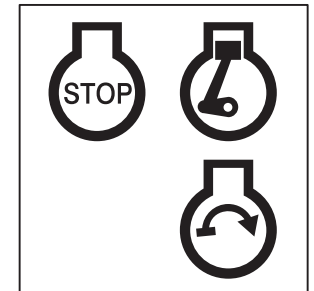


ic0137h.eps

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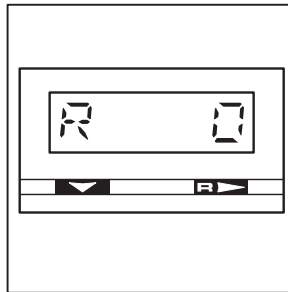
ic1271a.eps

IMPORTANT: Turn key to STOP position and then to start position to restart engine with ignition switch after it has been turned off with remote engine stop button.

Drilling Fluid Flowmeter

This gauge displays approximate rate of drilling fluid flow and keeps record of amount of drilling fluid used.

IMPORTANT: Contact your Ditch Witch dealer for calibration instructions.

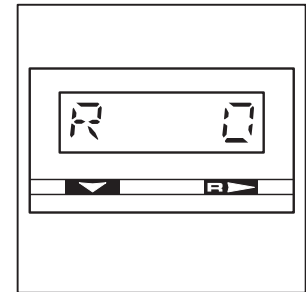


ic1264a.eps

Drilling Fluid Flowmeter

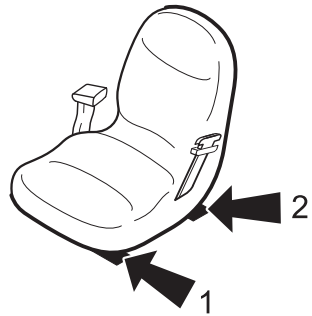
This gauge displays approximate rate of drilling fluid flow and keeps record of amount of drilling fluid used.

IMPORTANT: Contact your Ditch Witch dealer for calibration instructions.



ic1264a.eps

SEAT CONTROL DESCRIPTIONS



om0305c.eps

1. Seat slide control
2. Seat recline control

Seat Slide Control

This lever slides seat forward or backward.

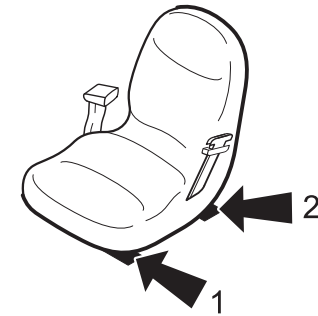
- Move lever left to slide forward or backward.
- Move lever right to lock in place.

Seat Recline Control

This lever reclines or raises back of operator's chair.

- Lift lever to recline or raise seatback.
- Release lever to lock in place.

SEAT CONTROL DESCRIPTIONS



om0305c.eps

1. Seat slide control
2. Seat recline control

Seat Slide Control

This lever slides seat forward or backward.

- Move lever left to slide forward or backward.
- Move lever right to lock in place.

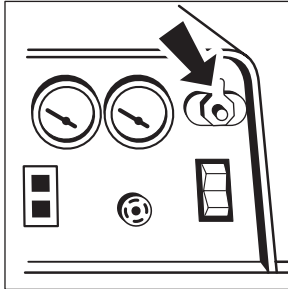
Seat Recline Control

This lever reclines or raises back of operator's chair.

- Lift lever to recline or raise seatback.
- Release lever to lock in place.

AUXILIARY OUTLET

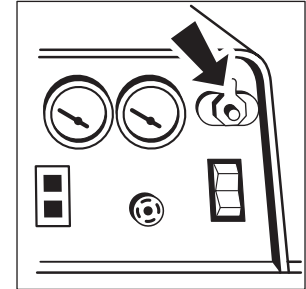
Auxiliary outlet can be used to provide up to 15 amps of power for cellular phones or other devices. Outlet has power when ignition is in on or off position.



om0286c.eps

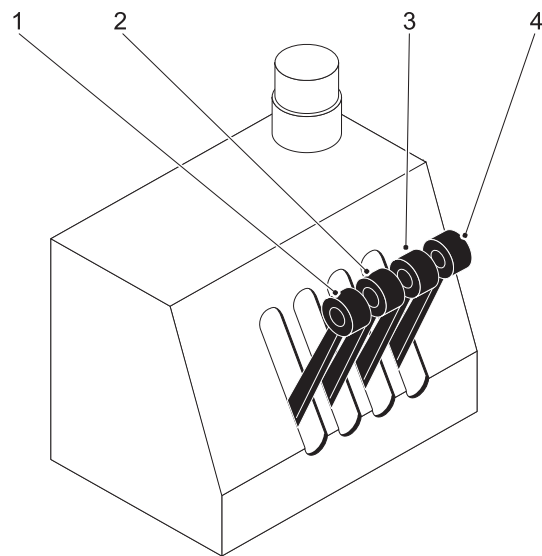
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om0286c.eps

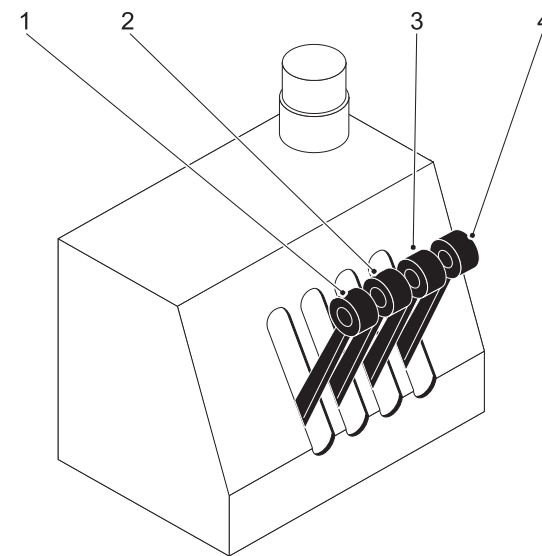
ANCHORING SYSTEM CONSOLE OVERVIEW



om0554h.eps

1. Left rotation control
2. Left thrust control
3. Right rotation control
4. Right thrust control

ANCHORING SYSTEM CONSOLE OVERVIEW



om0554h.eps

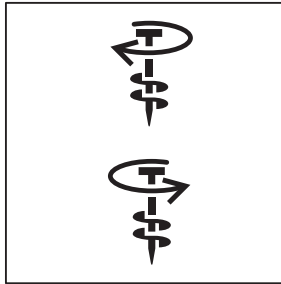
1. Left rotation control
2. Left thrust control
3. Right rotation control
4. Right thrust control

ANCHORIONG SYSTEM CONSOLE DESCRIPTIONS

Left Rotation Control

This lever controls rotation of left anchor.

- Push to drive anchor.
- Pull to remove anchor.

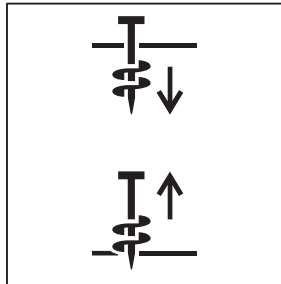


ic0140h.eps

Left Thrust Control

This lever controls thrust of left anchor.

- Push to move down.
- Pull to move up.

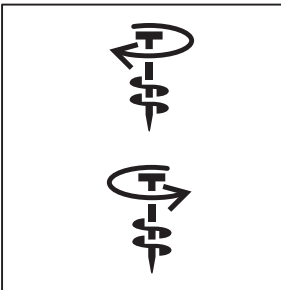


ic0141h.eps

Right Rotation Control

This lever controls rotation of right anchor.

- Push to drive anchor.
- Pull to remove anchor.



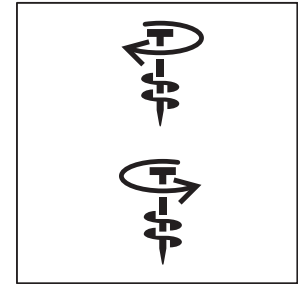
ic0140h.eps

ANCHORIONG SYSTEM CONSOLE DESCRIPTIONS

Left Rotation Control

This lever controls rotation of left anchor.

- Push to drive anchor.
- Pull to remove anchor.

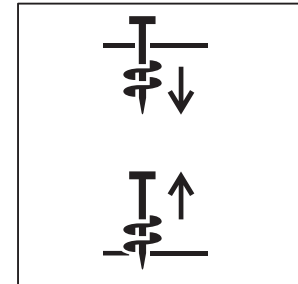


ic0140h.eps

Left Thrust Control

This lever controls thrust of left anchor.

- Push to move down.
- Pull to move up.

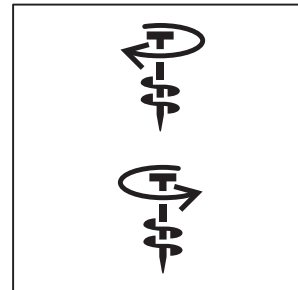


ic0141h.eps

Right Rotation Control

This lever controls rotation of right anchor.

- Push to drive anchor.
- Pull to remove anchor.

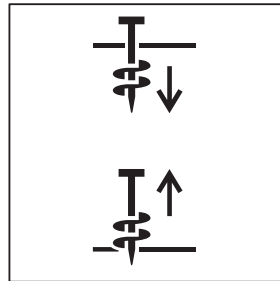


ic0140h.eps

Right Thrust Control

This lever controls thrust of right anchor.

- Push to move down.
- Pull to move up.

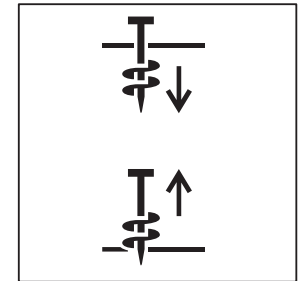


ic0141h.eps

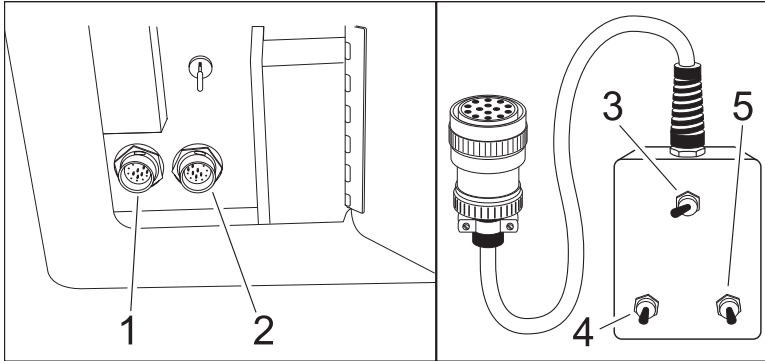
Right Thrust Control

This lever controls thrust of right anchor.

- Push to move down.
- Pull to move up.



ic0141h.eps

OVERRIDE BOX CONTROL OVERVIEW

om0282c.eps

1. Drive override connector
2. Drill override connector
3. Drilling fluid flow override switch
4. Thrust/pullback or left track override switch
5. Rotation or right track override switch

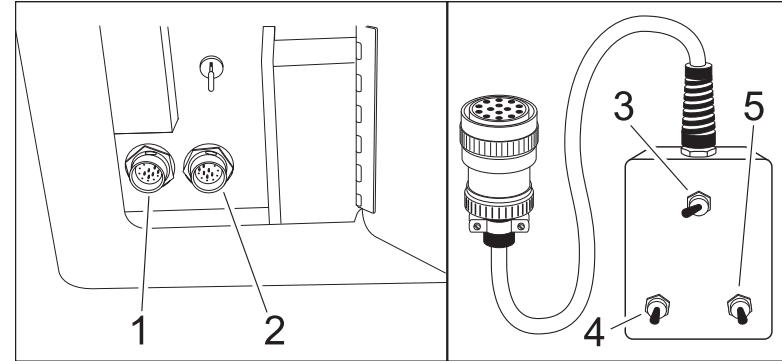
This override box allows limited control of certain critical machine functions in the event of certain component failures which may disable normal operation of these functions.

To override drive function:

1. Connect box to drive override connector (1).
2. Use left and right switches to operate left (4) and right (5) tracks.

To override drill function:

1. Connect box to drill override connector (2).
2. Use three switches to override drilling fluid (3), thrust/pullback (4), and rotation (5) functions.

OVERRIDE BOX CONTROL OVERVIEW

om0282c.eps

1. Drive override connector
2. Drill override connector
3. Drilling fluid flow override switch
4. Thrust/pullback or left track override switch
5. Rotation or right track override switch

This override box allows limited control of certain critical machine functions in the event of certain component failures which may disable normal operation of these functions.

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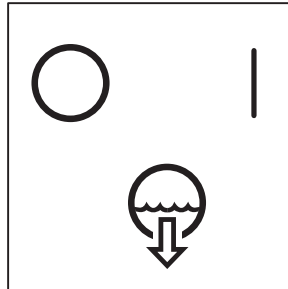
1. Connect box to drill override connector (2).
2. Use three switches to override drilling fluid (3), thrust/pullback (4), and rotation (5) functions.

OVERRIDE BOX CONTROL DESCRIPTIONS

Drilling Fluid Flow Override Switch

This switch turns drilling fluid on and off when override box is connected to drill connector.

- Move right to turn fluid on.
- Move left to turn fluid off.

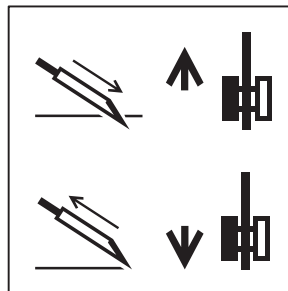


ic1350a.eps

Thrust/Pullback or Left Track Override Switch

This switch controls thrust and pullback when override box is connected to drill connector or left track when override box is connected to drive connector.

- Move up for thrust or to move track forward.
- Move down for pullback or to move track backward.



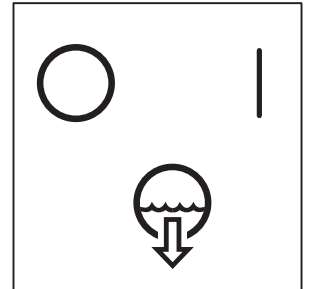
ic1351a.eps

OVERRIDE BOX CONTROL DESCRIPTIONS

Drilling Fluid Flow Override Switch

This switch turns drilling fluid on and off when override box is connected to drill connector.

- Move right to turn fluid on.
- Move left to turn fluid off.

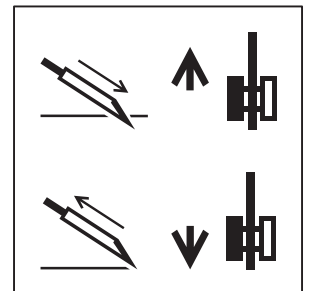


ic1350a.eps

Thrust/Pullback or Left Track Override Switch

This switch controls thrust and pullback when override box is connected to drill connector or left track when override box is connected to drive connector.

- Move up for thrust or to move track forward.
- Move down for pullback or to move track backward.

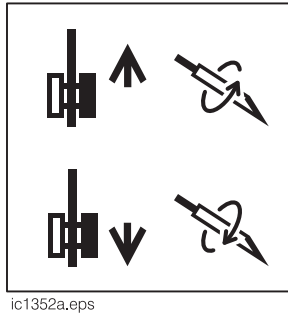


ic1351a.eps

Rotation or Right Track Override Switch

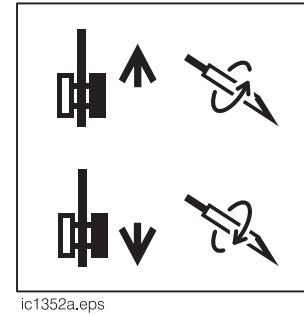
This switch controls rotation when override box is connected to drill connector or right track when override box is connected to drive connector.

- Move up to rotate counter-clockwise or to move track forward.
- Move down to rotate clockwise or to move track backward.

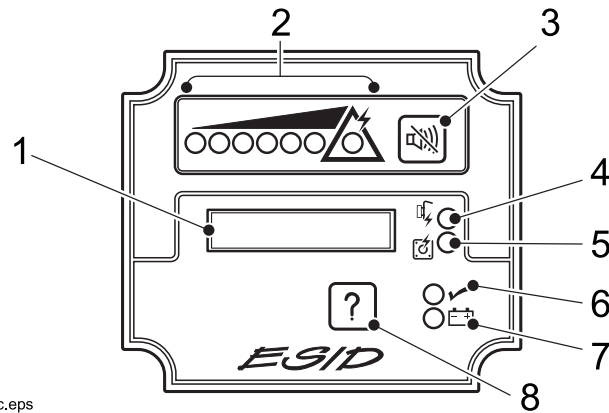
**Rotation or Right Track Override Switch**

This switch controls rotation when override box is connected to drill connector or right track when override box is connected to drive connector.

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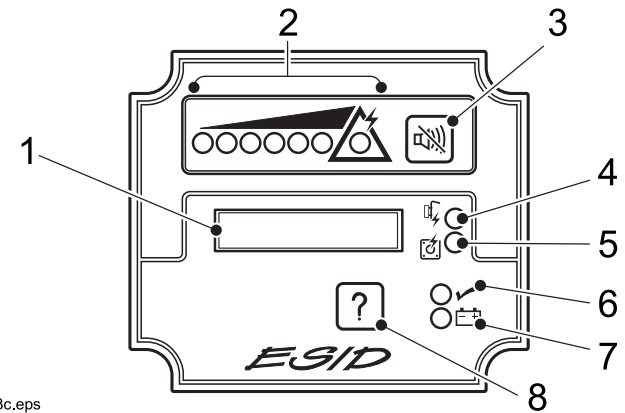
ESID OVERVIEW



Om0203c.eps

1. Alphanumeric display
2. Strike indicator
3. Alarm interrupt button
4. Voltage problem indicator
5. Current problem indicator
6. OK indicator
7. Electrical power supply indicator
8. Self test button

ESID OVERVIEW



Om0203c.eps

1. Alphanumeric display
2. Strike indicator
3. Alarm interrupt button
4. Voltage problem indicator
5. Current problem indicator
6. OK indicator
7. Electrical power supply indicator
8. Self test button

ESID DESCRIPTIONS

Alphanumeric Display

This area shows how much current and voltage is being detected as a percentage of strike condition. The line with the "V" shows voltage reading and the line with the "A" shows current reading.

This area also displays error codes (see "Troubleshoot Electric Strike System" in **MAINTENANCE**) and strike history information (contact your Ditch Witch dealer for more information).

Strike Indicator

Red lights come on as values in display increase. Light in triangle represents strike warning condition and will trigger alarm(s) and strobe(s). Remember that system can go from one or two lights to an electric strike very quickly.

See **SAFETY** for information about what to do in an electric strike.

Alarm Interrupt Button

This button turns off alarm at drilling unit during a strike.

Voltage Problem Indicator

Red light indicates a voltage problem. See "Troubleshoot Electric Strike System" in **MAINTENANCE**.

ESID DESCRIPTIONS

Alphanumeric Display

This area shows how much current and voltage is being detected as a percentage of strike condition. The line with the "V" shows voltage reading and the line with the "A" shows current reading.

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Alarm Interrupt Button

This button turns off alarm at drilling unit during a strike.

Voltage Problem Indicator

Red light indicates a voltage problem. See "Troubleshoot Electric Strike System" in **MAINTENANCE**.

Current Problem Indicator

Red light indicates a current problem. See "Troubleshoot Electric Strike System" in **MAINTENANCE**.

OK Indicator

Green light means system self test detected no problems. Strike system is ready to operate if electrical power supply indicator is also on.

Electrical Power Supply Indicator

Green light means control box has sufficient electrical power for operation. Strike system is ready to operate if OK indicator is also on.

Self Test Button

Press this button to start manual self test which checks all systems and circuits except voltage limiter.

Current Problem Indicator

Red light indicates a current problem. See "Troubleshoot Electric Strike System" in **MAINTENANCE**.

OK Indicator

Green light means system self test detected no problems. Strike system is ready to operate if electrical power supply indicator is also on.

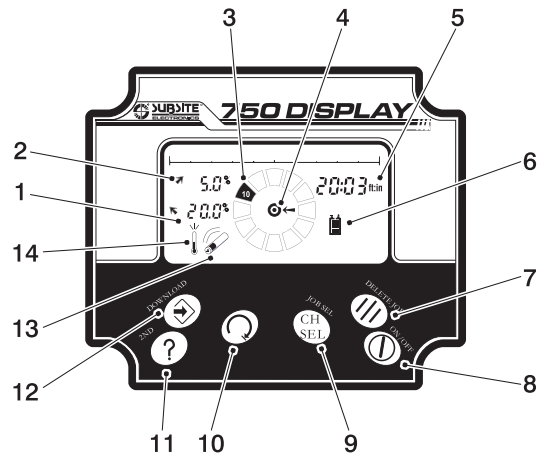
Electrical Power Supply Indicator

Green light means control box has sufficient electrical power for operation. Strike system is ready to operate if OK indicator is also on.

Self Test Button

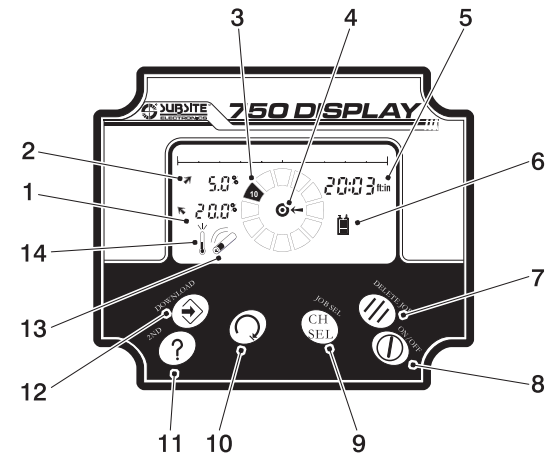
Press this button to start manual self test which checks all systems and circuits except voltage limiter.

SUBSITE 750 DISPLAY OVERVIEW



1. Left/right indicator and percentage display
2. Pitch/slope indicator and percentage display
3. Roll display
4. Target identifier
5. Depth estimate (pipe number--TMS option) display
6. 750 Display battery status indicator
7. Delete button
8. On/off button
9. Channel select button
10. Roll stop button
11. Recall button
12. Store button
13. Beacon battery status indicator
14. Beacon temperature indicator

SUBSITE 750 DISPLAY OVERVIEW



1. Left/right indicator and percentage display
2. Pitch/slope indicator and percentage display
3. Roll display
4. Target identifier
5. Depth estimate (pipe number--TMS option) display
6. 750 Display battery status indicator
7. Delete button
8. On/off button
9. Channel select button
10. Roll stop button
11. Recall button
12. Store button
13. Beacon battery status indicator
14. Beacon temperature indicator

SUBSITE 750 DISPLAY DESCRIPTIONS

Left/Right Indicator and Percentage Display

This arrow and number show compass beacon's left or right deviation from initialized reading in percentage or in degrees.

Pitch/Slope Indicator and Display

This arrow and number show pitch beacon's percent of grade.

Roll Display

This display shows beacon's roll angle.

Target Identifier

These arrows indicate approximate beacon location. Only one set of arrows (fore/aft or left/right) is active at a time.

SUBSITE 750 DISPLAY DESCRIPTIONS

Left/Right Indicator and Percentage Display

This arrow and number show compass beacon's left or right deviation from initialized reading in percentage or in degrees.

Pitch/Slope Indicator and Display

This arrow and number show pitch beacon's percent of grade.

Roll Display

This display shows beacon's roll angle.

Target Identifier

These arrows indicate approximate beacon location. Only one set of arrows (fore/aft or left/right) is active at a time.

Depth Estimate (Pipe Number--TMS Option) Display

This display shows beacon depth estimate. It also shows pipe number if using Trac Management System option.

750 Display Battery Status Indicator

This indicator shows whether display is getting proper power from drilling unit. If all five bars are not showing, check display power connections.

Beacon Battery Status Indicator

This indicator shows beacon's battery status (see beacon's instruction sheet).

Beacon Temperature Indicator

This indicator shows beacon's temperature (see beacon's instruction sheet).

Depth Estimate (Pipe Number--TMS Option) Display

This display shows beacon depth estimate. It also shows pipe number if using Trac Management System option.

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This indicator shows whether display is getting proper power from drilling unit. If all five bars are not showing, check display power connections.

Beacon Battery Status Indicator

This indicator shows beacon's battery status (see beacon's instruction sheet).

Beacon Temperature Indicator

This indicator shows beacon's temperature (see beacon's instruction sheet).

Delete Button

This button deletes last stored data when using Trac Management System option.

- Press to issue command over serial interface.
- Previous pipe number will appear in numeric display when data is deleted.



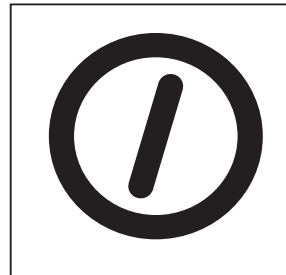
si1055a.eps

Second function: Press with Recall button to delete all jobs in internal logging memory.

On/Off Button

This button turns display unit on or off.

- Press to turn on.
- Press again to turn off.

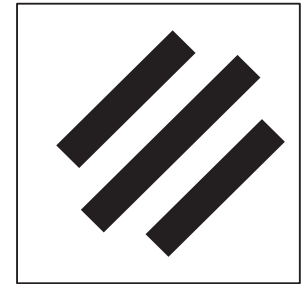


si1057a.eps

Delete Button

This button deletes last stored data when using Trac Management System option.

- Press to issue command over serial interface.
- Previous pipe number will appear in numeric display when data is deleted.



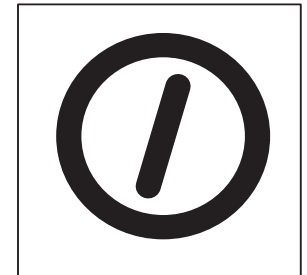
si1055a.eps

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On/Off Button

This button turns display unit on or off.

- Press to turn on.
- Press again to turn off.



si1057a.eps

Channel Select Button

This button selects between two radio channels.

- Press and release to display current channel.
- Press and hold to switch channels.
- Unit defaults to channel one each time unit is turned on.



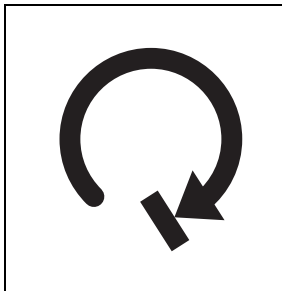
si1058a.eps

IMPORTANT: Make sure display and tracker are set to the same channel.

Second function: Press with Recall button to select job to open. "Init" and job number will be displayed.

Roll Stop Button

This feature is not yet available.



si1069a.eps

Channel Select Button

This button selects between two radio channels.

- Press and release to display current channel.
- Press and hold to switch channels.
- Unit defaults to channel one each time unit is turned on.



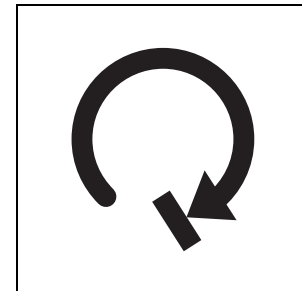
si1058a.eps

IMPORTANT: Make sure display and tracker are set to the same channel.

Second function: Press with Recall button to select job to open. "Init" and job number will be displayed.

Roll Stop Button

This feature is not yet available.



si1069a.eps

Recall Button

This button allows operator to view last stored data when using Trac Management System option.

- Press to issue command over serial interface.
- Data about previous pipe number (except depth estimate) will appear in display.



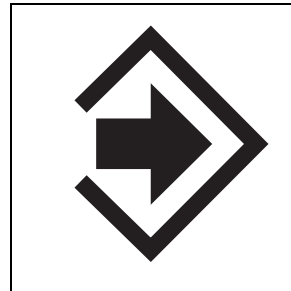
si1066a.eps

Second function: Press with other buttons to access second functions.

Store Button

This button allows operator to store currently displayed data.

- Press and hold after power up to display serial number.
- Press to transmit data over the serial interface.
- Pipe number will appear in numeric display when data is stored.



si1064a.eps

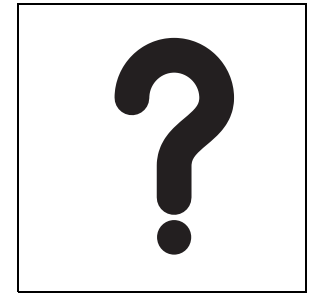
Second function: Press with Recall button to download all jobs stored in internal logging memory.

IMPORTANT: Connect display to PC running Trac Management System software **before** starting download.

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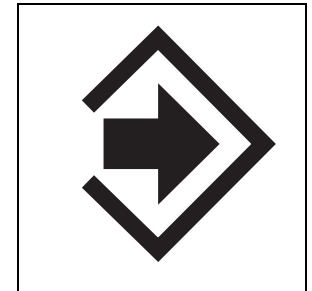
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si1064a.eps

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SAFETY

Follow these guidelines before operating any jobsite equipment:

- Complete proper training and read operator's manual before using equipment.
- Contact One-Call (888-258-0808) and any utility companies which do not subscribe to One-Call. Have all underground pipes and cables located and marked before operating equipment. If you damage a utility, contact utility company.
- Classify jobsite based on its hazards and use correct tools and machinery, safety equipment, and work methods for jobsite.
- Mark jobsite clearly and keep spectators away.
- Wear personal protective equipment.
- Review jobsite hazards, safety and emergency procedures, and individual responsibilities with all personnel before work begins. Safety videos are available from your Ditch Witch dealer.
- Replace missing or damaged safety shields and safety signs.
- Use equipment carefully. Stop operation and investigate anything that does not look or feel right.
- Do not operate unit where flammable gas is present.
- Contact your Ditch Witch dealer if you have any question about operation, maintenance, or equipment use.

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ACCESSORIES

Fire Extinguisher

If required, a fire extinguisher should be mounted near the power unit but away from possible points of ignition. The fire extinguisher should always be classified for both oil and electric fires. It should meet legal and regulatory requirements.

Lighting Kit

If you need additional light, plug lighting kit into provided outlet. Contact your Ditch Witch dealer for further information.

UNDERGROUND HAZARDS

Striking underground hazards can cause explosion, electrocution, fire, and exposure to hazardous materials.

Hazards include:

- Electric lines
- Natural gas lines
- Fiber optic cables
- Water lines
- Sewer lines
- Pipes carrying other chemicals, liquids, or gases
- Storage tanks

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EMERGENCY PROCEDURES

Before operating any equipment, review emergency procedures and check that all safety precautions have been taken.

EMERGENCY SHUTDOWN - Turn ignition switch to stop position or push remote engine stop button.

Electric Strike Description

When working near electric cables, remember the following:

- Electricity follows all paths to ground, not just path of least resistance.
- Pipes, hoses, and cables will conduct electricity back to all equipment.
- Low voltage current can injure or kill. Almost one-third of work-related electrocutions result from contact with less than 440 volts.

Most electric strikes are not noticeable, but indications of a strike include:

- power outage
- smoke
- explosion
- popping noises
- arcing electricity

If any of these occur, or if strike alarm sounds or flashes, assume an electric strike has occurred.

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If an Electric Line is Damaged

On Drilling Unit or Bonded Ground Mats

1. DO NOT MOVE. Remain on drilling machine or mats.
2. Warn people nearby that an electric strike has occurred.
3. Have someone contact electric company.
4. Reverse drilling direction and try to break contact. Do not touch drill pipe with hands or hand-held tools.
5. Press Electric Strike System status button.
 - If alarm sounds again, stay where you are and wait for electric company to shut off power.
 - If alarm does not sound and there is no other indication of a strike, wait at least one full minute before moving away from equipment. Utility might use automatic reclosers which will restart current flow. If alarm sounds again while waiting, stay where you are until electric company shuts off power.
 - If alarm does not sound but all lights in strike indicator are on, assume strike is continuing and stay where you are until electric company shuts off power.
6. Do not resume drilling or allow anyone into area until given permission by electric company.

Off Drilling Unit or Bonded Ground Mats

1. DO NOT TOUCH ANY EQUIPMENT connected to drilling unit.
2. Stay where you are unless you are wearing electric insulating boots. If you leave, do not return to area or allow anyone into area until given permission by electric company.

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If a Gas Line is Damaged

If you suspect a gas line has been damaged, take the following actions. The order and degree of action will depend on the situation.

- Immediately shut off engine(s), if this can be done safely and quickly.
- Remove any ignition source(s), if this can be done safely and quickly.
- Warn others that a gas line has been cut and that they should leave the area.
- Leave jobsite as quickly as possible.
- Immediately call your local emergency phone number and utility company.
- If jobsite is along street, stop traffic from driving near jobsite.
- Do not return to jobsite until given permission by emergency personnel and utility company.

If a Fiber Optic Cable is Damaged

Do not look into cut ends of fiber optic or unidentified cable. Vision damage can occur.

If Machine Catches on Fire

Perform emergency shutdown procedure and then take the following actions. The order and degree of action will depend on the situation.

- Immediately move battery disconnect switch (if equipped) to disconnect position.
- If fire is small and fire extinguisher is available, attempt to extinguish fire.
- If fire cannot be extinguished, leave area as quickly as possible and contact emergency personnel.

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JOBSITE CLASSIFICATION

Inspecting Jobsite

- Follow U.S. Department of Labor regulations on excavating and trenching (Part 1926, Subpart P) and other similar regulations.
- Contact One-Call (888-258-0808) and any utility companies which do not subscribe to One-Call.
- Inspect jobsite and perimeter for evidence of underground hazards, such as:
 - “Buried utility” notices
 - Utility facilities without overhead lines
 - Gas or water meters
 - Junction boxes
 - Drop boxes
 - Light poles
 - Manhole covers
 - Sunken ground
- Have an experienced locating equipment operator sweep area within 20’ (6 m) to each side of bore path. Verify previously marked line and cable locations.
- Mark location of all buried utilities and obstructions.
- Classify jobsite.

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- Classify jobsite.

Selecting a Classification

Jobsites are classified according to underground hazards present.

If working . . .	then classify jobsite as . . .
within 10' (3 m) of a buried electric line	electric
within 10' (3 m) of a natural gas line	natural gas
in sand or granite which is capable of producing crystalline silica (quartz) dust	crystalline silica (quartz) dust
within 10' (3 m) of any other hazard	other

NOTICE: If you have any doubt about jobsite classification, or if jobsite might contain unmarked hazards, take steps outlined previously to identify hazards and classify jobsite before working.

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Applying Precautions

Once classified, precautions appropriate for jobsite must be taken.

Electric Jobsite Precautions

In addition to using a directional drilling system with an electric strike system, use one or both of these methods.

- Expose line by careful hand digging or soft excavation. Use beacon to track bore path.
- Have service shut down while work is in progress. Have electric company test lines before returning them to service.

Natural Gas Jobsite Precautions

In addition to using a directional drilling system and positioning equipment upwind from gas lines, use one or both of these methods.

- Expose lines by careful hand digging or soft excavation. Use beacon to track bore path.
- Have gas shut off while work is in progress. Have gas company test lines before returning them to service.

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Crystalline Silica (Quartz) Dust Precautions

Follow OSHA or other guidelines for exposure to crystalline silica when trenching, sawing or drilling through material that might produce dust containing crystalline silica (quartz).

Other Jobsite Precautions

You may need to use different methods to safely avoid other underground hazards. Talk with those knowledgeable about hazards present at each site to determine which precautions should be taken or if job should be attempted.

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SAFETY ALERT CLASSIFICATIONS

These classifications and the icons defined on the following pages work together to alert you to situations which could be harmful to you, jobsite bystanders or your equipment. When you see these words and icons in the book or on the machine, carefully read and follow all instructions. YOUR SAFETY IS AT STAKE.

Watch for the three safety alert levels: **DANGER**, **WARNING** and **CAUTION**. Learn what each level means.

 **DANGER** indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.

 **WARNING** indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

 **CAUTION** indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.

Watch for two other words: **NOTICE** and **IMPORTANT**.

NOTICE can keep you from doing something that might damage the machine or someone's property. It can also alert you against unsafe practices.

IMPORTANT can help you do a better job or make your job easier in some way.

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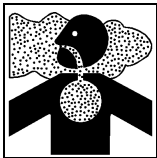
SAFETY ALERTS



⚠ DANGER Turning shaft will kill you or crush arm or leg. Stay away.



⚠ DANGER Electric shock. Contacting electric lines will cause death or serious injury. Know location of lines and stay away.

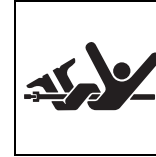


⚠ DANGER Deadly gases. Lack of oxygen or presence of gas will cause sickness or death. Provide ventilation.

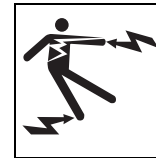


⚠ DANGER Moving parts. Being struck by wrench will kill or injure. Do not use drilling unit to turn or move drill string when wrench is used.

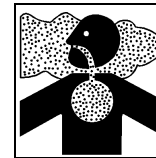
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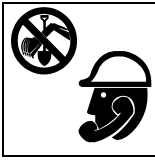
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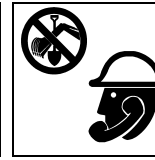
⚠ WARNING Jobsite hazards could cause death or serious injury. Use correct equipment and work methods. Use and maintain proper safety equipment.



⚠ WARNING Crushing weight could cause death or serious injury. Use proper procedures and equipment or stay away.



⚠ WARNING Moving parts could cut off hand or foot. Stay away.



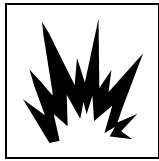
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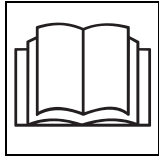
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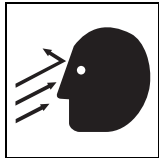
⚠ WARNING Moving parts could cut off hand or foot. Stay away.



⚠ WARNING Explosion possible. Serious injury or equipment damage could occur. Follow directions carefully.



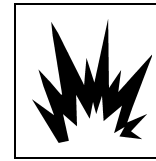
⚠ WARNING Incorrect procedures could result in death, injury, or property damage. Learn to use equipment correctly.



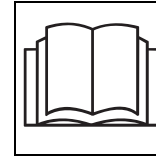
⚠ WARNING Looking into fiber optic cable could result in permanent vision damage. Do not look into ends of fiber optic or unidentified cable.



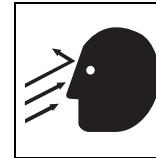
⚠ WARNING Fluid or air pressure could pierce skin and cause injury or death. Stay away.



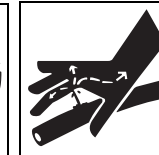
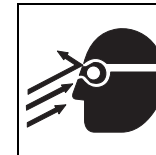
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⚠ WARNING Fluid or air pressure could pierce skin and cause injury or death. Stay away.

**⚠ WARNING**

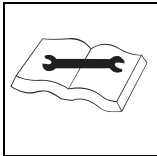
Fire or explosion possible. Fumes could ignite and cause burns. No smoking, no flame, no spark.

**⚠ WARNING**

Moving traffic - hazardous situation. Death or serious injury could result. Avoid moving vehicles, wear high visibility clothing, post appropriate warning signs.

**⚠ WARNING**

Hot pressurized cooling system fluid could cause serious burns. Allow to cool before servicing.

**⚠ WARNING**

Improper control function could cause death or serious injury. If control does not work as described in instructions, stop machine and have it serviced.

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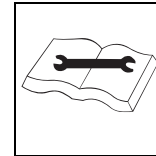
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CAUTION Flying objects may cause injury. Wear hard hat and safety glasses.



CAUTION Hot parts may cause burns. Do not touch until cool.



CAUTION Exposure to high noise levels may cause hearing loss. Wear hearing protection.



CAUTION Fall possible. Slips or trips may result in injury. Keep area clean.



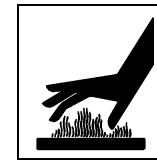
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CAUTION Improper handling or use of chemicals may result in illness, injury, or equipment damage. Follow instructions on labels and in material safety data sheets (MSDS).



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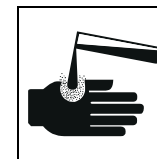
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PREPARATION

GATHER INFORMATION

A successful job begins before the bore. The first step in planning is reviewing information already available about the job and jobsite.

Job Plan

Review blueprints or other plans and make sure you have taken bore enlargement during backreaming and pullback into account. Check for information about existing or planned structures, elevations, or proposed work that may be taking place at the same time.

One-Call Services

Call area One-Call or similar services and have existing lines located and marked. Call any utilities in your area that do not subscribe to One-Call.

Pullback Material

Ask for a sample of the material you will be pulling back. Check its weight and stiffness. Contact the manufacturer for bend radius information. Check that you have appropriate pullback devices.

Traffic Control

If working near a road or other traffic area, contact local authorities about safety procedures and regulations.

Emergency Services

Have the telephone numbers for local emergency and medical facilities on hand. Check that you will have access to a telephone.

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INSPECT SITE

Inspect jobsite before transporting equipment. Check for the following:

- Overall grade or slope
- Changes in elevation such as hills or open trenches
- Obstacles such as buildings, railroad crossings, or streams
- Signs of utilities (See **SAFETY**)
- Traffic
- Access
- Soil type and condition
- Water supply
- Sources of locator interference (rebar, railroad tracks, etc.)

Take soil samples from several locations along bore path to determine best bit and backreamer combinations.

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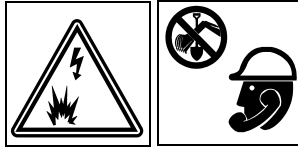
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Identify Hazards

Identify safety hazards and classify jobsite. See **SAFETY**.



WARNING Jobsite hazards could cause death or serious injury. Use correct equipment and work methods. Use and maintain proper safety equipment.

NOTICES:

- Wear personal protective equipment including hard hat, safety eye wear, and hearing protection.
- Do not wear jewelry or loose clothing.
- Notify One-Call and companies which do not subscribe to One-Call.
- Comply with all utility notification regulations before digging or drilling.
- Verify location of previously marked underground hazards.
- Mark jobsite clearly and keep spectators away.

Remember, jobsite is classified by hazards in place -- not by line being installed.

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Select Start and End Points

Select one end to use as a starting point. Consider the following when selecting a starting point:

Slope

Fluid system should be parked on a level site. Consider how slope will affect drilling unit set-up, bending pipe, and fluid flow out of hole.

Traffic

Vehicle and pedestrian traffic must be a safe distance from drilling equipment. Allow at least 10' (3 m) buffer zone around equipment.

Space

Check that starting and ending points allow enough space for gradual pipe bending. See "Minimum Setback" in this chapter.

Check that there is enough space to work and to set up Electric Strike System.

Comfort

Consider shade, wind, fumes, and other site features.

Drill downhill when possible so fluid will flow away from drilling unit.

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PLAN BORE PATH

The bore path, from entry to end, must be planned before drilling begins. Bore path can be marked on ground with spray paint or flags, or written on paper for operator reference.

For complicated bores, consult an engineer. Have jobsite surveyed and bore path calculated. Be sure engineer knows minimum entry pitch, bend limits of drill pipe and pullback material, pipe lengths, and location of all underground utilities.

For less complicated paths, bore will be limited by four measurements: recommended bend limits, entry pitch, minimum setback, and minimum depth. Recommended bend limits must be considered during any bend, not just during bore entry.

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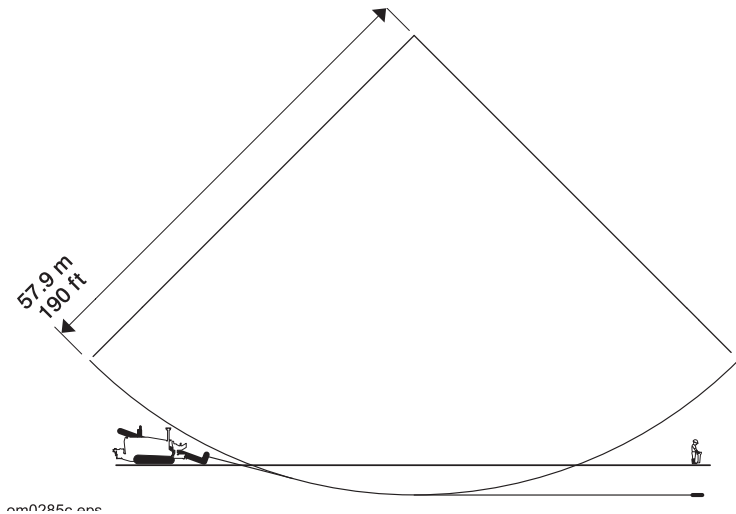
Recommended Bend Limit

Though Ditch Witch pipes are designed to bend, bending beyond recommended limits will cause damage that might not be seen. This damage adds up and can lead to sudden pipe failure.

JT4020 Mach 1 drill pipes have a tested bend radius of 190' (57.9 m), meaning a 90 degree bend, whether during entry and exit or when turning, requires 190' (57.9 m) of forward distance and approximately 298' (90.8 m) of pipe.

Use **APPENDIX**, sections A and B, to keep bends within bend limits and make sure pitch changes no more than 7% per pipe.

NOTICE: Bending pipe more sharply than recommended will damage pipe and cause failure over time.



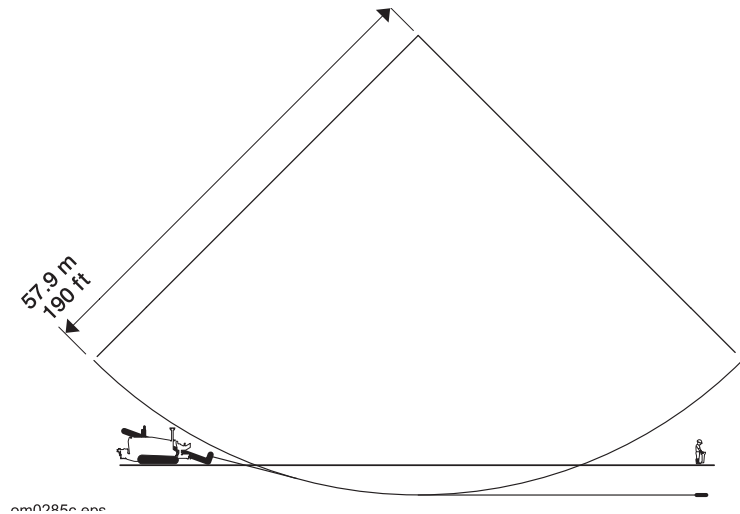
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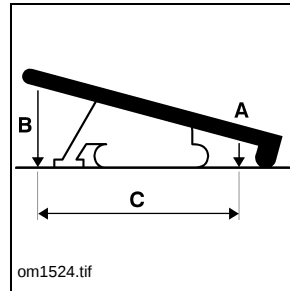


Entry Pitch

Entry pitch is drilling unit slope compared to slope of ground.

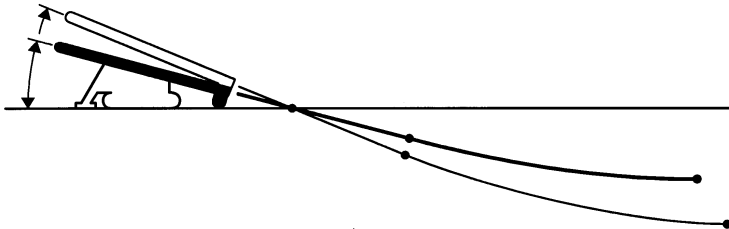
Entry pitch can be determined two ways:

1. Lay pitch beacon on ground and read pitch. Lay pitch beacon on drilling unit and read pitch. Subtract ground pitch from drilling unit pitch.
2. Measure from ground to front end of frame (A). Measure from ground to back end of frame (B). Subtract front measurement from back measurement to get rise. Measure distance between front and back points to get run (C). Divide rise by run and multiply by 100 to get pitch.



$$\frac{(B \ominus A)}{C} \times 100$$

3. A shallow entry pitch allows you to reach horizontal sooner and with less bending. Increasing entry pitch makes bore path longer and deeper.



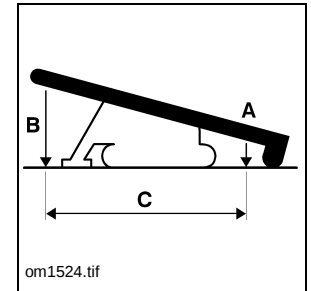
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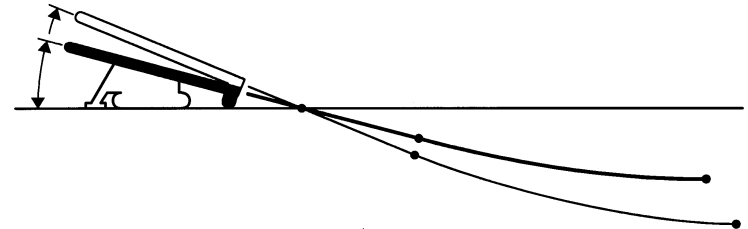
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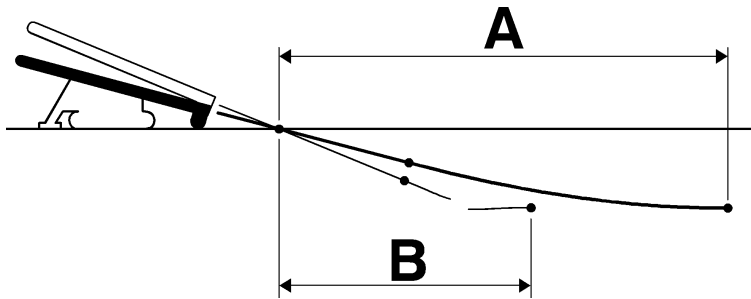


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Minimum Setback

Setback is the distance from entry to horizontal (A). If setback is too small (B), bend limits are exceeded and pipe can be damaged.

To determine the minimum setback for your required depth, use chart in **APPENDIX**, section B. Find entry pitch you will be using, then minimum setback.



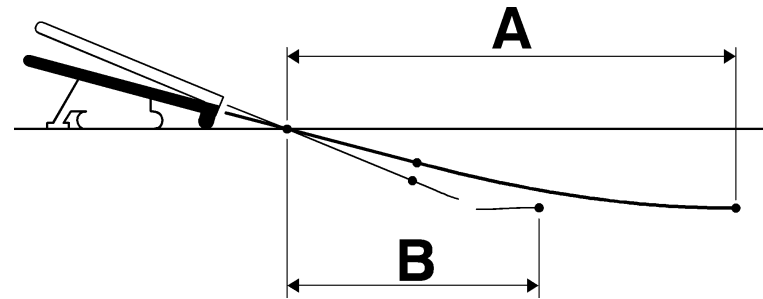
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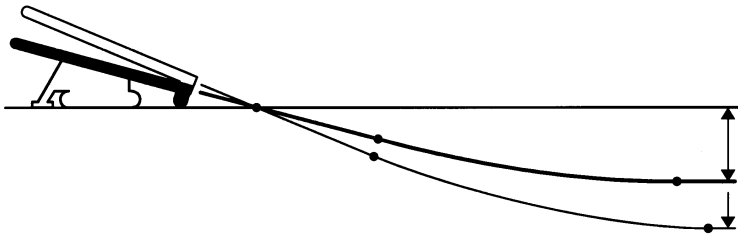
A. Proper setback B. Setback too small

Minimum Depth

Because pipe must be bent gradually, entry pitch and bend limits determine how deep the pipe will be when it reaches horizontal. Use the chart in **APPENDIX**, section B, to determine minimum depth for your job.

To reduce depth, reduce entry pitch. To increase depth, increase entry pitch and setback.

To find setback and entry pitch that will take you to desired depth, locate depth on chart in **APPENDIX**, section B. Then find corresponding setback and entry pitch.



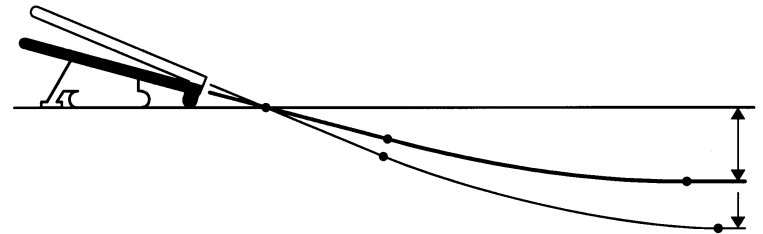
om1523.pcx

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CHECK SUPPLIES AND PREPARE EQUIPMENT

Check Supplies

- Receiver/transmitter or tracker with spare batteries
- Beacons with new and spare batteries
- Two-way radios with new and spare batteries
- Hydraulic wrench
- EZ-Connect/transition sub
- Anchoring equipment and accessories
- Bits, screens, nozzles
- Adapters, pipe, beacon housings
- Marking flags or paint
- Water and additional hoses
- Fuel
- Drilling fluid additives
- Fuses
- Keys
- Backreamers, swivels, pulling devices
- Wash down hose and spray gun
- Duct tape
- Spray lubricant
- Tool joint compound
- Electrically insulating boots and gloves
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Prepare Equipment

Check levels:

- Fuel
- Hydraulic fluid
- Engine coolant
- Battery charge
- Engine oil

Check condition and function:

- Drive chains
- Filters (air, oil, hydraulic)
- Fluid pump
- Couplers
- Tires and tracks
- Centrifugal pump
- Drilling fluid mixer
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PREPARE JOBSITE



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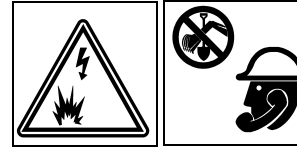
NOTICES:

- If jobsite classification is in question or if the possibility of unmarked electric utilities exists, classify jobsite as electric.
- Cutting high voltage cable can cause electrocution. Expose lines by hand before digging.

Mark Bore Path

Mark your planned bore path and all located utility lines with flags or paint.

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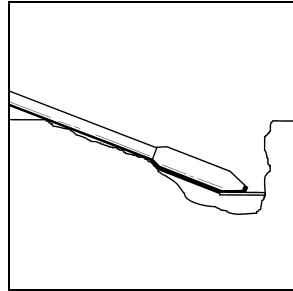
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Prepare Entry Point

For bore to be successful, first pipe must be straight.

To help ensure first pipe is not bent, dig a small starting hole so first pipe is drilled into a vertical surface.

To prevent bending or straining pipe, position drilling unit for straight entry.

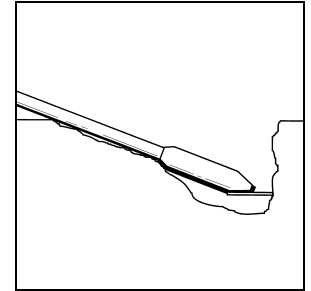


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RECORD BORE PATH

As the job is completed, record the actual bore path. List pitch and depth of each joint and a brief description of the procedure. In addition, draw a simple sketch of the site and record depth and rough location of pullback.

The Subsite Trac Management System is also available for plotting and tracking your bore path. It utilizes the Subsite 750 Tracker, 750 Display, a tracking beacon, and special software. The system can be run in the field using a laptop computer equipped with the Windows® 95 or higher operating system. See your Ditch Witch dealer for details.

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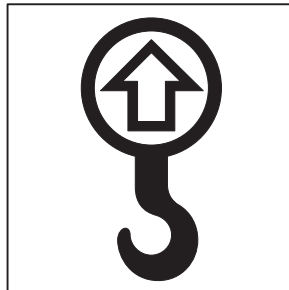


WARNING Crushing weight. If load falls or moves it could kill or crush you. Use proper procedures and equipment or stay away.

LIFT

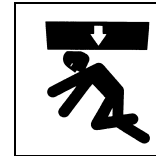
Points

Lifting points are identified by lifting decals. Lifting at other points is unsafe and can damage machinery.



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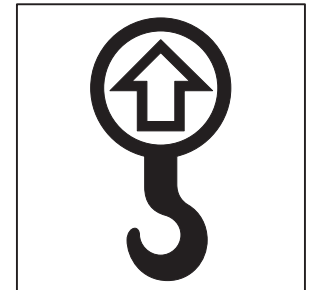


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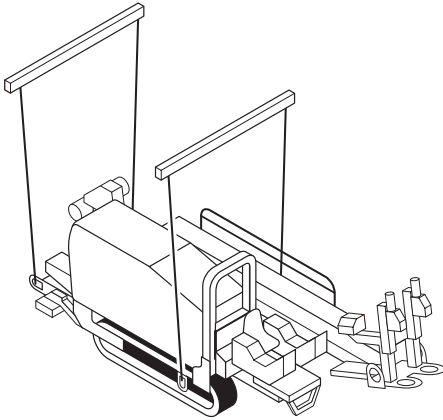


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Procedure

Drilling Unit

Use a crane capable of supporting the equipment's size and weight. See **SPECIFICATIONS** or measure and weigh equipment before lifting. Use four lift points. Attach securely to cross members.



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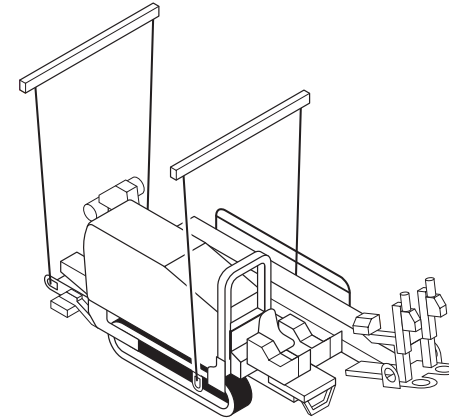
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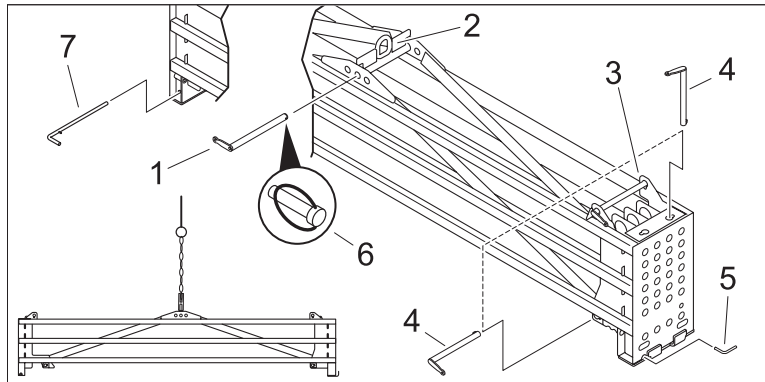


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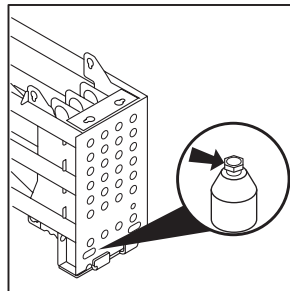
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Removal



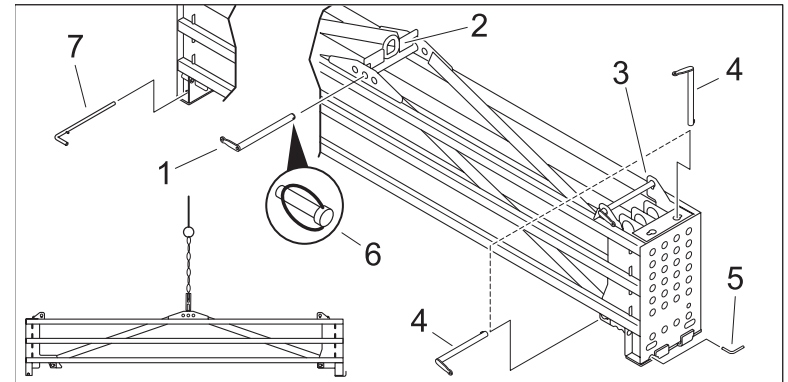
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1. Insert lift pin block (2) and secure with lift pin (1) and lynch pin (6).
2. Raise pipe with pipe lifter on machine.
3. Remove support pins (4) from top of pipe box (3). Insert pins under both ends of pipe box and secure with lynch pins.
4. Attach chain to lift pin block.
5. Loosen four pin retainer bolts, if used. Two bolts are located on each end of the pipe box.
6. Pull rear pins (5) and front pin (7) and lift box off drill frame.



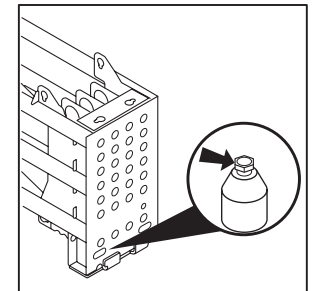
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Removal



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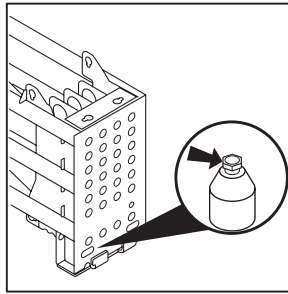
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Loading

1. Guide pipe box onto centering pin on rear of pipeloader frame. Lower completely onto frame.
2. Insert rear and front pins (5, 7).
3. Tighten four retainer bolts, if desired, to bolt pipe box onto pipe box. Two bolts are located on each end of the pipe box.

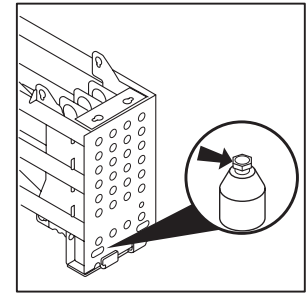


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4. Raise pipe with pipe lifter on machine.
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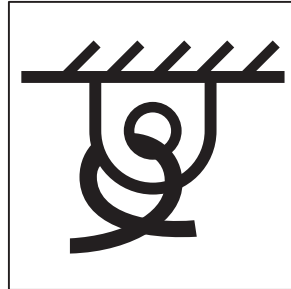
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TIEDOWN

Points

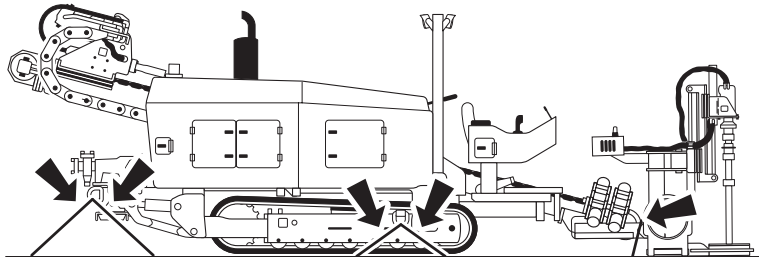
Tiedown points are identified by tiedown decals. Securing to trailer at other points is unsafe and can damage machinery.



ic1320a.eps

Procedure

Loop tiedowns around unit at tiedown points. Make sure tiedowns are tight before transporting.

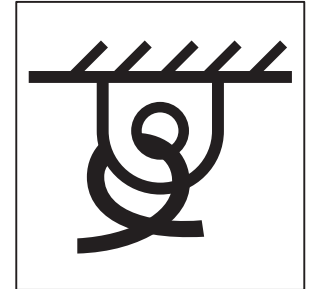


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TIEDOWN

Points

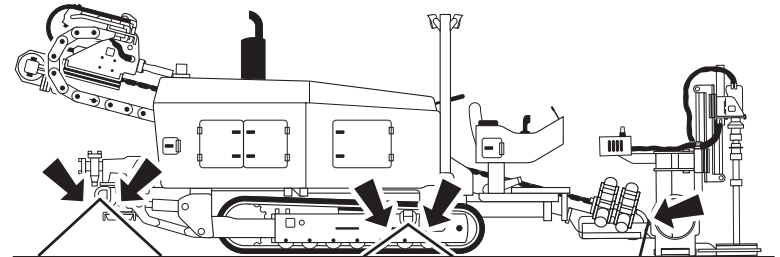
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ic1320a.eps

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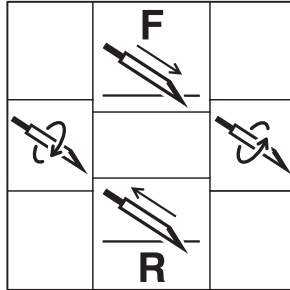


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OPERATE TRACK CONTROL

To steer drilling unit, follow instructions for type of steering desired.

IMPORTANT: Tight steering must be done in low ground drive speed.



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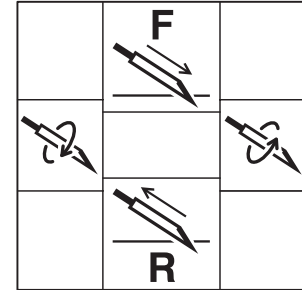
To steer while moving forward, push forward and then move to left or right. Drilling unit will gradually turn to left or right. **For tight steering,** unit will counterrotate when joystick reaches corner.

To steer while moving backward, pull back and then move to left or right. Drilling unit will gradually turn to left or right. **For tight steering,** unit will counterrotate when joystick reaches corner.

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ic1268a.eps

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HAUL



WARNING Crushing weight. If load falls or moves it could kill or crush you. Use proper procedures and equipment or stay away.

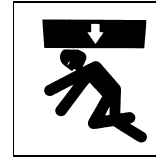
NOTICES:

- Load and unload trailer on level ground.
- Incorrect loading can cause trailer swaying.
- Attach trailer to vehicle before loading or unloading.

Loading onto Trailer

1. Fasten trailer to truck.
2. Check that trailer tire pressure is at recommended level.
3. Fasten and adjust seat belt.
4. Move drilling unit to rear of trailer and align with ramps or center of trailer bed.
5. Ensure ground drive is in low speed, slow engine to idle, and slowly drive unit onto trailer.
6. Lower stabilizers to trailer floor.
7. Lower drill frame to trailer floor.
8. Move drill/park/drive switch to center position and stop engine when unit is safely positioned on trailer bed.
9. Attach tiedowns to drilling unit where tiedown decals are located.

HAUL



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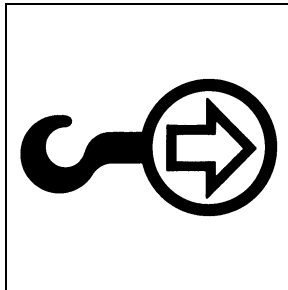
Unloading from Trailer

1. Lower trailer or ramps.
2. Remove tiedowns.
3. Fasten and adjust seat belt.
4. Start engine.
5. Raise stabilizers.
6. Raise drill frame.
7. Ensure ground drive is in low speed, slow engine to idle, and slowly back unit down trailer or ramps.

TOW

Points

Towing points are identified by towing decals. Towing at other points may be unsafe and can damage machinery.



Procedure

Under normal conditions, drilling unit should not be towed. If towing is necessary:

- Tow for short distances at less than 1 mph (1.6 kph).
- Attach chains to indicated tow points facing towing vehicle.
- Use maximum towing force of 1.5 times unit weight.
- Disengage power to tracks.

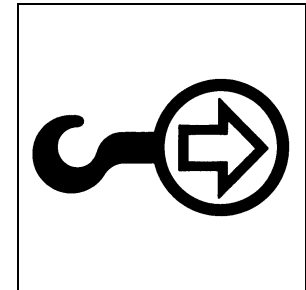
Unloading from Trailer

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5. Raise stabilizers.
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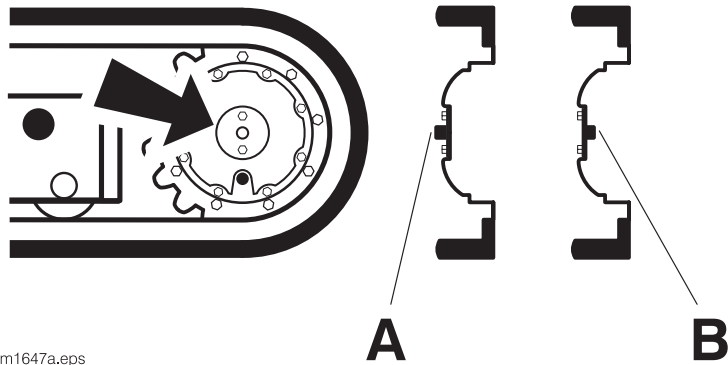
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To disengage track power, reverse small cover plate in center of planetary on each track drive.

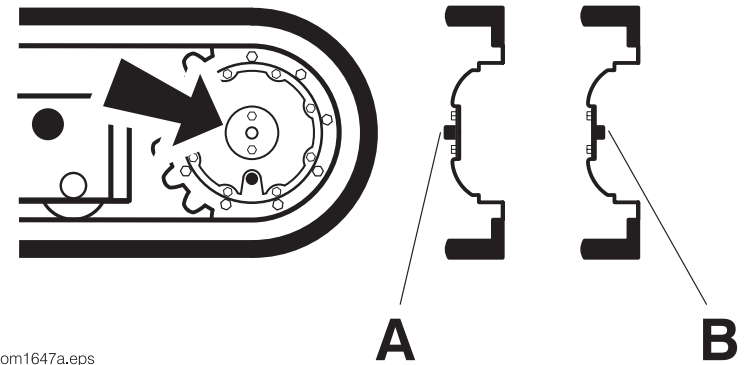
IMPORTANT: When track power is disengaged, unit has no brakes.



A. Normal operation B. Towing

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A. Normal operation B. Towing

To attach chains to tow points, determine which points are facing towing vehicle.

If **back** tow points are facing towing vehicle, choose option A or option B.

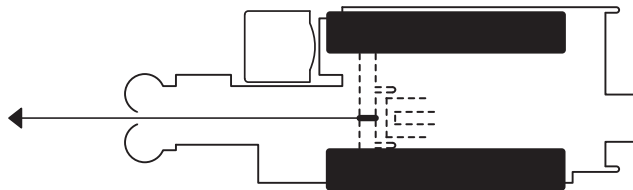


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Option A: Loop chain through both tow points and attach to common cross member. Always pull straight back.

Option B: Loop chain through each tow point and attach chains to towing vehicle. Always pull straight back.

If **front** tow points are facing towing vehicle, put cab in drive position, select drive mode, loop chain through tow point, and pull straight forward.



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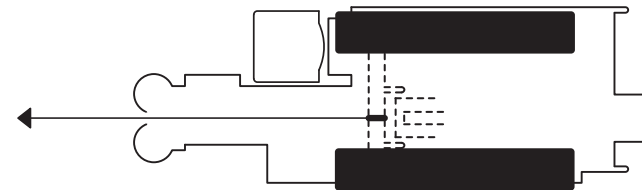


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SETUP

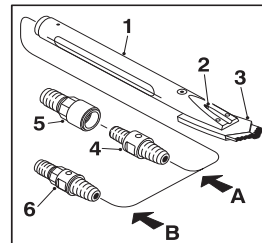
UNLOAD

1. Drive drilling unit off trailer, following directions in **TRANSPORTATION**.
2. Review bore plan and select drilling unit position and fluid unit position.

ASSEMBLE DRILL STRING

Select Nozzle and Bit

1. Select nozzles and bit. A variety of nozzles and bits are available to suit your particular job conditions. See **APPENDIX**, section D, for information about nozzles. Contact your Ditch Witch dealer for more information.
2. Insert nozzle (2) into beacon housing (1).
3. Attach bit (3) to beacon housing.
4. Install beacon, following beacon manufacturer's instructions for:
 - Battery replacement,
 - Beacon positioning.
5. Follow beacon manufacturer's instructions to check beacon operation.



SETUP

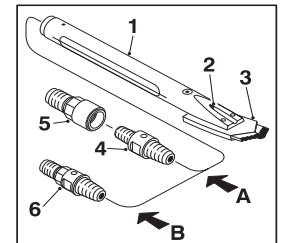
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Attach Transition Sub

1. Remove pipe guides.
2. Pull transition sub into lower wrench.
3. Close wrench.
4. Lube joints.
5. Use full machine torque to tighten joint.

Attach Beacon Housing**Machine Torque**

1. Pull tool into lower wrench.
2. Close wrench.
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HydraTong

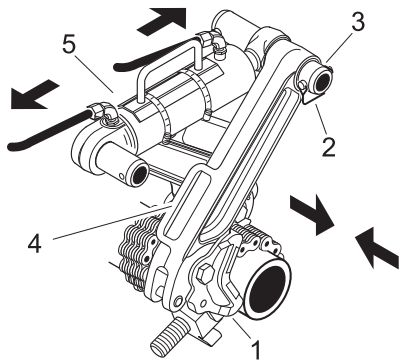
1. Attach downhole tool to first drill pipe and hand tighten.



⚠ DANGER

Moving parts. Being struck by wrench will kill or injure. Do not use drilling unit to turn or move drill string when wrench is used.

2. Attach HydraTong in join position.



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- Attach chain tongs (1) to both sides of joint. Place tongs as close to joint as possible for maximum torque.
- Remove snapper pins (2) from slide pins (3), and insert slide pins into wrench handles (4).
- Attach each end of hydraulic cylinder (5) to slide pins and insert snapper pins.

HydraTong

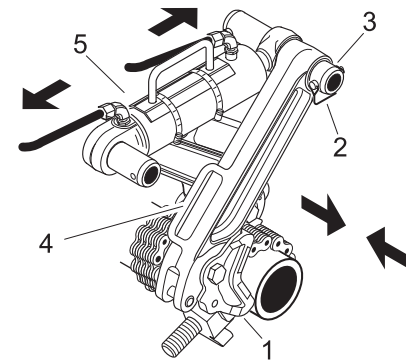
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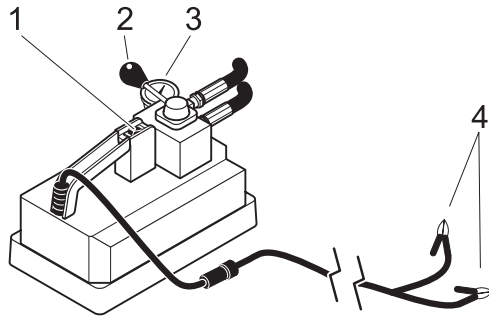
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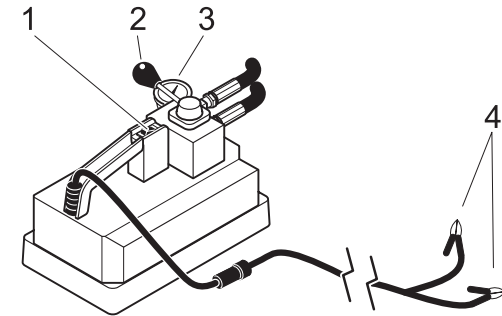
3. Connect HydraTong power pack.



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- Attach hoses from power pack to cylinder.
 - Attach leads (4) to 12 Volt battery.
4. Move shuttle valve handle (2) toward gauge and press power switch (1) to tighten joint.
 5. To reposition chain tongs and continue tightening joint, move handle away from gauge, then back toward gauge, and then press power switch.
 6. Monitor gauge (3) and refer to decal to achieve proper preload.
 7. Move handle to center (neutral) position to relieve pressure.
 8. Disconnect hoses and remove HydraTong components.

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Connect Drill Pipe

1. Start drilling unit engine.
2. Align transition sub in front wrench.
3. Clamp tool in front wrench.
4. Load pipe.
 - Make sure shuttle stop is positioned correctly.
 - Use pipe lubricator switch to lubricate threads in front wrench.
 - Use pipe lubricator switch to fill applicator at back of pipeloader.
 - Use gripper switch to grip pipe.
 - Use loader shuttle switch to move pipe to spindle.

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5. Connect pipe.

- Move carriage forward until saver sub nears male pipe thread.
- Continue to move carriage forward and rotate spindle until pipe screws into saver sub.
- Use pipe gripper switch to relax grippers.
- Move carriage forward until front end of pipe is aligned with transition sub male thread.
- Use machine power to slowly rotate spindle and drill pipe onto transition sub male thread.
- Use pipe lift switch to raise pipe that is in pipe box.
- Use grip switch to open grippers.
- Use loader shuttle switch to move shuttle back against shuttle stop.
- Use pipe lift switch to lower pipe completely into shuttle.

6. Slowly tighten to full machine torque.

7. Disengage front wrench and move carriage back to top of frame.

8. Turn off engine.

9. Reinstall blocks on guides.

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POSITION DRILLING UNIT AND FRAME

1. Start engine and move drilling unit to appropriate distance from start of bore.
2. Tilt frame as needed to reach desired entry pitch.
3. Lower stabilizers until stabilizers begin to put pressure on ground.
4. Continue lowering to increase entry pitch. If possible, keep tracks on ground in soft soil conditions.

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ASSEMBLE ELECTRIC STRIKE SYSTEM

Anytime drilling unit is used in an electric jobsite, electric strike system must be properly set up, tested, and used. In addition to ESID control module, strike system includes bonding cables, barriers and protective boots and gloves. Boots and gloves must meet the following standards:

- Wear high-top boots with legs of pants tucked completely inside. Boots must meet the electric hazard protection requirements of ANSI Z-41, 1991, when tested at 14,000 volts.
- Gloves must have 17,000 AC maximum use voltage, according to ASTM specification D120-87.

If working around higher voltage, use gloves and boots with appropriately higher ratings.

NOTICE: The strike system does not prevent electric strikes or detect strikes before they occur. **If alarms are activated, a strike has already occurred** and equipment is electrified.

Read and follow directions in **SAFETY**. Review safety procedures before each job.

FCC Statement

The Electric Strike System has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, can cause harmful interference to radio communications. Operation of this equipment in a residential area could cause harmful interference which the user will be required to correct at his own expense.

Changes or modifications not expressly approved in writing by The Charles Machine Works, Inc. may void the user's authority to operate this equipment.

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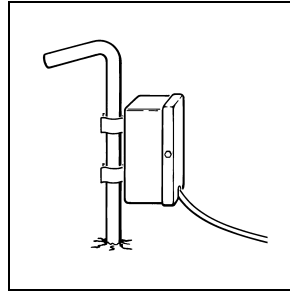
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Assemble Voltage Detector

1. Drive voltage stake into ground at least 6' (2 m) away from any part of system.
2. Clip voltage limiter to voltage stake.



Test Strike System

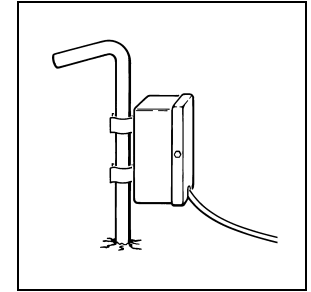
If system fails any part of this test, see “Troubleshoot Strike System” in **MAINTENANCE**. Do not drill until test is completed successfully.

You can also test ESID further by simulating an electric strike (see “Use Electric Strike Simulator” in **MAINTENANCE**.)

1. Turn on drilling unit.
2. ESID control module will perform internal tests which check everything but alarms and strobe.
3. If green OK indicator and electrical power supply indicator lights remain on, press self test button to perform total test of strike system. During this test:
 - All lights should glow.
 - Alphanumeric readout should display numbers.
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ANCHOR

**⚠ WARNING**

Crushing weight. If load falls or moves, it could kill or crush you. Use proper procedures and equipment or stay away.

NOTICES:

- Drive anchors properly before drilling.
- Wear high-top boots with legs of pants completely tucked inside.
- If you are not driving two anchors to full depth, drive optional ground rod into soil away from drilling unit.

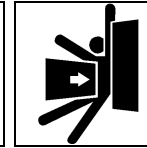
IMPORTANT: If you will be loading extra drill pipe piece by piece, see “Load Single Piece of Pipe” in **OPERATION** for more precautions.

**⚠ DANGER**

Turning shaft can kill you or crush arm or leg. Stay away.

NOTICE: Do not replace anchor collar bolt with one longer than original. Clothing could catch on turning shaft.

ANCHOR

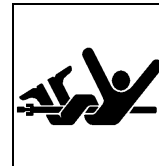
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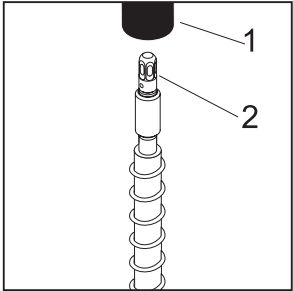
Select Anchor

Many anchor types are available. Choose the correct anchor type based on jobsite conditions.

Anchor type	Situation used
3.5 inch cap bit	hard/soft rock, asphalt, concrete, cobble
auger bit	soft soil to hard soil, soft rock; available in different sizes.

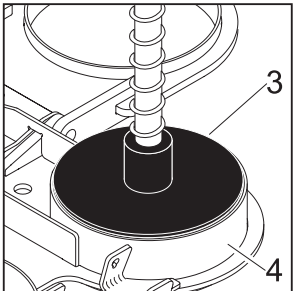
Attach Anchor to Anchor Driver

1. Raise anchor driver to top of anchor frame.
2. Pull collar (1) up.



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3. Position lower part of anchor and anchor cap (3) inside anchor plate (4).
4. Guide top of anchor (2) into collar. Raise and turn anchor slightly until collar clicks and locks onto anchor shaft.



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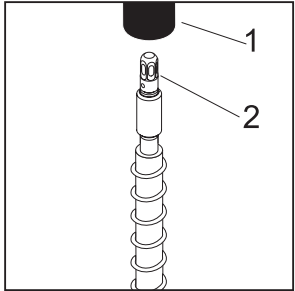
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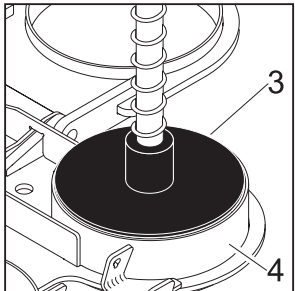
Attach Anchor to Anchor Driver

1. Raise anchor driver to top of anchor frame.
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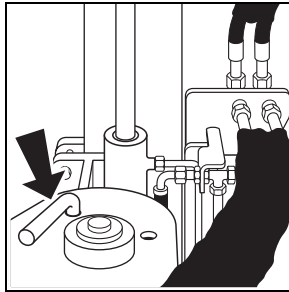
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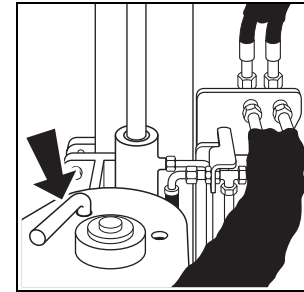
Drive Anchors

1. Raise anchor shaft to top of anchor frame.
2. Use anchor rotation and thrust controls to drive anchor into ground.
3. Anchor is set when cap rests firmly on centering cap.
4. Repeat process for other anchor.
5. To drive additional anchors, or to use side anchor placement:
 - Raise collar to disconnect anchor shaft from anchor driver.
 - Raise anchor driver to top of anchor frame.
 - Remove spring clip from pin and remove pin.
 - Swing anchor driver to outer position.
 - Place pin in second hole and replace spring clip.
 - Attach anchor to anchor driver and repeat steps 2 and 3.
6. Disconnect anchors from anchor drivers before drilling.



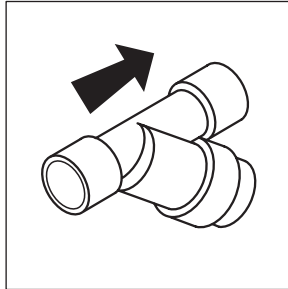
Drive Anchors

1. Raise anchor shaft to top of anchor frame.
2. Use anchor rotation and thrust controls to drive anchor into ground.
3. Anchor is set when cap rests firmly on centering cap.
4. Repeat process for other anchor.
5. To drive additional anchors, or to use side anchor placement:
 - Raise collar to disconnect anchor shaft from anchor driver.
 - Raise anchor driver to top of anchor frame.
 - Remove spring clip from pin and remove pin.
 - Swing anchor driver to outer position.
 - Place pin in second hole and replace spring clip.
 - Attach anchor to anchor driver and repeat steps 2 and 3.
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CONNECT FLUID SYSTEM

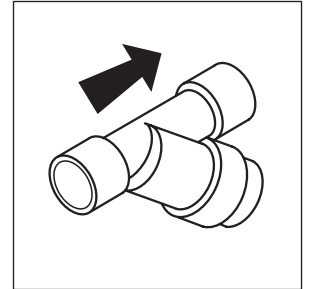
1. Connect fluid hose from mixing system to drilling fluid pump. A 3" (76 mm) or larger, non-collapsible hose is required.
2. Install y-strainer between mixing unit and drilling fluid pump. Position strainer so that drilling fluid flows in the direction of the arrow. In most cases, positioning strainer at outlet of mixing unit gives best results.



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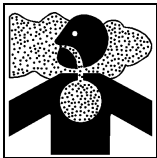


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OPERATION

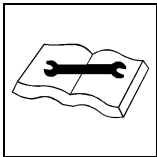
This section covers basic operation. This section also covers operation of manual and automated pipeloader controls.

For questions about specific situations, contact your Ditch Witch dealer.

**WARNING**

Jobsite hazards could cause death or serious injury. Use correct equipment and work methods. Use and maintain proper safety equipment.

NOTICE: Cutting or drilling concrete containing sand or rock containing quartz may result in exposure to silica dust. Use respirator, water spray or other means to control dust. Silica dust can cause lung disease and is known to the State of California to cause cancer.

**WARNING**

Improper control function could cause death or serious injury. If control does not work as described in instructions, stop machine and have it serviced.

**WARNING**

Crushing weight. If load falls or moves, it could kill or crush you. Use proper procedures and equipment or stay away.

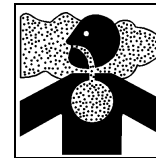
NOTICE: Anchor drilling unit properly before drilling.

EMERGENCY SHUTDOWN: Push engine stop button or turn ignition switch to stop position.

OPERATION

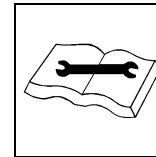
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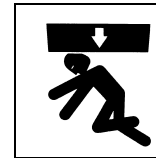
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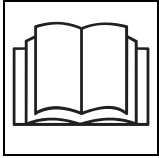
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OPERATE TRACKER CONTROL MODE

Overview

**⚠ WARNING**

Incorrect procedures could result in death, injury, or property damage. Learn to use equipment correctly.

This mode allows 750 Tracker operator to disable hydraulic power to drilling unit thrust and rotation within 16 seconds. **This mode will not stop thrust and rotation immediately.**

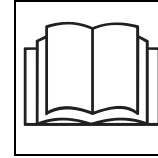
When tracker and display communications cease, tracker control light on drilling unit will come on and thrust and rotation will be disabled.

Troubleshooting tip: If thrust and rotation do not work, check whether tracker control light on drilling unit is on. If it is, communication has probably stopped between tracker and display or tracker is set to incorrect code. If communication cannot be restored, install tracker control key on drilling unit. Tracker control light will go off and thrust and rotation will function.

IMPORTANT: Tracker operator cannot disable thrust and rotation from tracker with tracker control key installed in drilling unit and turned to disable position.

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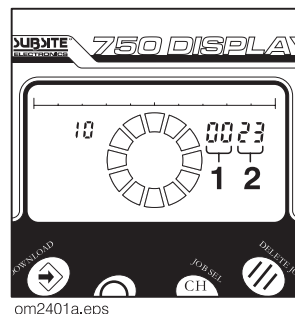
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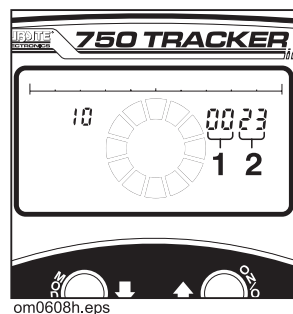
1. Turn on drilling unit. Press and hold download button to display serial number on 750 Display.



2. Turn on 750 Tracker and check four-digit display code.
 - Hold fore/aft/left/right button and press mode to review and start sending code.

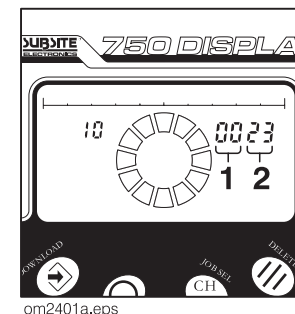
IMPORTANT: Continue to hold down fore/aft/left/right button to adjust code.

- Use on/off button to advance first two digits (1) and use depth button to lower first two digits.
- Use up arrow button to advance last two digits (2) and use down arrow to lower last two digits.
- Press and hold button to advance or lower value quickly.



Operation

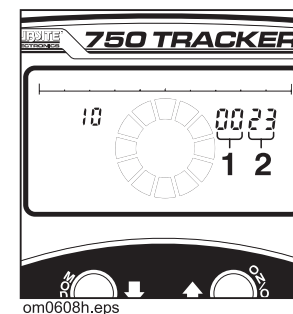
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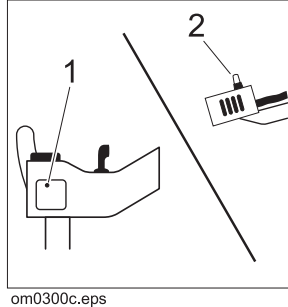
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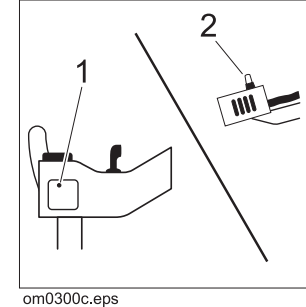
3. Remove tracker control key (1) from drilling unit and keep in tracker operator's possession.
4. Drill and track bore until drill head enters target pit or exits ground.
5. Turn off tracker. After 8-16 seconds, tracker control light (2) on drilling unit will come on and hydraulic power to thrust and rotation will be disabled.



6. Change downhole tools.
7. **If you are tracking backreamer's path**, turn on tracker and enable code transmission. After 8-16 seconds, tracker control light on drilling unit will go off and thrust and rotation will function.

If you are not tracking backreamer's path, install tracker control key on drilling unit. Tracker control light on drilling unit will go off and thrust and rotation will function.

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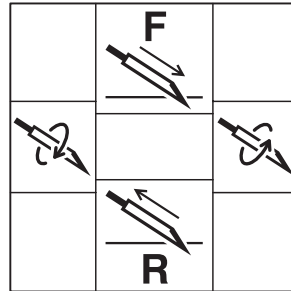


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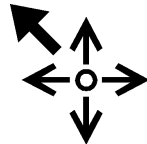
OPERATE CARRIAGE CONTROL

The carriage control has eight positions which allow the four basic functions to be combined. The descriptions below summarize functions that occur when control is put at a combined position.

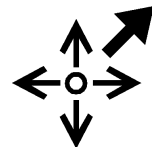


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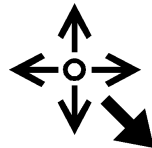
Moves carriage forward.
Rotates pipe clockwise (makeup).



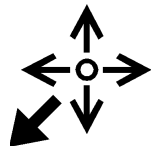
Moves carriage forward.
Rotates pipe counterclockwise.



Moves carriage backward.
Rotates pipe counterclockwise (breakout).

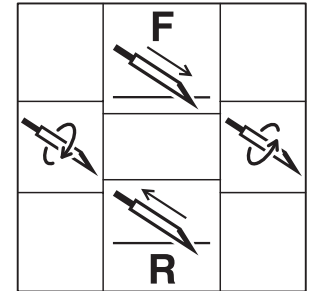


Moves carriage backward.
Rotates pipe clockwise.



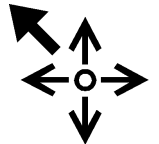
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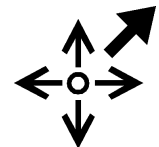


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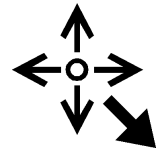
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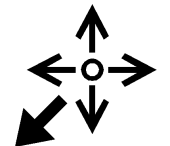
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Moves carriage backward.
Rotates pipe clockwise.



START SYSTEM

1. Start drilling unit and remote fluid unit. Allow both engines to warm up.

IMPORTANT: Ensure that mixture of drilling fluid matches drilling conditions.

2. Enable tracker control mode if desired (see “Operate Tracker Control Mode”).
3. Press top of drilling unit throttle switch until engine is at full throttle.
4. Press and hold quick fill fluid pump switch until pipe fills and fluid pressure begins to rise.

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DRILL FIRST PIPE



⚠ DANGER Turning shaft can kill you or crush arm or leg. Stay away.

NOTICES:

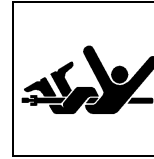
- Keep everyone at least 10' (3 m) away from turning drill string.
- Push rod or pipe slowly. Forcing can bend string. Do not use bent rod or pipe.



⚠ WARNING Jobsite hazards could cause death or serious injury. Use correct equipment and work methods. Use and maintain proper safety equipment.

1. Visually check for drilling fluid flow.
2. Choose clock position.
3. Slowly move carriage forward. Drill first pipe as straight as possible.
4. Monitor gauges.

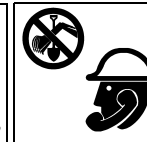
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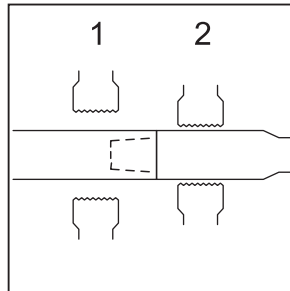
ADD PIPE



⚠ DANGER

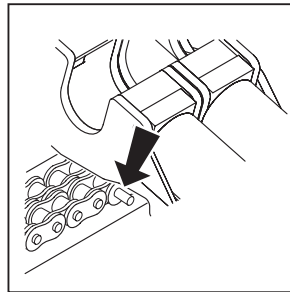
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NOTICE: Do not clamp near female end of pipe or it will be damaged. Clamp on pipe when joint is between wrenches but as near front wrench (2) as possible.



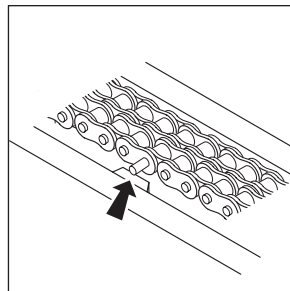
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IMPORTANT: Joint is properly positioned for clamping when alignment pin becomes visible behind rear wrench.



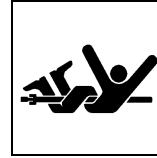
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IMPORTANT: Use alignment pin to position carriage every time a pipe joint is broken out to ensure pipe will go into pipe box.



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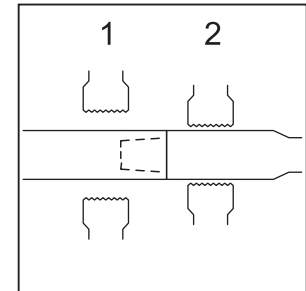
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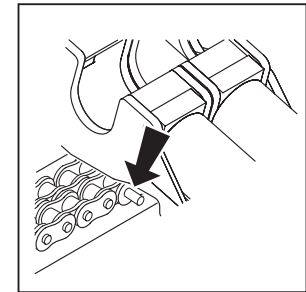
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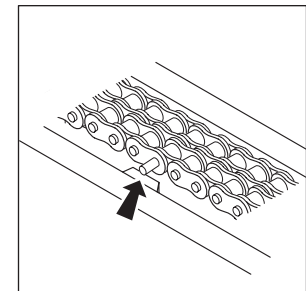
om0575h.eps

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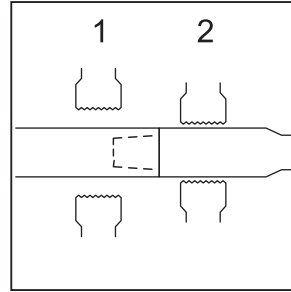
om0295c.eps

Manual Pipeloader Controls

1. Press top of drilling unit throttle switch until engine is at full throttle.

2. Break joint at saver sub.

- Release joystick when joint between saver sub and pipe is between front (2) and rear (1) wrenches.
- Locate drill head.
- Engage front wrench.
- Rotate spindle counterclockwise.
- Continue rotation and slowly move carriage back as threads unscrew.
- Stop rotation and move carriage to back of frame.



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3. Load pipe.

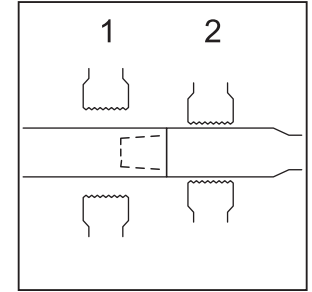
- Make sure shuttle stop is properly positioned on pipeloader and lift arms are completely lowered.
- Close grippers.
- Lube upper pipe threads.
- Use loader shuttle switch to move pipe to spindle and use lube switch to lube lower threads.
- Use pipe lift switch to raise pipe in box.

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- Use pipe lift switch to raise pipe in box.

4. Connect pipe to saver sub.

- Move carriage forward until saver sub meets pipe.
- Continue to advance carriage and rotate spindle until saver sub screws onto pipe.

IMPORTANT: Always rotate clockwise unless breaking pipe joint. Rotating counterclockwise will unscrew joints.

- Press pipe grip switch to relax pipeloader grippers.

5. Connect new pipe.

- Slowly move carriage forward and rotate spindle until pipe screws together.
- Slowly rotate joint until spindle stops turning to fully torque joint.
- Open wrench.
- Press pipe grip switch to open pipeloader grippers fully.

IMPORTANT: Press pipe gripper switch for 1-2 seconds.

- Press pipe shuttle switch to retract shuttles against shuttle stop.
- Press pipe lift switch to lower pipe lifters.

6. Press and hold quick fill fluid pump switch until pipe fills and fluid pressure begins to rise.

7. Rotate spindle.

8. Slowly move carriage forward. Adjust rotation speed control according to bit size and soil conditions.

9. Engage and set cruise control as desired (see "Operate Cruise Control").

10. Monitor gauges.

11. Locate drill head with tracker at least every half-length of pipe.

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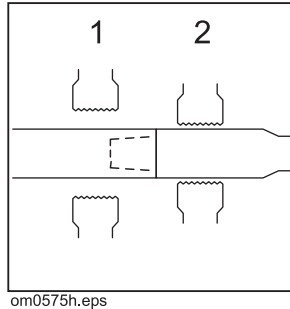
11. Locate drill head with tracker at least every half-length of pipe.

Automated Pipeloader Control

1. Press top of drilling unit throttle switch until engine is at full throttle.
2. Enable automated pipeloader system.
 - Front wrench must be open and shuttles retracted for add pipe function to work.
 - Press top of add pipe/manual/remove pipe switch. Green control cycle light will come on.
 - Grippers will open, pipe will be lowered, and then green control cycle light will flash.

3. Break joint at saver sub.

- Release joystick when joint between saver sub and pipe is between front (2) and rear (1) wrenches.
- Locate drill head.
- Engage stationary wrench.
- Slowly rotate spindle counterclockwise.
- Continue rotation and slowly move carriage back as threads unscrew.
- Stop rotation and move carriage to back of frame.
- While carriage is moving, green control cycle light will come on. Grippers will grip, pipe will be lubed, and then green control cycle light will flash.

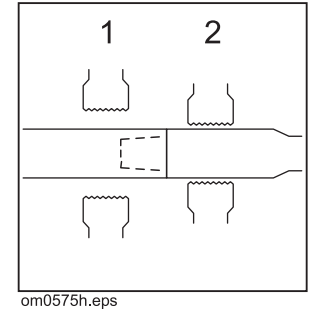


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4. Load pipe.

- Make sure shuttle stop is properly positioned on pipeloader.
- When carriage is moved to back of drill frame, press resume switch. Green control cycle light will come on.
- Pipe will be moved to spindle, front joint will be lubed, pipe in box will be lifted, and then green control cycle light will flash.

5. Connect pipe to saver sub.

- Move carriage forward until saver sub meets pipe.
- Continue to slowly advance carriage and rotate spindle until saver sub screws onto pipe.
IMPORTANT: Always rotate clockwise unless breaking pipe joint. Rotating counterclockwise will unscrew joints.
- Press resume. Green control cycle light will come on.
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 - Slowly rotate joint until spindle stops turning to fully torque joint.
 - Open wrench.
 - Press resume. Green control cycle light will come on.
 - Pipeloader grippers will open, shuttles will retract, pipe lifters will lower, and then green control cycle light will flash.
7. Press and hold quick fill fluid pump switch until pipe fills and fluid pressure begins to rise.
8. Rotate spindle.
9. Slowly move carriage forward. Adjust rotation speed control according to bit size and soil conditions.
10. Engage and set cruise control as desired (see "Operate Cruise Control").
11. Monitor gauges.
12. Locate drill head with tracker at least every half-length of pipe.

6. Connect new pipe.
 - Slowly move carriage forward and rotate spindle until pipe screws together.
 - Slowly rotate joint until spindle stops turning to fully torque joint.
 - Open wrench.
 - Press resume. Green control cycle light will come on.
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OPERATE CRUISE CONTROL

All Mach 1 drilling units have a cruise control feature. In order for cruise control to function, front wrench must be open and shuttles must be under pipe box. Cruise control can be used in both thrust and pullback modes.

Engage

Thrust/Pullback and Rotation Control

Position joystick so that thrust or pullback and rotation are at desired operational speeds and then press set button. Green control cycle light will come on. Release joystick.

Thrust/Pullback Control Only

Position joystick to desired thrust or pullback setting. Press set button. Green control cycle light will come on. Release joystick. Operator controls rotation with joystick.

Adjust Thrust or Pullback

To increase thrust or pullback speed while joystick is in neutral position, press resume button.

To decrease thrust or pullback speed while joystick is in neutral position, press set button.

Adjust Rotation

To increase rotation speed, move joystick to left and press resume.

To decrease rotation speed, move joystick to left and press set button.

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To increase rotation speed, move joystick to left and press resume.

To decrease rotation speed, move joystick to left and press set button.

Override

Move joystick out of neutral and beyond current setting. Unit will increase to new setting. Release joystick to return to previous setting.

Disengage

Move joystick out of neutral and in opposite direction of carriage travel. Green control cycle light will go off.

Resume

Position joystick out of neutral in forward or backward direction and press resume button. Green control cycle light will come on.

IMPORTANT: Use resume to return to previous settings. If different settings are needed, use set to reactivate cruise control.

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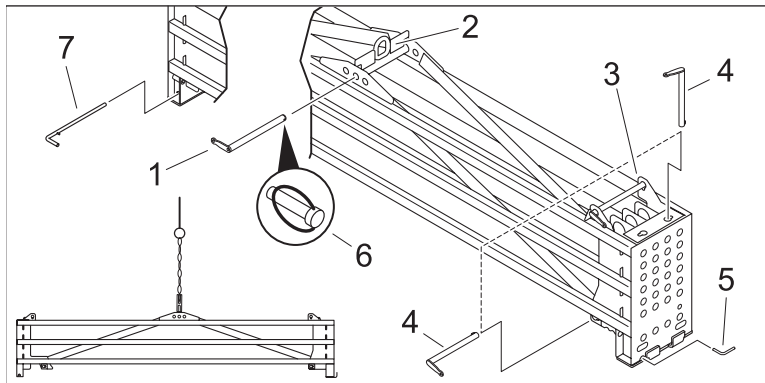
REMOVE/ADD PIPE BOX



⚠ WARNING Crushing weight. If load falls or moves it could kill or crush you. Use proper procedures and equipment or stay away.

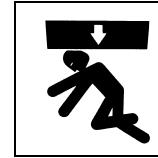
Use crane capable of supporting the equipment's size and weight. See **SPECIFICATIONS** or measure and weigh equipment before lifting.

NOTICE: Lift only one box of pipe at a time.



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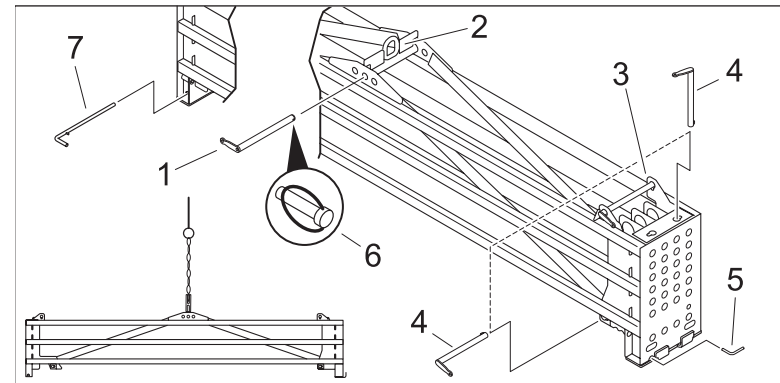
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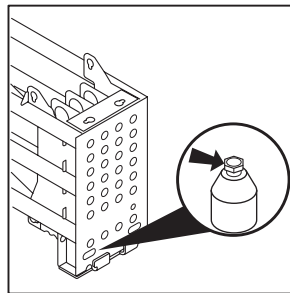
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Removal

1. Insert lift pin block (2) and secure with lift pin (1) and lynch pin (6).
2. Raise pipe with pipe lifter on machine.
3. Remove support pins (4) from top of pipe box (3). Insert pins under both ends of pipe box and secure with lynch pins.
4. Attach chain to lift pin block.
5. Loosen four pin retainer bolts, if used. Two bolts are located on each end of the pipe box.
6. Pull rear pins (5) and front pin (7) and lift box off drill frame.



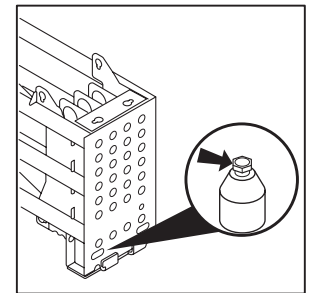
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Loading

1. Guide pipe box onto centering pin on rear of pipeloader frame. Lower completely onto frame.
2. Insert rear and front pins (5, 7).
3. Tighten four retainer bolts, if desired, to bolt pipe box onto pipe box. Two bolts are located on each end of the pipe box.
4. Raise pipe with pipe lifter on machine.
5. Remove bottom support pins (4) from both ends of pipe box. Store support pins in holes on top of pipe box (3).

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CORRECT DIRECTION

Correcting direction is a skill operators gain with experience and knowledge of equipment and soil conditions. These instructions only cover basic procedures. For information about specific equipment or jobsites, contact your Ditch Witch dealer.

To track progress and make corrections, one crew member locates the drill head and sends instructions to the operator.

Corrections are made by tracking the drill head, comparing current position to bore plan, and steering drill head as needed.

Basic rules to consider when correcting are:

- Steering ability depends on soil condition; bit, head, and nozzle used; roll of drill head; and distance pushed without rotation.
- All corrections should be made as gradually as possible. See "Bend Limits" in **SETUP**.
- Over correcting will cause "snaking." This can damage pipe and will make drilling and pullback more difficult. Begin to straighten out of each correction as early as possible.
- Do not push an entire piece of drill pipe into ground without rotation. This can exceed bend radius and cause pipe failure.

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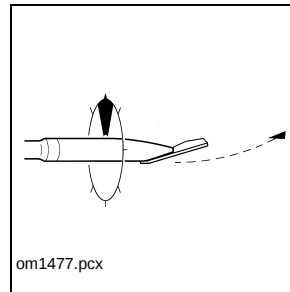
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1. Locate drill head. Take readings available with your beacon and locating equipment such as:
 - depth
 - pitch
 - left/right information
 - temperature
 - beacon roll
2. Compare position to bore plan. Determine direction drilling should go.
3. Position drill head.

The drill head position is determined by reading beacon roll. Roll is displayed as a clock face position.



To position drill head:

1. Read beacon roll.
2. Slowly rotate pipe until locator displays appropriate beacon roll.

To change direction:

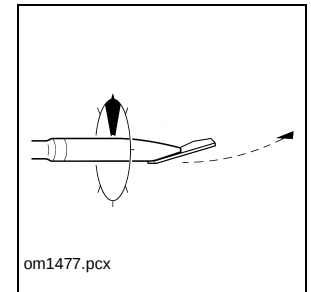
1. Rotate pipe to clock position you intend to travel.
2. Push pipe into ground.

To move forward without changing direction:

1. Rotate pipe.
2. Push pipe into ground.

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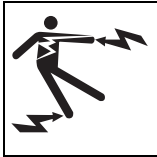
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ADD PIPE TO PIPE BOX

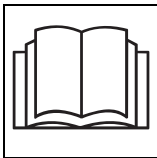
Load a single drill pipe or up to a whole row of drill pipe into fourth row of pipe box to finish bore without changing pipe boxes. Pipe can be added as soon as fourth row of pipe has been started and other rows are empty.



⚠ DANGER Electric shock. Contacting electric lines will cause death or serious injury. Know location of lines and stay away.

NOTICES:

- Do not attempt to load and unload pipe while drilling or backreaming. Unprotected worker can be injured by electric strike.
- On electrical jobsite, load and unload pipe only if grid mats are properly set up and connected to drilling unit and loader is wearing electrically insulating boots and gloves.



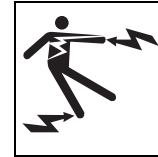
⚠ WARNING Incorrect procedures could result in death, injury, or property damage. Learn to use equipment correctly.

NOTICES:

- Open or close **both** auxiliary shuttles. Moving shuttles with one auxiliary shuttle open and one closed will damage equipment and cause possible injury.
- Carriage must be in full back position to load and unload pipe.

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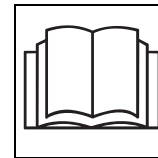
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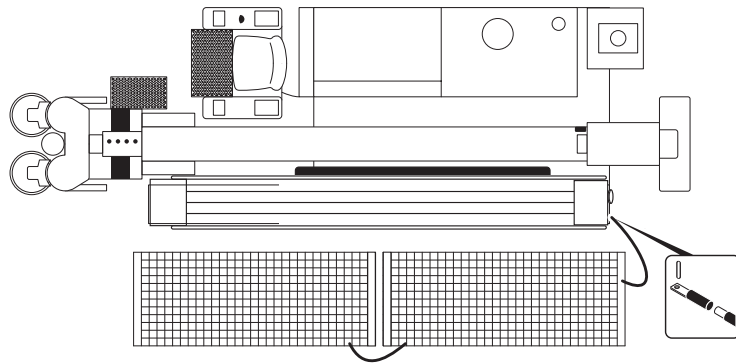
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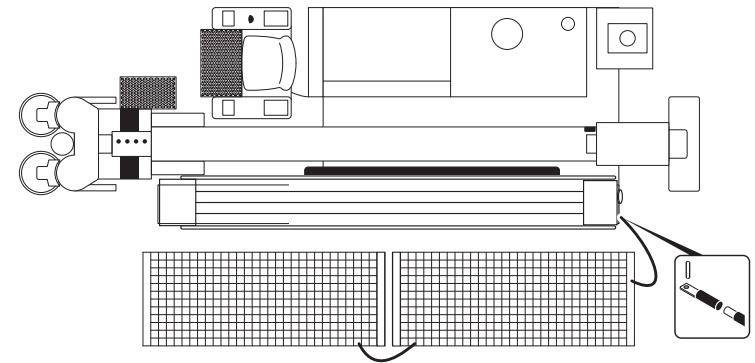
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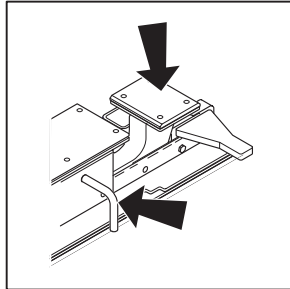
1. Place grid mats on the ground on pipe box side of drilling unit.
2. Connect mats.
3. Connect bonding cable to drilling unit.
4. Position drill pipe box on edge of mat.



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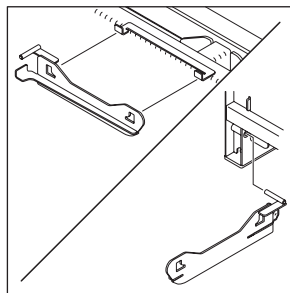
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5. Ensure shuttle stop is fully lowered.
6. Extend shuttles fully.
7. Pull and hold pins on each shuttle and slide out auxiliary shuttles.



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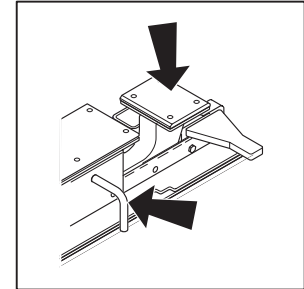
8. Remove pipe stop (stored on outside of drill frame) and attach to front of pipe box.
9. Load a pipe in auxiliary shuttles and rest it against pipe stop.
10. Use pipe shuttle switch to move auxiliary shuttles under row 4.



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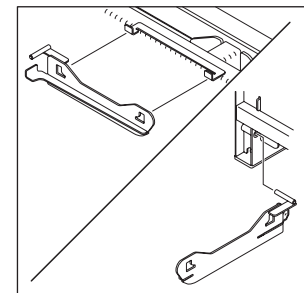
11. Use pipe lift switch to raise pipe into row 4.
12. Fully extend shuttles.
13. Repeat steps 9-12 to load more pieces of pipe into row 4.
14. Move pipe to pipeloader grippers.
 - Use pipe lift switch to raise last pipe into row 4.
 - Use pipe shuttle switch to move shuttles out.
 - Use pipe lift switch to lower pipe into front grippers.
15. Close both auxiliary shuttles, remove pipe stop and store it on drill frame, and step away from drilling unit before operating pipeloader.

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SURFACE DRILL HEAD



⚠ DANGER

Moving parts. Being struck by wrench will kill or injure. Do not use drilling unit to turn or move drill string when wrench is used.

1. Guide drill head to target pit or up through surface. Make all bends gradual. See “Bend Limits” in **SETUP**.
2. Clean area around exit point.
3. If using tracker control mode, tracker operator turns off tracker to disable drilling unit thrust/pullback and rotation hydraulics. Tracker operator waits for green light to enter pit and change tools.

If not using tracker control mode, tracker operator signals to drilling unit operator to stop engine before changing downhole tools.

4. Turn fluid flow control to off position and remote throttle switch to idle position as soon as drill head emerges.
5. Clean drill head especially around threads.

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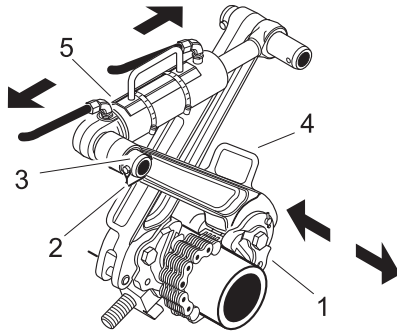
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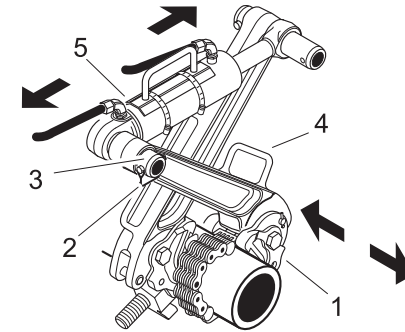
6. Attach HydraTong in break position.



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- Attach chain tongs (1) to both sides of joint. Place tongs as close to joint as possible for maximum torque.
- Remove snapper pins (2) from slide pins (3), and insert slide pins into wrench handles (4).
- Attach each end of hydraulic cylinder (5) to slide pins and insert snapper pins.

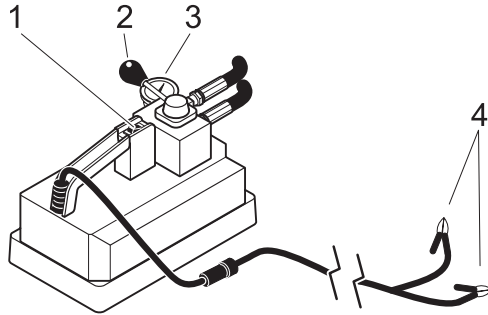
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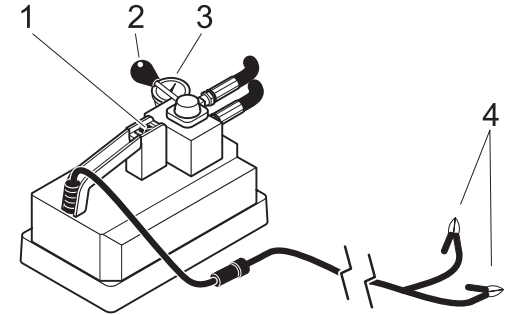
7. Connect HydraTong power pack.



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- Attach hoses from power pack to cylinder.
 - Attach leads (4) to 12 Volt battery.
8. Move shuttle valve handle (2) toward gauge and press power switch (1) to tighten joint.
 9. To reposition chain tongs and continue tightening joint, move handle away from gauge, then back toward gauge, and then press power switch.
 10. Monitor gauge (3) and refer to decal to achieve proper preload.
 11. Move handle to center (neutral) position to relieve pressure.
 12. Disconnect hoses and remove HydraTong components.
 13. Remove drill head. Keep threads clean.

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ASSEMBLE BACKREAM STRING

When the bore is completed, bore can be enlarged by backreaming or material can be pulled back.

Backreaming Procedure

Soil, devices used, and jobsite conditions determine the procedures used in each backream. While this chapter includes basic backreaming information, contact your Ditch Witch dealer for information and training in your soil type and with your equipment.



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NOTICE: Keep everyone away from material being installed.



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Jobsite hazards could cause death or serious injury. Use correct equipment and work methods. Use and maintain proper safety equipment.

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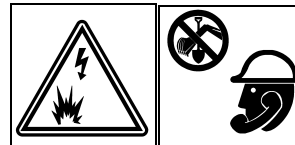


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1. Select backreaming devices.
2. Determine fluid rate requirements and install appropriate nozzles to provide sufficient flow.
3. Attach pullback devices.
4. If using backreamer to track backream, recalibrate tracker with beacon installed in housing.
5. If using tracker control mode, turn on tracker or install tracker control key on drilling unit to restore hydraulic power to thrust/pullback and rotation.
6. Press top of drilling unit throttle switch until engine is at full throttle.
7. Set drilling fluid flow.
8. Check that fluid flows through all nozzles.
9. Engage and set cruise control as desired (see "Operate Cruise Control").
10. Pull pipe through bore.

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Backreaming Tips

- Plan backreaming job before drilling. Plan bore path as straight as possible. Check bend limits of pullback material. Check that appropriate pullback devices are on hand.
- Keep all bends as gradual as possible.
- Drilling fluid quality is a key factor in backreaming success. Contact your Ditch Witch dealer for information on testing water, selecting additives, and mixing drilling fluid.
- Backreaming requires more fluid than drilling. Make sure enough fluid is used.

Select Pullback Devices

1. Backreamer - enlarges hole as pipe is pulled back through bore.
2. Backreamer Beacon Housing - allows backream path to be tracked.
3. Swivel - attached to pullback material through pullback device; allows pipe, cutter, and expander to rotate without twisting pullback material.
4. Nozzle - controls fluid flow from backreamer to bore.

Pullback devices are available in a wide variety of sizes and types. Soil type, size and type of pullback material, and drilling fluid affect backreamer choice. To determine which combination will work best at your jobsite, contact your Ditch Witch dealer.

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Determine Fluid Requirements

Backreaming is only successful when enough fluid reaches the bore. The amount of fluid needed depends on size of bore, pullback material, and soil condition.

This section describes how to find the minimum amount of fluid needed in perfect conditions. Use more fluid than recommended or the bore might be dry and unsuccessful.

1. Determine size of backreamer and outside diameter of pullback material. Use **APPENDIX**, section B, to find amount of fluid needed for each.

For example, you find that a 6" (15.2 cm) backreamer requires at least 1.5 gal/ft (19 L/m) and a 3" (7.6 cm) product diameter requires at least .4 gal/ft (5 L/m).

2. Subtract amount needed for pullback material from amount needed for backreamer. This answer is amount of fluid needed to drill each foot or meter.

You now find you need at least 1 gal for every foot (12 L for every meter) drilled.

3. Multiply answer by distance per minute you plan to backream. The answer is an estimate of amount of fluid you will need for each minute of backreaming.

Now, if backreaming 2 ft/min (.6 m/min), you need at least 2 gal (7.6 L) for each minute of backreaming.

4. Estimate pressure you will be using.
5. Using **APPENDIX**, section C, select nozzles that, added together, supply at least the amount of fluid per minute needed for the flow and pressure you will be using. A combination of nozzles that will supply more fluid per minute is recommended.

Determine Fluid Requirements

Backreaming is only successful when enough fluid reaches the bore. The amount of fluid needed depends on size of bore, pullback material, and soil condition.

This section describes how to find the minimum amount of fluid needed in perfect conditions. Use more fluid than recommended or the bore might be dry and unsuccessful.

1. Determine size of backreamer and outside diameter of pullback material. Use **APPENDIX**, section B, to find amount of fluid needed for each.

For example, you find that a 6" (15.2 cm) backreamer requires at least 1.5 gal/ft (19 L/m) and a 3" (7.6 cm) product diameter requires at least .4 gal/ft (5 L/m).

2. Subtract amount needed for pullback material from amount needed for backreamer. This answer is amount of fluid needed to drill each foot or meter.

You now find you need at least 1 gal for every foot (12 L for every meter) drilled.

3. Multiply answer by distance per minute you plan to backream. The answer is an estimate of amount of fluid you will need for each minute of backreaming.

Now, if backreaming 2 ft/min (.6 m/min), you need at least 2 gal (7.6 L) for each minute of backreaming.

4. Estimate pressure you will be using.
5. Using **APPENDIX**, section C, select nozzles that, added together, supply at least the amount of fluid per minute needed for the flow and pressure you will be using. A combination of nozzles that will supply more fluid per minute is recommended.

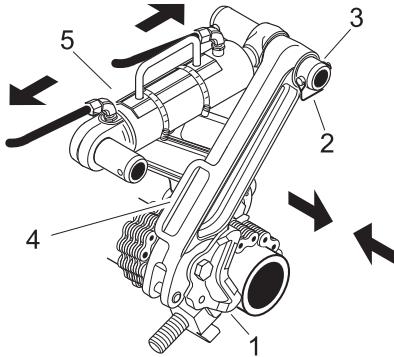
Attach Pullback Devices

1. Attach transition sub (if used) and backreamer to lead pipe.



⚠ DANGER Moving parts. Being struck by wrench will kill or injure. Do not use drilling unit to turn or move drill string when wrench is used.

2. Attach HydraTong in join position.



om0322c.eps

- Attach chain tongs (1) to both sides of joint. Place tongs as close to joint as possible for maximum torque.
- Remove snapper pins (2) from slide pins (3), and insert slide pins into wrench handles (4).
- Attach each end of hydraulic cylinder (5) to slide pins and insert snapper pins.

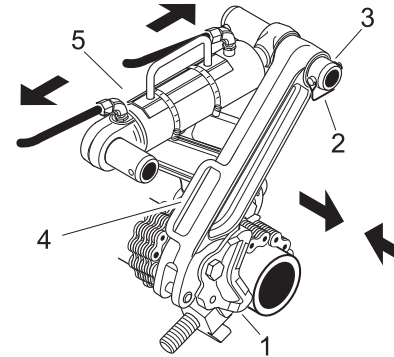
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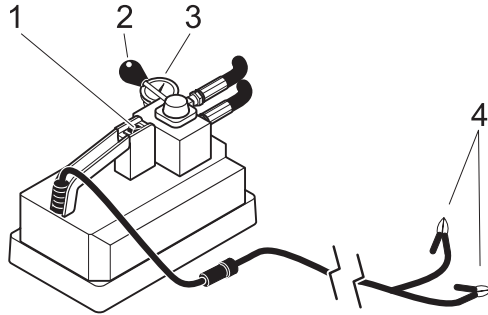
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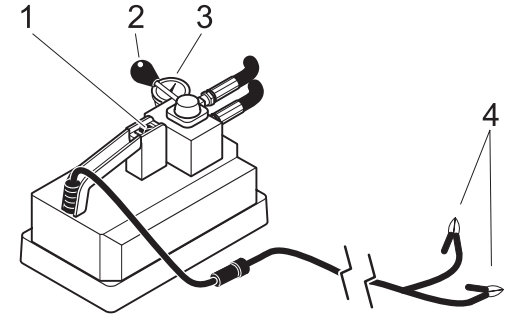
3. Connect HydraTong power pack.



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- Attach hoses from power pack to cylinder.
 - Attach leads (4) to 12 Volt battery.
4. Move shuttle valve handle (2) toward gauge and press power switch (1) to tighten joint.
 5. To reposition chain tongs and continue tightening joint, move handle away from gauge, then back toward gauge, and then press power switch.
 6. Monitor gauge (3) and refer to decal to achieve proper preload.
 7. Move handle to center (neutral) position to relieve pressure.
 8. Disconnect hoses and remove HydraTong components.
 1. Attach remaining pullback devices.
 2. Attach pullback material to end of backream string and hand tighten.

3. Connect HydraTong power pack.



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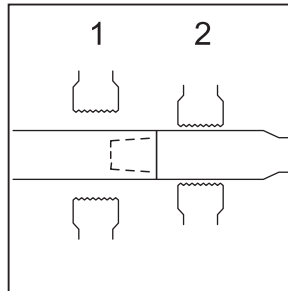
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REMOVE PIPE

**⚠ DANGER**

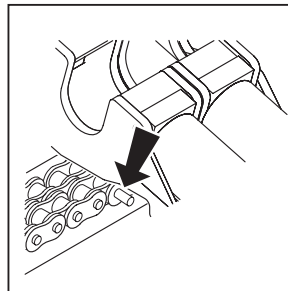
Turning shaft can kill you or crush arm or leg. Stay away.

NOTICE: Do not clamp near female end of pipe or it will be damaged. Clamp on pipe when joint is between wrenches but as near front wrench (2) as possible.



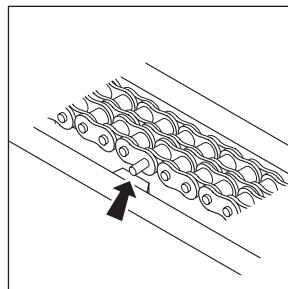
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IMPORTANT: Joint is properly positioned for clamping when alignment pin becomes visible behind rear wrench.



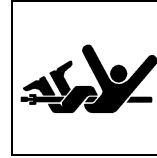
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IMPORTANT: Use alignment pin to position carriage every time a pipe joint is broken out to ensure pipe will go into pipe box.



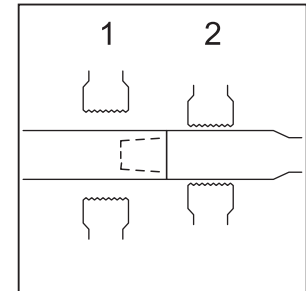
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REMOVE PIPE

**⚠ DANGER**

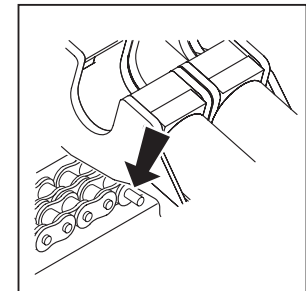
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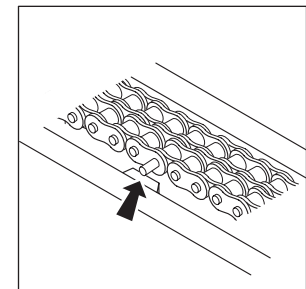
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IMPORTANT: Joint is properly positioned for clamping when alignment pin becomes visible behind rear wrench.



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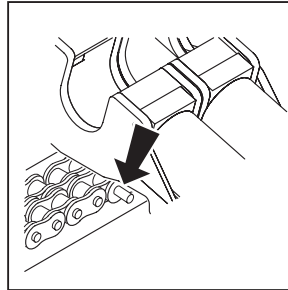
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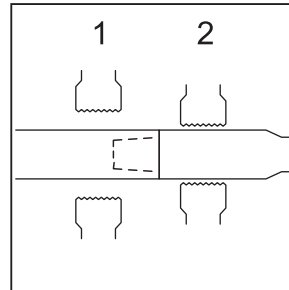
Manual Pipeloader Controls

1. Stop carriage when alignment pin becomes visible behind rear wrench.



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2. Clamp pipes.
 - Engage front wrench (2).
 - Engage rear wrench (1).
3. Break front joint.
 - Turn rear wrench counterclockwise to break joint.
 - Disengage rear wrench and rotate wrench clockwise.

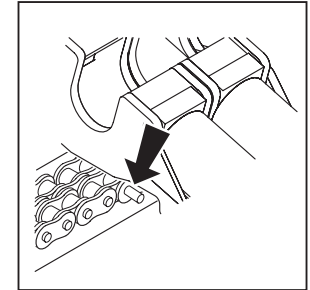


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4. Grip pipe.
 - Open pipeloader grippers.
 - Use pipe lift control to lift pipes off shuttle.
 - Extend shuttles to spindle position.
 - Close pipeloader grippers. Leave grippers loose enough to allow pipe to rotate.
 - Use pipe lift control to lower lifters.

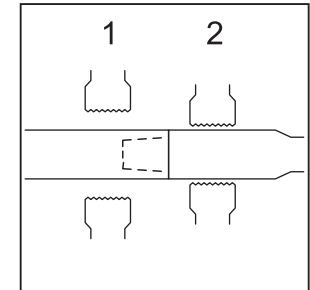
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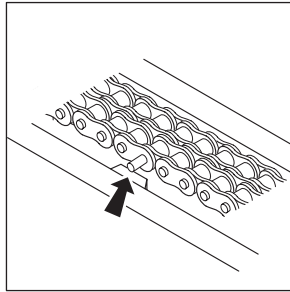
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5. Unscrew front joint.

- Slowly rotate spindle counterclockwise and move carriage back to unscrew pipe.
- Continue to move carriage back until pipe is properly positioned in rotating wrench.

6. Break rear joint.

- Engage rear wrench.
- Slowly rotate spindle counterclockwise and move carriage back until joint is loosened. **Do not** fully unscrew joint.
- Disengage rear wrench.
- Move carriage back until front end of pipe is aligned with front end of pipe box or alignment pin is even with tab on drill frame.
- Press grip switch to close pipe grippers.
- Rotate spindle counterclockwise and move carriage back until saver sub is unscrewed from pipe.
- Move carriage to back of frame.



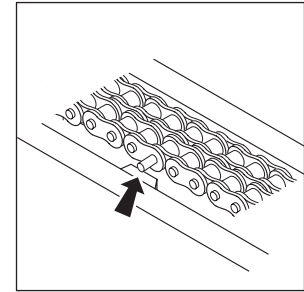
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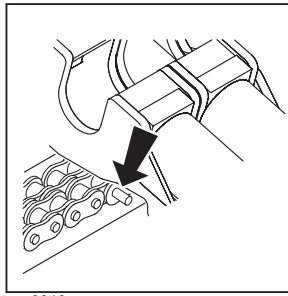
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7. Load pipe into pipe box.
 - Move shuttle under pipe box to shuttle stop.
 - Release pipeloader grippers and raise lift arms to place pipe in box.
 - Press manual lube switch to lube front joint.
8. Attach saver sub to next pipe.
 - Move carriage forward until saver sub touches pipe.
 - Rotate spindle and move carriage forward just enough to allow saver sub to screw onto pipe. Tighten joint to full machine torque.
9. Disengage front wrench to release pipe.

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 - Move shuttle under pipe box to shuttle stop.
 - Release pipeloader grippers and raise lift arms to place pipe in box.
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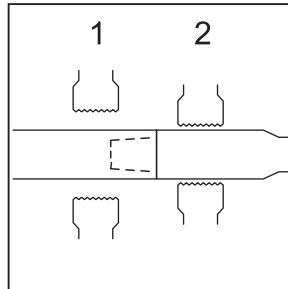
Automated Pipeloader Control

1. Enable automated pipeloader system.
 - Front wrench must be open and shuttles retracted for remove pipe function to work.
 - Press bottom of add pipe/manual/remove pipe switch. Green control cycle light will come on.
 - Grippers will open, pipe will be lowered and lifted off shuttles, and then green control cycle light will flash.
2. Stop carriage when alignment pin becomes visible behind rear wrench.



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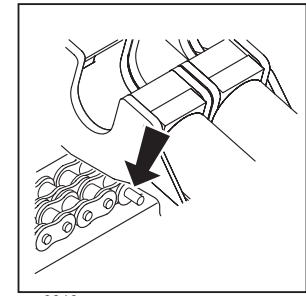
3. Clamp pipes.
 - Engage front wrench (2).
 - Engage rear wrench (1).



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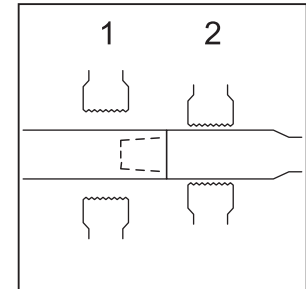
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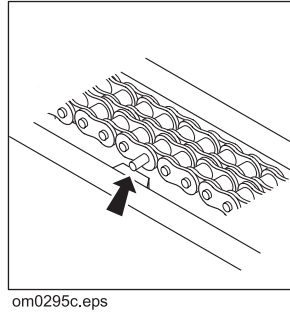
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4. Break front joint.
 - Turn rear wrench counterclockwise to break joint.
 - Disengage rear wrench and rotate wrench clockwise.
5. Grip pipe.
 - Press resume. Green control cycle light will come on.
 - Shuttles will extend, pipe grippers will grip fully and relax open, pipe lifters will lower, and then green control cycle light will flash.
6. Unscrew front joint.
 - Slowly rotate spindle counterclockwise and move carriage back to unscrew pipe.
 - Continue to move carriage back until pipe is properly positioned in rear wrench.

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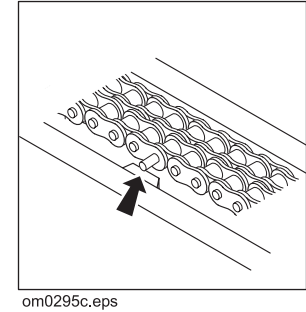
7. Break rear joint.

- Engage rear wrench.
- Slowly rotate spindle counterclockwise and move carriage back until joint is loosened. **Do not** fully unscrew joint.
- Disengage rear wrench.
- Move carriage back until front end of pipe is aligned with front end of pipe box or alignment pin is even with tab on frame.
- Press resume. Green control cycle light will come on.
- Pipe grippers will close and then green control cycle light will flash.
- Rotate spindle counterclockwise and move carriage back until saver sub is unscrewed from pipe.
- Move carriage to back of frame.



7. Break rear joint.

- Engage rear wrench.
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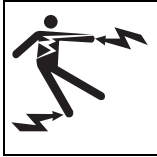


8. Load pipe into pipe box.
 - Press resume. Green control cycle light will come on.
 - Shuttles will retract under edge of pipe box and then green control cycle light will flash.
 - Move carriage forward until it clears end of pipe box. Green control cycle light will come on.
 - Shuttles will retract to shuttle stop, front joint will be lubed, pipe grippers will release pipe, pipe lifters will raise until pipe is off shuttles, and then green control cycle light will flash.
9. Attach saver sub to next pipe.
 - Move carriage forward until saver sub touches pipe.
 - Rotate spindle and move carriage forward just enough to allow saver sub to screw onto pipe. Slowly tighten joint to full machine torque.
10. Disengage front wrench to release pipe.

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REMOVE PIPE FROM PIPE BOX

Unload all drill pipe loaded with auxiliary shuttles. Pipe in fourth row of pipe box can be unloaded only when all other rows are empty.

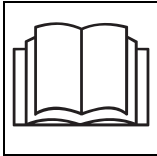


⚠ DANGER

Electric shock. Contacting electric lines will cause death or serious injury. Know location of lines and stay away.

NOTICES:

- Do not attempt to load and unload pipe while drilling or backreaming. Unprotected worker can be injured by electric strike.
- On electrical jobsite, load and unload pipe only if grid mats are properly set up and connected to drilling unit and loader is wearing electrically insulating boots and gloves.



⚠ WARNING

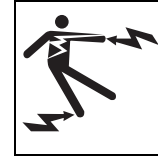
Incorrect procedures could result in death, injury, or property damage. Learn to use equipment correctly.

NOTICES:

- Open or close **both** auxiliary shuttles. Moving shuttles with one auxiliary shuttle open and one closed will damage equipment and cause possible injury.
- Carriage must be in full back position to load and unload pipe.

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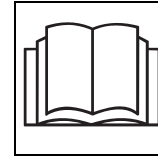


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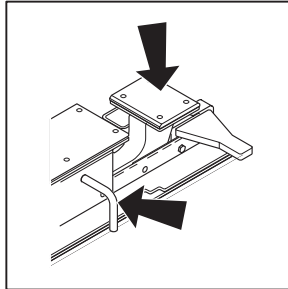
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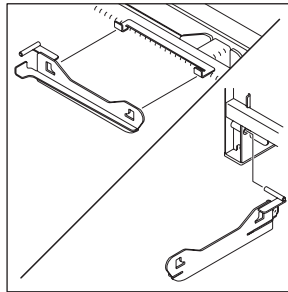
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1. Ensure shuttle stop is fully lowered.
2. Extend shuttles fully.
3. Pull and hold pins on each shuttle and slide out auxiliary shuttles.



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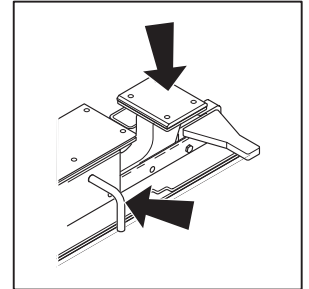
4. Remove pipe stop (stored on outside of drill frame) and attach to front of pipe box.



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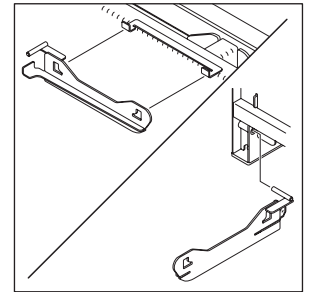
5. Use pipe lift switch to raise pipe in row 4.
6. Move pipe to auxiliary shuttles.
 - Use shuttle switch to move shuttles in.
 - Use pipe lift switch to lower pipe into auxiliary shuttles.
7. Use shuttle switch to move shuttles out.
8. Remove pipe from auxiliary shuttles and store properly.
9. Repeat steps 5-8 to unload remaining added drill pipe.
10. After all added drill pipe is unloaded with auxiliary shuttles, close both auxiliary shuttles, remove pipe stop and store it on drill frame, step away from pipeloader, and finish loading remaining drill pipe into row 4 using standard procedure.

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REMOVE PULLBACK DEVICE

The pullback device can be removed when the last pipe is on the frame.

It can also be removed when a target pit along the bore path has been reached. Remaining pipe is then pulled back and removed.

**⚠ DANGER**

Moving parts. Being struck by wrench will kill or injure. Do not use drilling unit to turn or move drill string when wrench is used.

1. Press bottom of drilling unit throttle switch until engine is at low throttle.
2. Move fluid pump switch to off position and turn drilling unit off.
3. Clean pullback device.

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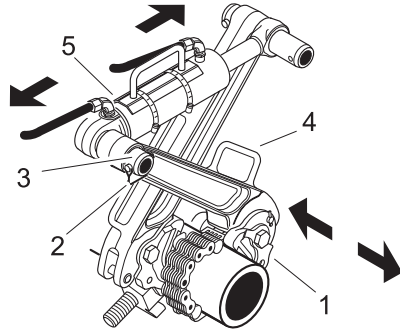
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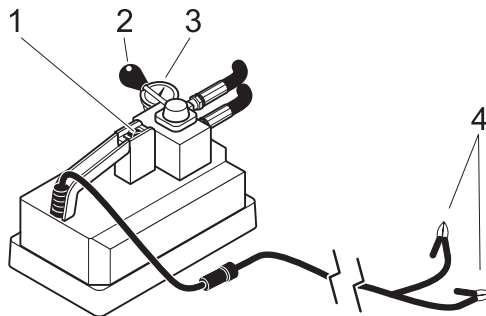
4. Attach HydraTong in break position.



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- Attach chain tongs (1) to both sides of joint. Place tongs as close to joint as possible for maximum torque.
- Remove snapper pins (2) from slide pins (3), and insert slide pins into wrench handles (4).
- Attach each end of hydraulic cylinder (5) to slide pins and insert snapper pins.

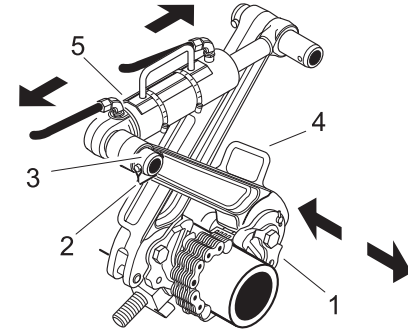
5. Connect HydraTong power pack.



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- Attach hoses from power pack to cylinder.
- Attach leads (4) to 12 Volt battery.

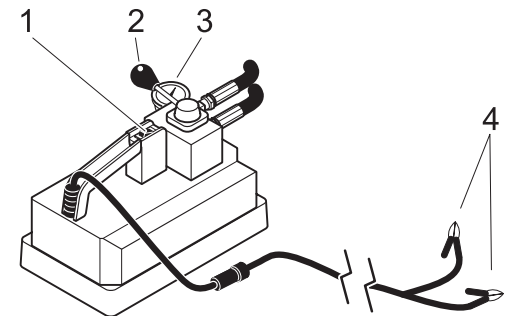
4. Attach HydraTong in break position.



n0321c.eps

- Attach chain tongs (1) to both sides of joint. Place tongs as close to joint as possible for maximum torque.
- Remove snapper pins (2) from slide pins (3), and insert slide pins into wrench handles (4).
- Attach each end of hydraulic cylinder (5) to slide pins and insert snapper pins.

5. Connect HydraTong power pack.



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- Attach hoses from power pack to cylinder.
- Attach leads (4) to 12 Volt battery.

6. Move shuttle valve handle (2) toward gauge and press power switch (1) to tighten joint.
7. To reposition chain tongs and continue tightening joint, move handle away from gauge, then back toward gauge, and then press power switch.
8. Monitor gauge (3) and refer to decal to achieve proper preload.
9. Move handle to center (neutral) position to relieve pressure.
10. Disconnect hoses and remove HydraTong components.
11. Remove pullback device.

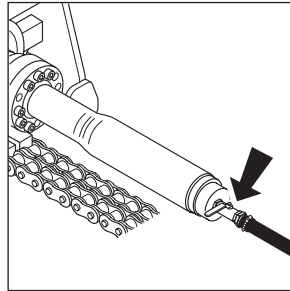
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ANTIFREEZE DRILLING UNIT

Your drilling unit can be left overnight in freezing conditions by circulating an approved antifreeze (p/n 265-644) through unit.

To circulate antifreeze through drilling unit:

1. Fill antifreeze tank with 8 gal (30 L) of approved antifreeze.
2. Install plug on suction side of drilling fluid pump.
3. Open valve below antifreeze tank.
4. Install antifreeze reclaimer adapter in spindle. Ensure valve (shown) is open.
5. Turn drilling fluid potentiometer counterclockwise to zero position.
6. Start unit and set throttle to slow position.
7. Set pump switch to on position.
8. Slowly turn drilling fluid potentiometer clockwise until indicator light comes on.
9. Run pump until antifreeze comes out of spindle.
10. Turn pump switch to off position. Close valve on antifreeze reclaimer adapter.



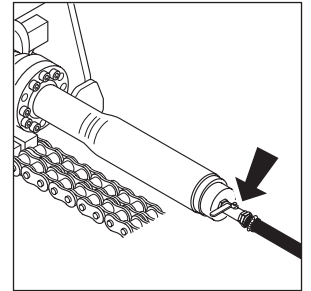
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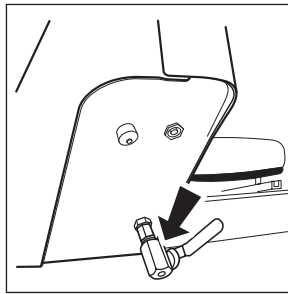
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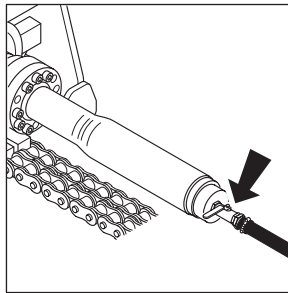
11. Open valve below right operator's console (shown).
12. Repeat steps 5-8.
13. Close valve below right console when antifreeze runs out of valve below right console.
14. Turn pump switch to off position.



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To reclaim antifreeze:

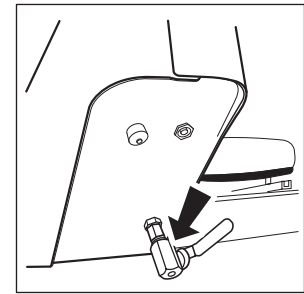
1. Hold hose on antifreeze reclaimer over top of antifreeze tank.
2. Open valve on reclaimer.
3. Connect drilling fluid transfer hose from tanks to drilling fluid pump inlet.
4. Close valve below antifreeze tank.
5. Start machine and run at low throttle.
6. Turn drilling fluid pump on low speed.
7. Turn drilling fluid pump off when drilling fluid comes out of reclaimer hose.
8. Remove antifreeze reclaimer.



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IMPORTANT: Antifreeze can be removed from antifreeze tank and disposed of properly or it can be reused until it is too diluted with drilling fluid to protect against freezing.

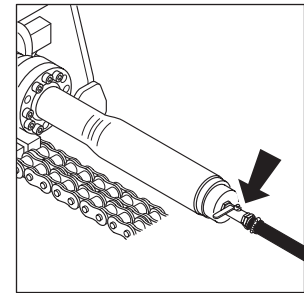
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om0299c.eps

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BREAKDOWN

REMOVE ANCHORS



⚠ WARNING Crushing weight. If load falls or moves, it could kill or crush you. Use proper procedures and equipment or stay away.

1. Use anchor rotation and thrust controls to slowly remove anchor shaft from ground.
2. Repeat process for other anchor.

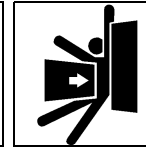
RINSE EQUIPMENT

Spray water onto equipment to remove dirt and mud. Some pressure might be needed to remove dried mud from wrench area.

NOTICE: Do not spray water onto operator's console. Electrical components could be damaged. Wipe down instead.

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DISCONNECT

Disconnect and store the following hoses and cables (if used):

- electric cable
- electric strike system voltage stake
- fluid hose
- override control box

STOW TOOLS

Make sure all quick wrenches, bits, pullback devices, and other tools are loaded on trailer.

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LUBRICATION

**⚠ WARNING**

Fluid under pressure can pierce skin and cause injury or death. Stay away.

NOTICES:

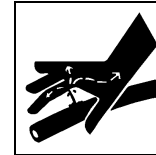
- Before using system, check that all connections are tight and all lines are undamaged.
- Fluid leaks can be hard to detect. Use a piece of cardboard or wood, rather than hands, to search for leaks.
- Wear protective clothing and eye protection.
- If you are injured, seek immediate medical attention.

**⚠ WARNING**

Crushing weight. If load falls or moves, death or serious injury can result. Use proper procedures and equipment or stay away.

NOTICE: Unless otherwise instructed, all service in this chapter should be performed with the engine(s) shut off.

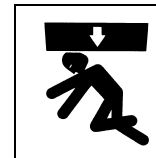
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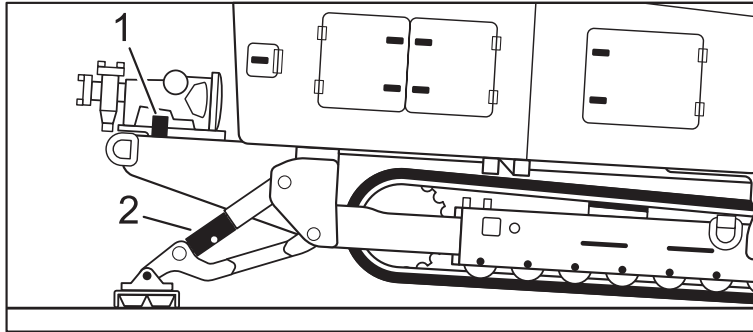
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Working Under Drilling Unit

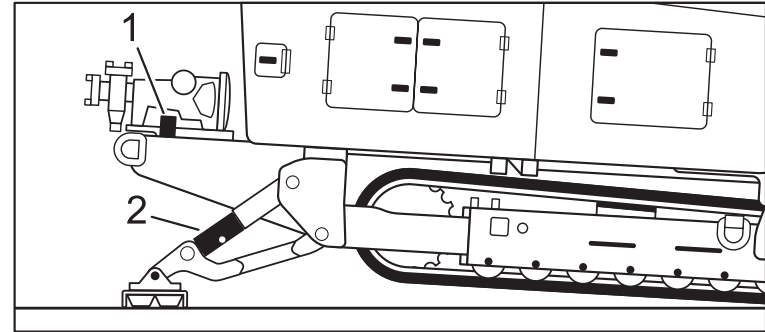


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Before working under drilling unit supported by stabilizer cylinder, make sure drilling unit is parked on hard surface. Remove cylinder lock pinned to frame (1) and place over extended cylinder rod (2). Reinstall pins to secure cylinder lock to rod.

Before working under front end of drill frame, install jackstands under frame.

Working Under Drilling Unit



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Before working under front end of drill frame, install jackstands under frame.

OVERVIEW

Interval	Task	Page no.
10	check engine oil	163
	check hydraulic oil	173
	check fluid pump oil	175
50	check rotation gearbox oil	171
	check carriage travel gearbox oil (two gearboxes)	172
	check ground drive gearbox oil (two gearboxes)	172
	change fluid pump oil (initial)	175
	change hydraulic filters (initial)	174
	lube sliding output shaft	171
	lube vise wrenches	166
	lube thrust chain	166
	lube thrust chain idler	166
100	change engine oil and filter (initial)	164
250	change hydraulic oil filters	174
	change engine oil and filter	164
1000	change hydraulic oil and filters*	174
	change rotation gearbox oil	171
	change carriage travel gearbox oil	172
	change ground drive gearbox oil	172
	change fluid pump oil	175
	lube sliding output shaft	171
As needed	change pipe auto lubricator grease container	168

*If ambient temperature exceeds 100° F (37° C) for 50% of time, change oil and filters every 500 hours.

For engine maintenance, see your John Deere® manual.

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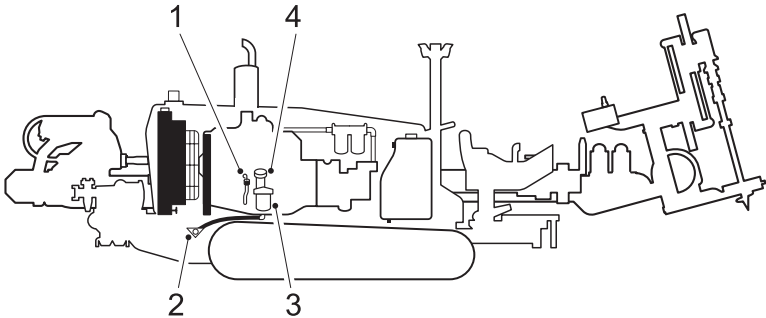
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Lubricant chart:	
MPG	Multipurpose grease
DEO	Diesel engine oil
MPL	Multipurpose gear oil (SAE 80W90) meeting API service classification GL-5
THF	Tractor hydraulic fluid: Phillips 66 HG Fluid, Mobilfluid 423, Chevron Tractor Hydraulic Fluid, Texaco TDH Oil, or equivalent
TJC	Tool joint compound: standard or summer grade
EPG	Open gear extreme pressure grease in spray form (p/n 256-034) or tube (p/n 256-666)

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ENGINE OIL



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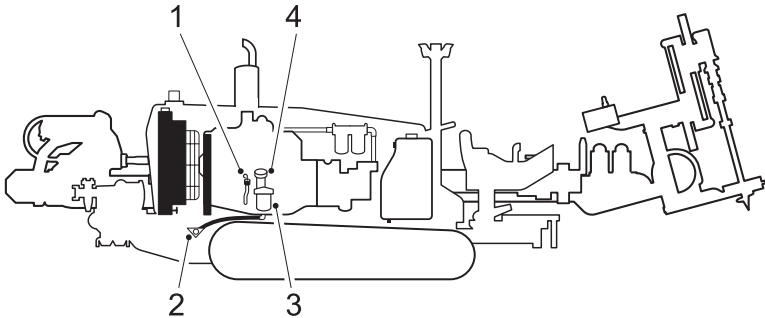
Ref.	Task	Hours	Lubricant
1	check oil	10	DEO
2, 3, 4	change oil and filter (initial)	100	DEO
2, 3, 4	change oil and filter	250	DEO

IMPORTANT: Use genuine Ditch Witch filters and tool joint compound to maintain warranty.

Check

Check engine oil every 10 hours at dipstick (1). If low, fill with DEO at oil fill (4).

ENGINE OIL



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1	check oil	10	DEO
2, 3, 4	change oil and filter (initial)	100	DEO
2, 3, 4	change oil and filter	250	DEO

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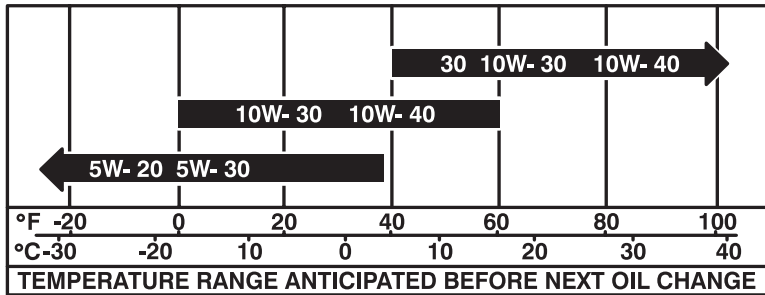
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Change

Change engine oil and filter (3) after first 100 hours. Use John Deere Break-in oil during first 100 hours if makeup oil is required. (See John Deere dealer.) After that, change every 250 hours. Drain oil (2), change filter (3), and refill with 24 qt (23 L) of DEO (4).

If operating in extremely dusty conditions, change oil more frequently. Use oil specified in temperature chart.

Engine Oil Temperature Chart

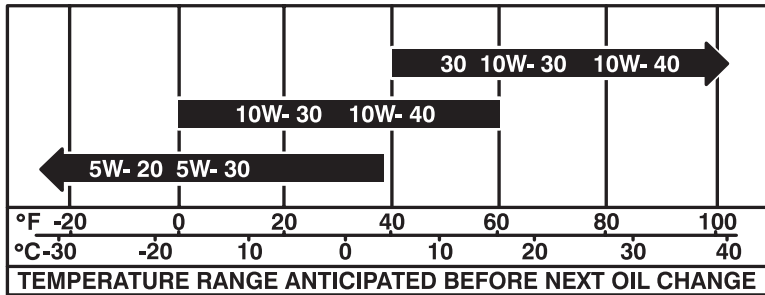


Change

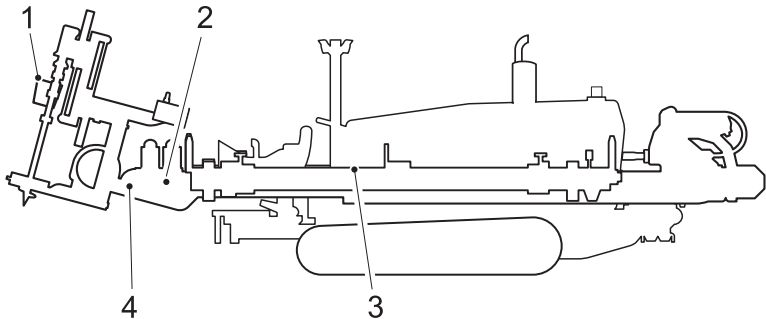
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Engine Oil Temperature Chart



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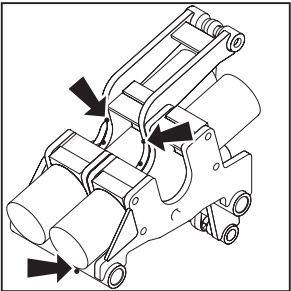
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Ref.	Task	Hours	Lubricant
2	lube vise wrenches	50	MPG
3	lube thrust chain	50	DEO
4	lube thrust chain idler	50	MPG
1	change pipe auto lubricator pail	as needed	TJC

IMPORTANT: Use genuine Ditch Witch filters and tool joint compound to maintain warranty.

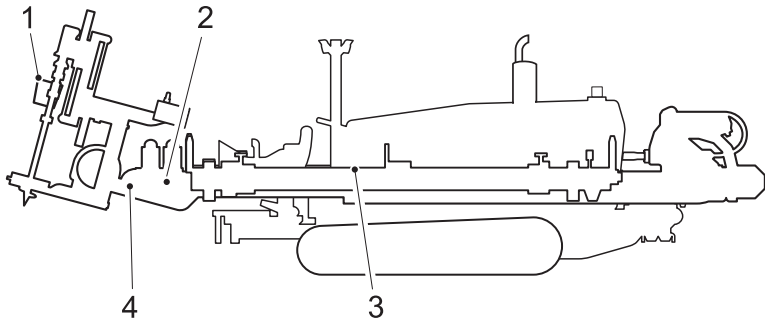
Vise Wrenches

Lube ten zerks with MPG every 50 hours.



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FRAME



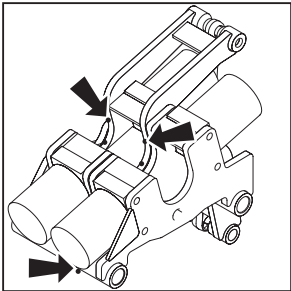
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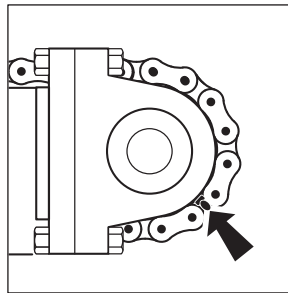
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Thrust Chain

Lube thrust chain with DEO every 50 hours.

Thrust Chain Idler

Lube fittings (one on each side of front sprocket) with MPG every 50 hours.



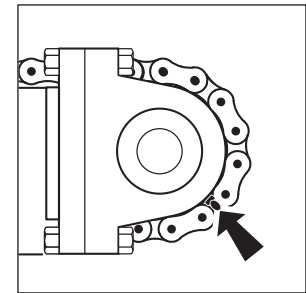
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Thrust Chain

Lube thrust chain with DEO every 50 hours.

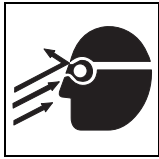
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Pipe Auto Lubricator



WARNING Fluid or air pressure could pierce skin and cause injury or death. Stay away.

NOTICES:

- TJC is expelled forcefully. Do not stand directly in front of tee.
- Air pockets in TJC may cause pump to malfunction. Each time pail is installed, place lid on pail and tap on ground to settle TJC before installation.
- Do not operate pump with handle/nozzle insert removed. Nozzle assembly contains small parts that may be pushed out of position or lost.

TJC Selection

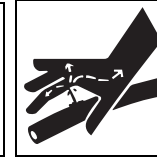
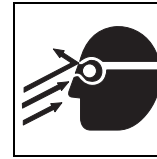
IMPORTANT: Use only Ditch Witch TJC. It is formulated to work with auto lubricator. Use of other material can plug lubricator system and void warranty.

Use standard grade TJC (P/N 259-858) for drilling in temperatures up to 75°F (24°C). Use summer grade TJC (P/N 259-830) for drilling in temperatures above 65°F (18°C).

Cold Weather Drilling Information

In operating temperatures below freezing, nozzle may not spray in “fan” pattern. To ensure proper protection, manually apply TJC to pipe tool joints.

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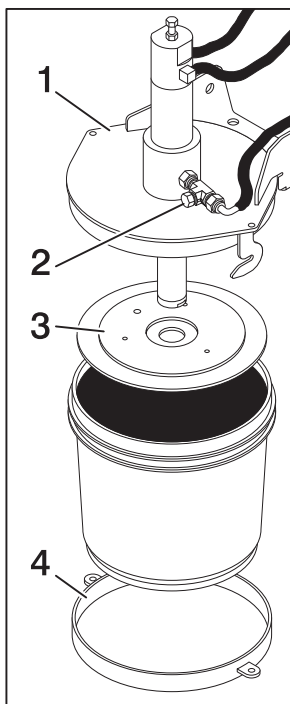
In operating temperatures below freezing, nozzle may not spray in “fan” pattern. To ensure proper protection, manually apply TJC to pipe tool joints.

Procedure

Inspect rear applicator daily and replace if damaged. Visually check TJC level daily and change pail as needed. Inspect spray nozzle frequently to ensure it is free from obstructions and functioning properly. Clean nozzle as needed.

To change pail:

1. Remove wingnuts and capscrews attaching clamp ring (4) to pump bracket (1).
2. Rotate clamp ring slightly to clear hooks on bracket and remove pail from pump.
3. Remove follower plate (3) from empty pail and install into new pail. Press firmly on plate until TJC comes up center circle.
4. Remove clamp ring from empty pail and install onto new pail.
5. Install pail into place over pump dip tube. Use hooks on bracket to support clamp ring.
6. Install capscrews and wingnuts.
7. Remove cap (2) from discharge tee on pump. Operate pump until discharged TJC is free of air pockets. Replace cap.



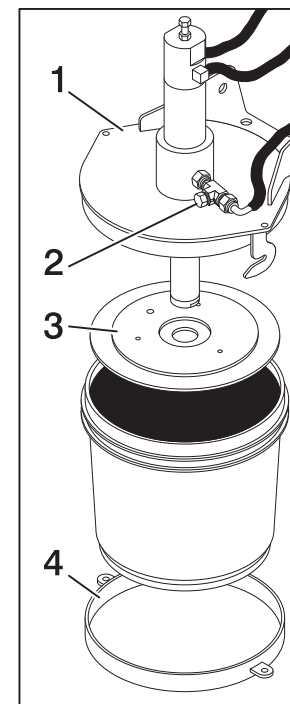
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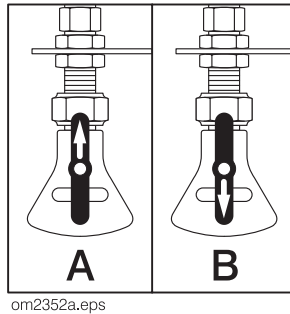
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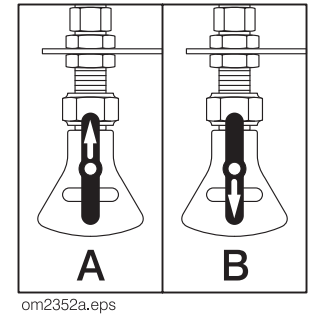
1. Rotate handle to the upward, or cleanout, position (A).
2. Operate pump until obstruction is flushed.
3. Rotate handle to the downward, or spray, position (B).
4. Clean nozzle guard. If necessary, pull handle/nozzle insert out of housing to clean with fine wire or solvent.



NOTICE: Do not operate pump with handle/nozzle insert removed. Small parts may be lost.

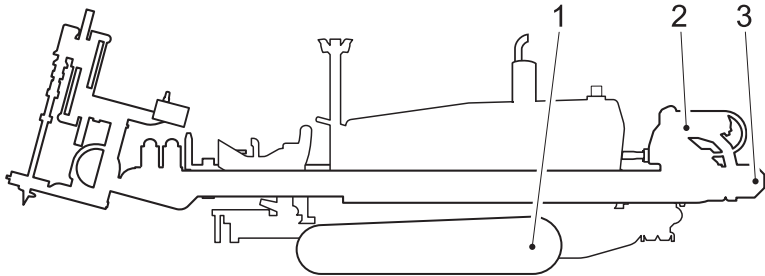
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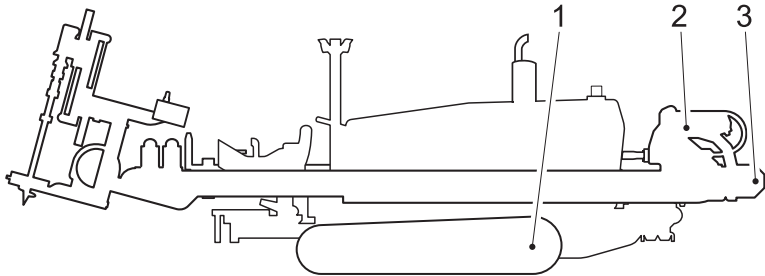
GEARBOXES



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Ref.	Task	Hours	Lubricant
2	check rotation gearbox oil	50	MPL
3	check carriage travel gearbox oil (two gearboxes)	50	MPL
1	check ground drive gearbox oil (two gearboxes)	50	MPL
2	lube sliding output shaft	50	EPG
2	change rotation gearbox oil	1000	MPL
3	change carriage travel gearbox oil (two gearboxes)	1000	MPL
1	change ground drive gearbox oil (two gearboxes)	1000	MPL
2	lube sliding output shaft	1000	EPG

GEARBOXES



om0270c.eps

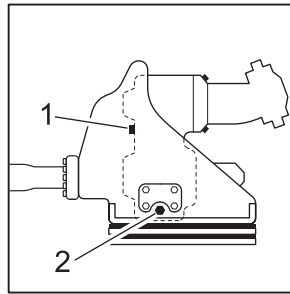
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3	check carriage travel gearbox oil (two gearboxes)	50	MPL
1	check ground drive gearbox oil (two gearboxes)	50	MPL
2	lube sliding output shaft	50	EPG
2	change rotation gearbox oil	1000	MPL
3	change carriage travel gearbox oil (two gearboxes)	1000	MPL
1	change ground drive gearbox oil (two gearboxes)	1000	MPL
2	lube sliding output shaft	1000	EPG

Rotation Gearboxes

Check

IMPORTANT: Drill frame must be level for accurate reading.

Check gearbox every 50 hours. Oil should be level with plug. Fill with MPL at fill plug (1) as needed.



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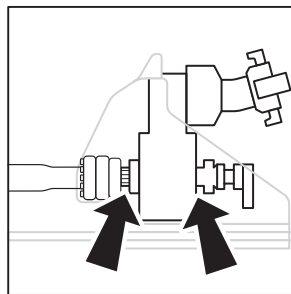
Change

Drain oil at gearbox oil drain (2) every 1000 hours. Refill with MPL.

Sliding Output Shaft

Clean and lube both sides of sliding output shaft and saver sub wrench collar every 50 hours with extreme pressure spray lubricant (p/n 256-034).

Remove and clean sliding output shaft and saver sub wrench collar every 1000 hours and repack with extreme pressure lubricant (p/n 256-666).



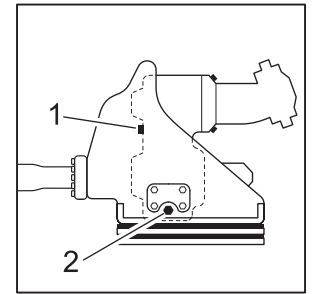
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Rotation Gearboxes

Check

IMPORTANT: Drill frame must be level for accurate reading.

Check gearbox every 50 hours. Oil should be level with plug. Fill with MPL at fill plug (1) as needed.



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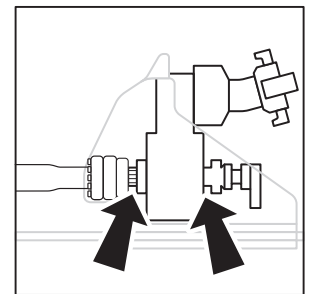
Change

Drain oil at gearbox oil drain (2) every 1000 hours. Refill with MPL.

Sliding Output Shaft

Clean and lube both sides of sliding output shaft and saver sub wrench collar every 50 hours with extreme pressure spray lubricant (p/n 256-034).

Remove and clean sliding output shaft and saver sub wrench collar every 1000 hours and repack with extreme pressure lubricant (p/n 256-666).



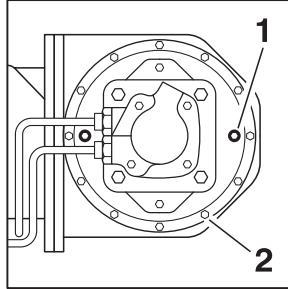
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Carriage Travel Gearboxes

Check

IMPORTANT: Drill frame must be level for accurate reading.

Check two gearboxes every 50 hours. Oil should be level with plug (1). Fill with MPL at plug as needed.



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Change

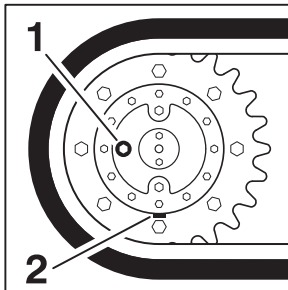
Drain oil every 1000 hours by loosening 12 bolts (2) until seal cracks and oil runs out. Refill with MPL.

Ground Drive Gearboxes

Check

IMPORTANT: Drilling unit must be on level ground for accurate reading.

Check gearbox every 50 hours. Rotate plug (1) until level with center of gearbox. Open plug. If oil does not come out, fill with MPL as needed. Never fill more than halfway.



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Change

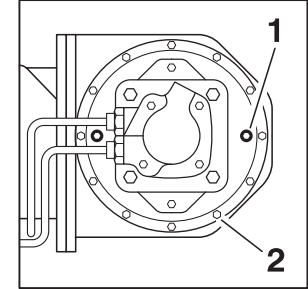
Remove plug (2) and drain oil every 1000 hours. Refill with MPL.

Carriage Travel Gearboxes

Check

IMPORTANT: Drill frame must be level for accurate reading.

Check two gearboxes every 50 hours. Oil should be level with plug (1). Fill with MPL at plug as needed.



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Change

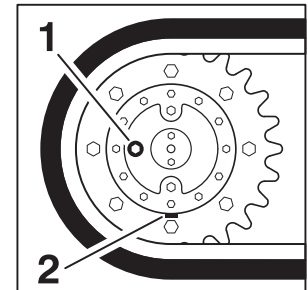
Drain oil every 1000 hours by loosening 12 bolts (2) until seal cracks and oil runs out. Refill with MPL.

Ground Drive Gearboxes

Check

IMPORTANT: Drilling unit must be on level ground for accurate reading.

Check gearbox every 50 hours. Rotate plug (1) until level with center of gearbox. Open plug. If oil does not come out, fill with MPL as needed. Never fill more than halfway.

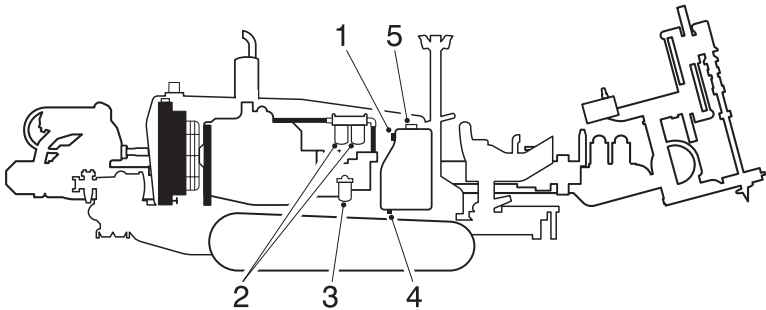


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Change

Remove plug (2) and drain oil every 1000 hours. Refill with MPL.

HYDRAULIC OIL



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Ref.	Task	Hours	Lubricant
1	check oil	10	THF
2,3	change oil filters (initial)	50	THF
2, 3	change oil filters	250	THF
2, 3, 4, 5	change oil and filters *	1000	THF

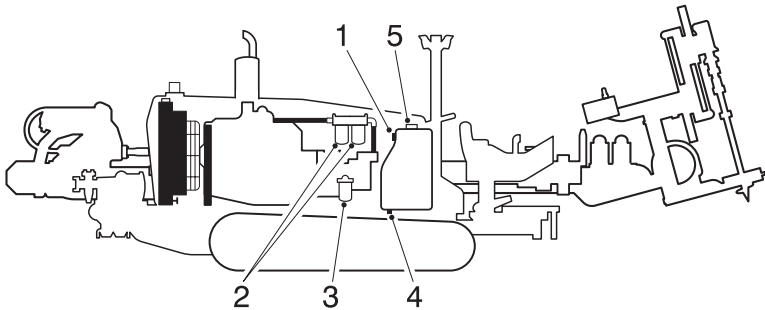
*If ambient temperature exceeds 100° F (37° C) for 50% of time, change oil and filters every 500 hours.

IMPORTANT: Use genuine Ditch Witch filters and tool joint compound to maintain warranty.

Check

Check hydraulic oil every 10 hours. Maintain fluid level at halfway point on sight glass (1), when engine is off and fluid is cool. Refill with THF at hydraulic oil fill (5).

HYDRAULIC OIL



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Ref.	Task	Hours	Lubricant
1	check oil	10	THF
2,3	change oil filters (initial)	50	THF
2, 3	change oil filters	250	THF
2, 3, 4, 5	change oil and filters *	1000	THF

*If ambient temperature exceeds 100° F (37° C) for 50% of time, change oil and filters every 500 hours.

IMPORTANT: Use genuine Ditch Witch filters and tool joint compound to maintain warranty.

Check

Check hydraulic oil every 10 hours. Maintain fluid level at halfway point on sight glass (1), when engine is off and fluid is cool. Refill with THF at hydraulic oil fill (5).

Change

Change three hydraulic oil filters at 250 hours. Drain hydraulic oil (4), change filters (2, 3), and refill with THF at hydraulic oil fill (5) every 1000 hours. If ambient temperature exceeds 100°F (37°C) for 50% of time, change oil and filter every 500 hours.

Replace break-in oil filters (p/n 153-407) with standard filters (p/n 153-408) at 50 hours. Replace standard filter every 250 hours thereafter. Change standard filter sooner if indicated by filter indicator.

IMPORTANT: If hydraulic system must be opened for repair, install break-in filter (p/n 153-407) for first 50 hours of operation. If this filter becomes plugged in fewer than 20 hours, replace with another break-in filter. After 50 hours of normal operation, replace with standard filter (p/n 153-408).

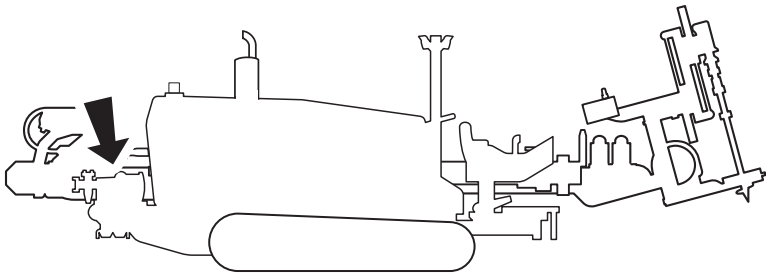
Change

Change three hydraulic oil filters at 250 hours. Drain hydraulic oil (4), change filters (2, 3), and refill with THF at hydraulic oil fill (5) every 1000 hours. If ambient temperature exceeds 100°F (37°C) for 50% of time, change oil and filter every 500 hours.

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FLUID PUMP

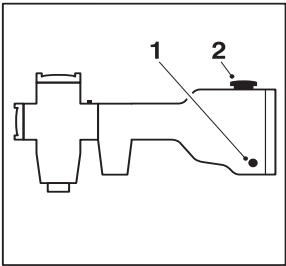


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Ref.	Task	Hours	Lubricant
	check fluid pump oil	10	SAE10W30
	change fluid pump oil (initial)	50	SAE10W30
	change fluid pump oil	1000	SAE10W30

Check

Check oil level in fluid pump every 10 hours. Refill (2) as needed with SAE 30W engine oil.

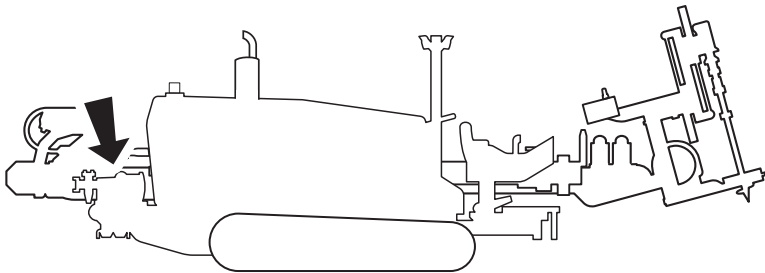


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Change

Change oil after first 50 hours and every 1000 hours thereafter. Drain at plug (1). Fill (2) with 11 qt (10.4 L) of oil.

FLUID PUMP

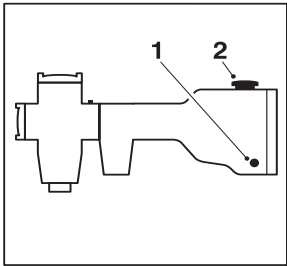


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Ref.	Task	Hours	Lubricant
	check fluid pump oil	10	SAE10W30
	change fluid pump oil (initial)	50	SAE10W30
	change fluid pump oil	1000	SAE10W30

Check

Check oil level in fluid pump every 10 hours. Refill (2) as needed with SAE 30W engine oil.



om2330a.eps

Change

Change oil after first 50 hours and every 1000 hours thereafter. Drain at plug (1). Fill (2) with 11 qt (10.4 L) of oil.

MAINTENANCE

NOTICE: Unless otherwise instructed, all service in the section should be performed with the engine(s) shut off.

OVERVIEW

Interval	Task	Page no.
daily	check pipelader control switches	191
10	inspect hoses	182
	check and fill coolant in overflow bottle	180
50	check radiator	180
	check belt	179
	check batteries	179
	change fuel filter (initial)	187
500	change fuel filter	187
600	check radiator SCA level	181
1000	check air filter	187
2000 or 5000	change coolant (depending on coolant used)	181

MAINTENANCE

NOTICE: Unless otherwise instructed, all service in the section should be performed with the engine(s) shut off.

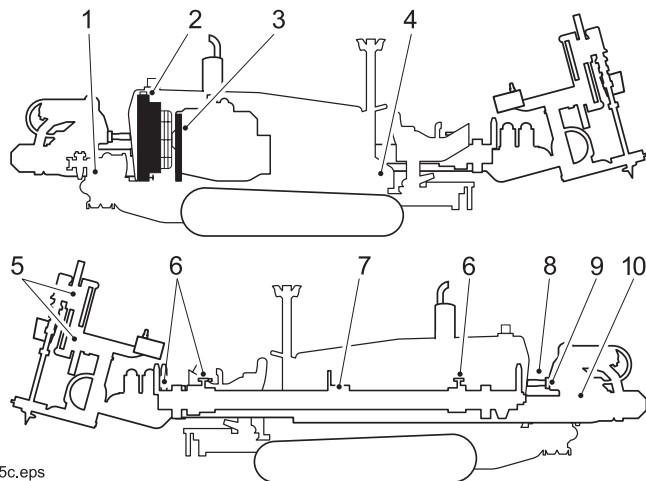
OVERVIEW

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as needed	check fluid pump ball valve	182
	replace saver sub	183
	replace pipeloader inserts	184
	replace pipe guide inserts	184
	replace pipe lubricator insert	184
	replace anchor driver glide strips	185
	replace carriage slide bars	185
	check muffler	186
	check track support slide pads	188
	check thrust chain tension	189
	check track tension and condition	190
	replace pipe guide blocks	185
	clean pipe and repair pipe threads	192

as needed	check fluid pump ball valve	182
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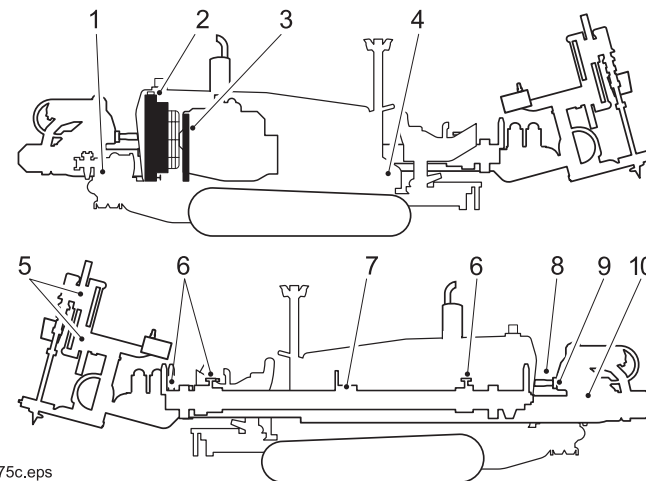
GENERAL COMPONENTS



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Ref	Task	Frequency
n/a	inspect hoses	10
2	check and refill coolant in overflow bottle	10
2	check radiator	50
3	check belt	50
4	check batteries	50
2	check radiator SCA level	500
2	change coolant (depending on coolant used)	2000 or 5000
1	check fluid pump ball valve	as needed
9	replace saver sub	as needed
6	replace pipeloader inserts	as needed
7	replace pipe guide inserts	as needed
8	replace pipe lubricator insert	as needed
5	replace anchor driver glide strips	as needed
10	replace carriage slide bars	as needed
n/a	replace pipe guide blocks	as needed

GENERAL COMPONENTS



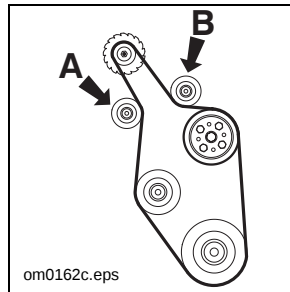
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Ref	Task	Frequency
n/a	inspect hoses	10
2	check and refill coolant in overflow bottle	10
2	check radiator	50
3	check belt	50
4	check batteries	50
2	check radiator SCA level	500
2	change coolant (depending on coolant used)	2000 or 5000
1	check fluid pump ball valve	as needed
9	replace saver sub	as needed
6	replace pipeloader inserts	as needed
7	replace pipe guide inserts	as needed
8	replace pipe lubricator insert	as needed
5	replace anchor driver glide strips	as needed
10	replace carriage slide bars	as needed
n/a	replace pipe guide blocks	as needed

NOTICE: Before disconnecting any hydraulic line, turn engine off and operate all controls to relieve pressure. Lower, block or support any raised component. Cover connection with heavy cloth and loosen connector nut slightly to relieve residual pressure. Catch all fluid in container.

Belt

This belt powers alternator, fan drive and water pump. Check condition of tensioner (A) and idler pulley (B) every 50 hours. Check for correct position of belt and check for belt wear.



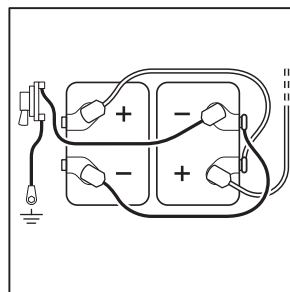
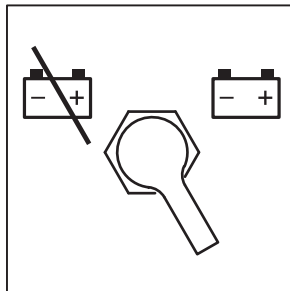
Batteries

IMPORTANT: Use battery disconnect switch when servicing, welding, and during long-term storage.

Keep batteries clean and free of corrosion. Apply coat of grease to cable clamps after cleaning.

In cold weather, batteries lose some starting ability. Closely watch voltmeter for signs of battery discharge.

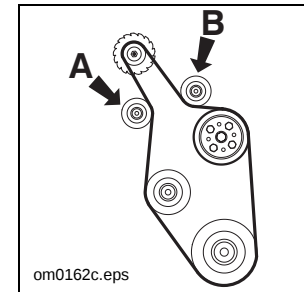
If batteries will not hold charge, see your Ditch Witch dealer for replacement batteries. When replacing batteries, refer to wiring diagram.



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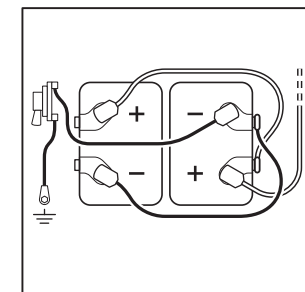
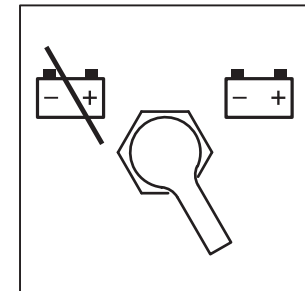
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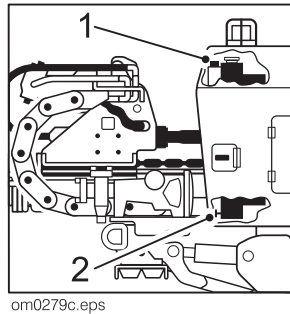
If batteries will not hold charge, see your Ditch Witch dealer for replacement batteries. When replacing batteries, refer to wiring diagram.



Radiator

Check coolant level, with engine cool, at overflow tank (1) every 10 hours. If low, add approved coolant.

Check radiator for dirt, grass, and other foreign matter every 50 hours. Clean out with compressed air or spray wash if required. Remove grill and spray through radiator toward engine. If grease and oil are present on radiator, spray with solvent and allow to soak overnight. Be careful not to damage fins with high-pressure air or water. Check more often if operating in dusty or grassy conditions.



Approved Coolant

This unit was filled with John Deere Cool-Gard coolant before shipment from factory. Add only John Deere Cool-Gard (p/n 255-006) or any fully-formulated, ethylene glycol based, low-silicate, heavy-duty diesel engine coolant meeting ASTM specification D5345 (prediluted) or D4985 (concentrate) and containing supplemental coolant additives (SCAs) meeting John Deere specification JDM H24A2.

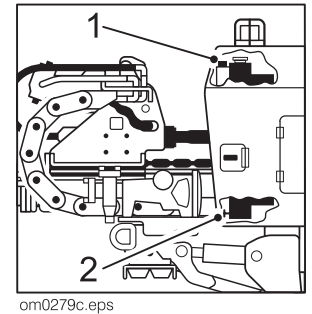
NOTICE:

- Do not use water or high-silicate automotive-type coolant. This will lead to engine damage or premature engine failure.
- Do not mix heavy-duty diesel engine coolant and automotive-type coolant. This will lead coolant breakdown and engine damage.

Radiator

Check coolant level, with engine cool, at overflow tank (1) every 10 hours. If low, add approved coolant.

Check radiator for dirt, grass, and other foreign matter every 50 hours. Clean out with compressed air or spray wash if required. Remove grill and spray through radiator toward engine. If grease and oil are present on radiator, spray with solvent and allow to soak overnight. Be careful not to damage fins with high-pressure air or water. Check more often if operating in dusty or grassy conditions.



Approved Coolant

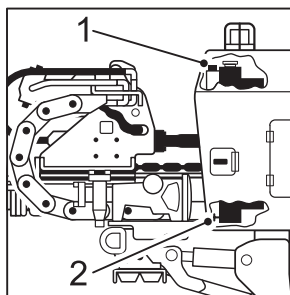
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NOTICE:

- Do not use water or high-silicate automotive-type coolant. This will lead to engine damage or premature engine failure.
- Do not mix heavy-duty diesel engine coolant and automotive-type coolant. This will lead coolant breakdown and engine damage.

Test SCA level every 500 hours using 3-Way Heavy Duty Coolant Test Kit (p/n 256-032). If SCA levels do not fall within appropriate range, replenish with a heavy-duty coolant conditioner such as John Deere coolant conditioner (p/n 256-033).

IMPORTANT: Always check expiration date on 3-Way Heavy Duty Coolant Test Kit. An expired kit will not give accurate readings.



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Drain cooling system at drain (2) and refill with approved coolant as indicated below.

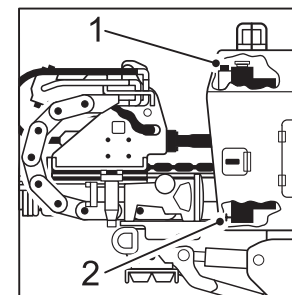
Situation	Interval
if using approved coolant other than John Deere Cool-Gard	2000 hours
if proper SCA levels are not maintained when using Cool-Gard	2000 hours
if using Cool-Gard with properly maintained SCA levels	5000 hours

NOTICE:

- Coolant change interval depends on coolant used and whether SCA levels are properly maintained. Read note above carefully to ensure coolant is changed at the correct interval.
- The use of non-approved coolant may lead to engine damage or premature engine failure and will void engine warranty.

Test SCA level every 500 hours using 3-Way Heavy Duty Coolant Test Kit (p/n 256-032). If SCA levels do not fall within appropriate range, replenish with a heavy-duty coolant conditioner such as John Deere coolant conditioner (p/n 256-033).

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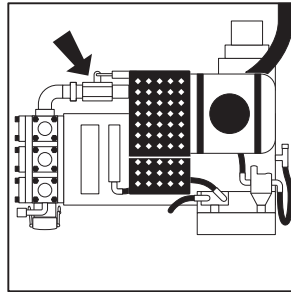
Situation	Interval
if using approved coolant other than John Deere Cool-Gard	2000 hours
if proper SCA levels are not maintained when using Cool-Gard	2000 hours
if using Cool-Gard with properly maintained SCA levels	5000 hours

NOTICE:

- Coolant change interval depends on coolant used and whether SCA levels are properly maintained. Read note above carefully to ensure coolant is changed at the correct interval.
- The use of non-approved coolant may lead to engine damage or premature engine failure and will void engine warranty.

Fluid Pump Ball Valve

Check hydraulic ball valve for leaks. Tighten stem packing as needed. See your Ditch Witch dealer for replacement packing.



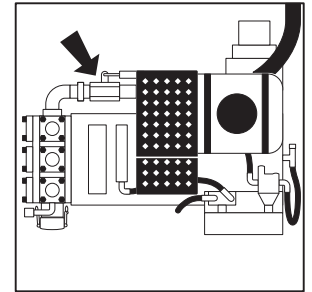
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Inspect Hoses

Check all hoses every ten hours. Check for leaks or bad connections.

Fluid Pump Ball Valve

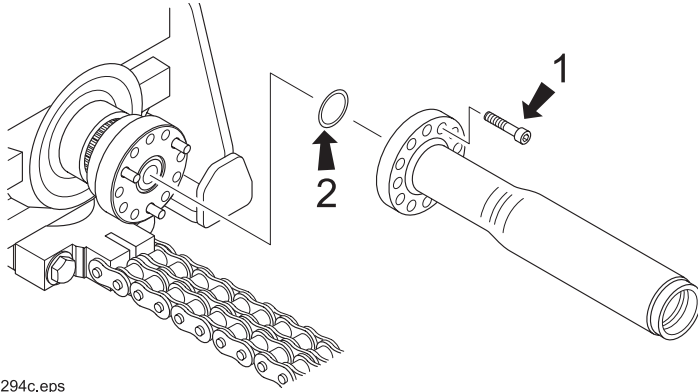
Check hydraulic ball valve for leaks. Tighten stem packing as needed. See your Ditch Witch dealer for replacement packing.



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Inspect Hoses

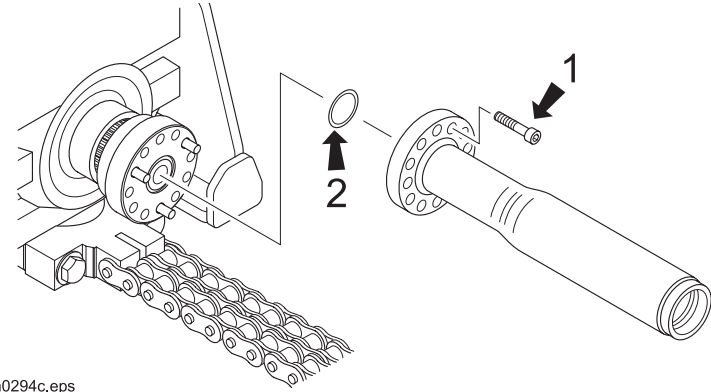
Check all hoses every ten hours. Check for leaks or bad connections.

Saver Sub

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As needed, replace saver sub on spindle.

- Remove nine bolts (1) that attach saver sub to spindle. Do not remove three indexing dowels from spindle.
- Remove and replace o-ring (2), if necessary.
- Install in reverse order and torque nine bolts in a cross pattern to 270 ft•lb (365 N•m). Apply Loctite® 242 to bolts before installation.

Saver Sub

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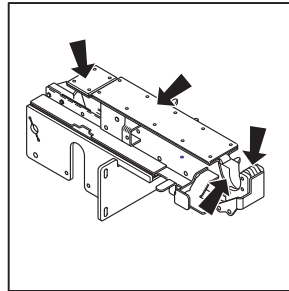
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- Install in reverse order and torque nine bolts in a cross pattern to 270 ft•lb (365 N•m). Apply Loctite® 242 to bolts before installation.

Pipeloder Inserts

Check all indicated areas for wear. Flip gripper inserts for additional life. Replace all inserts as needed. See your Ditch Witch dealer for replacement parts.

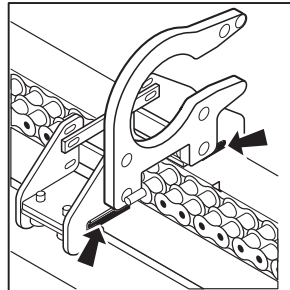
IMPORTANT: Ensure bolts are tightened evenly to enable inserts to slide freely.



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Pipe Guide Inserts

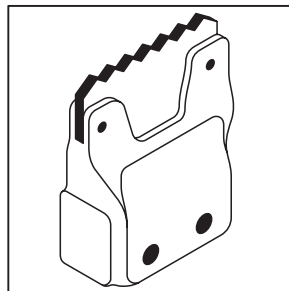
Check pipe guide inserts for wear. Adjust with shims or replace insert as needed. See your Ditch Witch dealer for replacement parts.



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Pipe Lubricator Insert

Check pipe lubricator insert for wear. Replace as needed. See your Ditch Witch dealer for replacement parts.

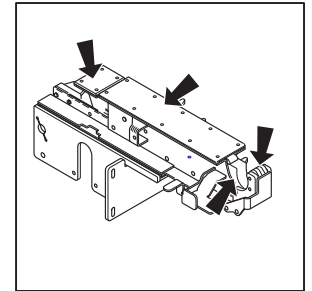


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Pipeloder Inserts

Check all indicated areas for wear. Flip gripper inserts for additional life. Replace all inserts as needed. See your Ditch Witch dealer for replacement parts.

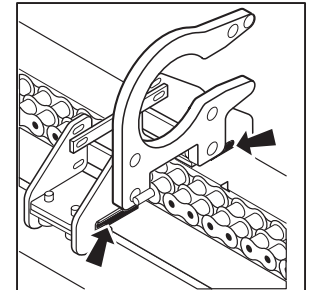
IMPORTANT: Ensure bolts are tightened evenly to enable inserts to slide freely.



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Pipe Guide Inserts

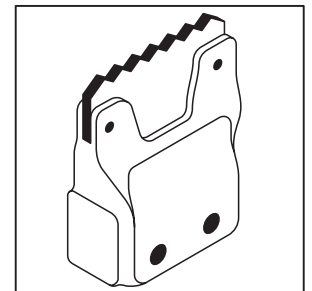
Check pipe guide inserts for wear. Adjust with shims or replace insert as needed. See your Ditch Witch dealer for replacement parts.



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Pipe Lubricator Insert

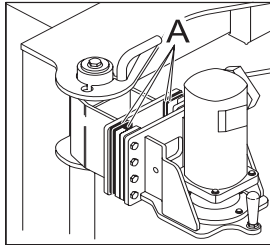
Check pipe lubricator insert for wear. Replace as needed. See your Ditch Witch dealer for replacement parts.



om2353a.eps

Anchor Driver Glide Strips

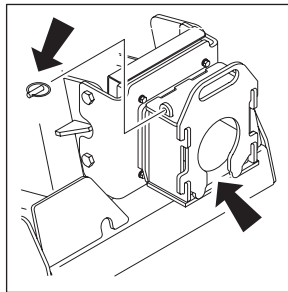
Check anchor driver glide strips for wear. Tighten or replace as needed. See your Ditch Witch dealer for replacement parts.



Om0164c.eps

Pipe Guide Blocks

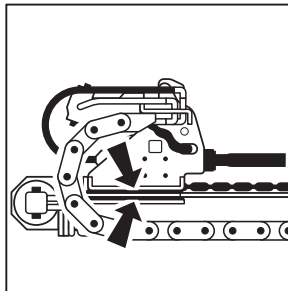
Check pipe guide blocks for wear. Rotate blocks and replace as needed. See your Ditch Witch dealer for replacement parts.



om0302c.eps

Carriage Slide Bars

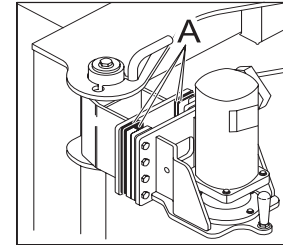
Check carriage slide bars for wear. Adjust with shims or replace as needed. See your Ditch Witch dealer for replacement parts.



om0280c.eps

Anchor Driver Glide Strips

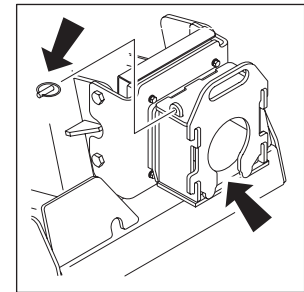
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Om0164c.eps

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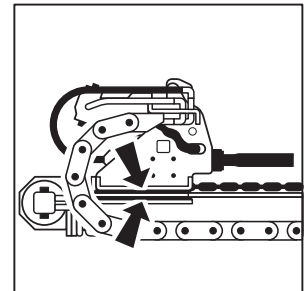
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om0302c.eps

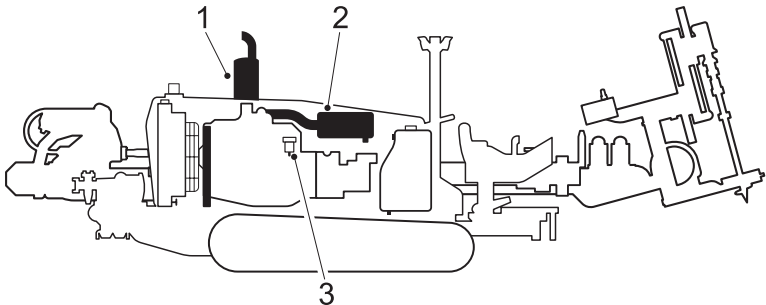
Carriage Slide Bars

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om0280c.eps

FILTERS



om0276c.eps

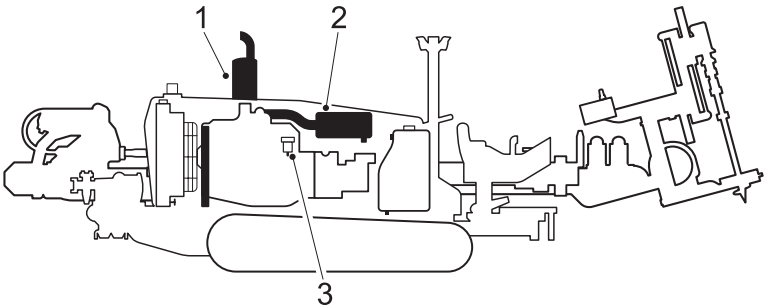
Ref	Task	Frequency
3	change fuel filter (initial)	50
3	change fuel filter	600
2	check air filter	1000
1	check muffler	as needed

IMPORTANT: Use genuine Ditch Witch filters and tool joint compound to maintain warranty.

Muffler

Change muffler as needed.

FILTERS



om0276c.eps

Ref	Task	Frequency
3	change fuel filter (initial)	50
3	change fuel filter	600
2	check air filter	1000
1	check muffler	as needed

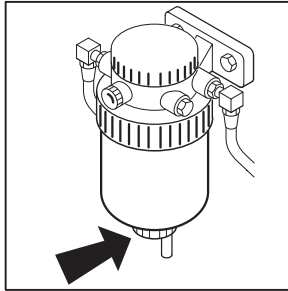
IMPORTANT: Use genuine Ditch Witch filters and tool joint compound to maintain warranty.

Muffler

Change muffler as needed.

Fuel Filter

Drain water out of filter daily. Replace fuel filter after 50 hours of operation and every 600 hours thereafter. If you refuel from cans, replace filter more often. See parts manual or contact your Ditch Witch dealer for correct replacement filter.



om1811a.eps

Air Filter

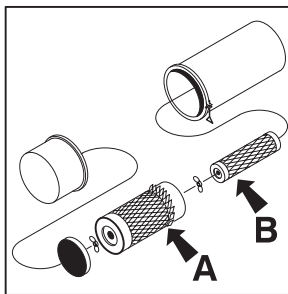
Change air filter when red band on air filter service indicator pops up or every 1000 hours. Change more often in dusty conditions.

To change:

- Open air filter case.
- Remove paper element (A).
- If indications exist that dirt has gotten past paper element, remove safety element (B).
- Wipe inside of housing and wash end cup.
- Insert new element(s)
- Close air filter case.
- Reset air filter service indicator.



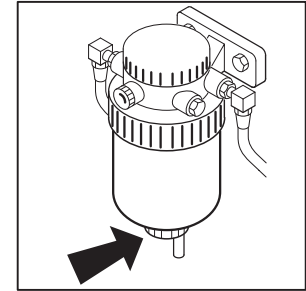
ic1348a.eps



om1812a.eps

Fuel Filter

Drain water out of filter daily. Replace fuel filter after 50 hours of operation and every 600 hours thereafter. If you refuel from cans, replace filter more often. See parts manual or contact your Ditch Witch dealer for correct replacement filter.



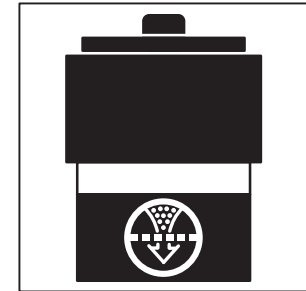
om1811a.eps

Air Filter

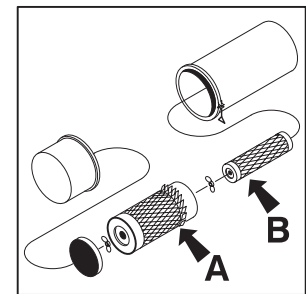
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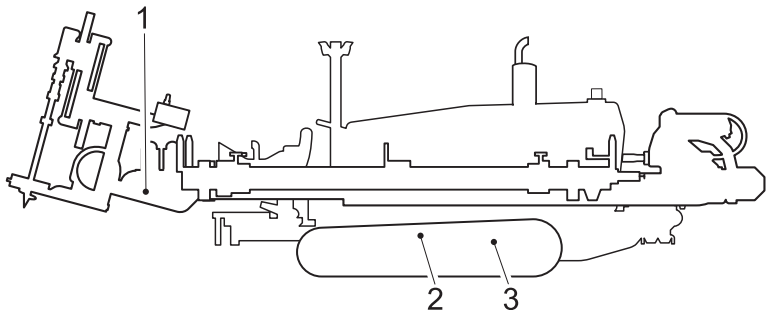


ic1348a.eps



om1812a.eps

POWER COMPONENTS

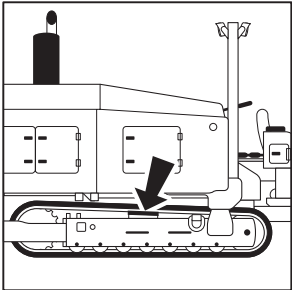


om0277c.eps

Ref	Task	Frequency
2	check track support slide pads	as needed
1	check thrust chain tension	as needed
3	check track tension and condition	as needed

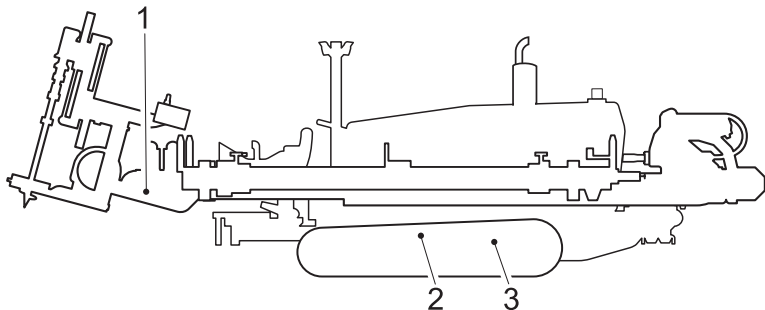
Track Support Slide Pads

Replace track support slide pads as needed.



om2313a.eps

POWER COMPONENTS

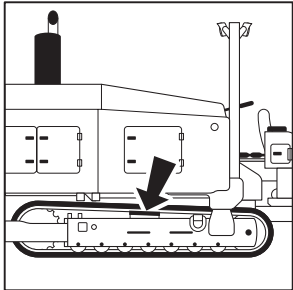


om0277c.eps

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1	check thrust chain tension	as needed
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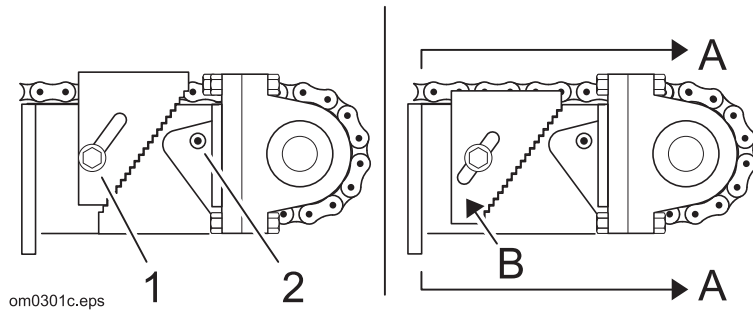
Track Support Slide Pads

Replace track support slide pads as needed.



om2313a.eps

Thrust Chain Tension

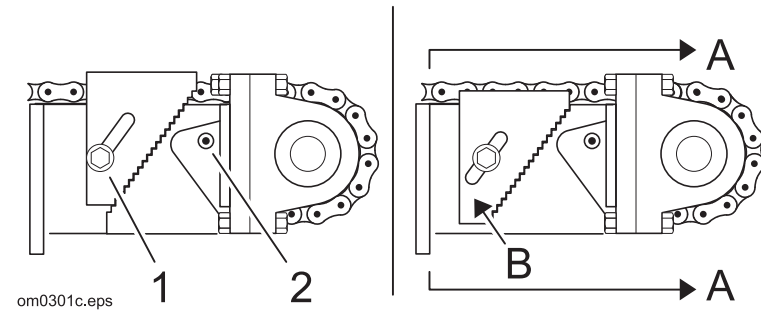


Adjust thrust chain tension as needed.

To adjust:

1. Lower anchor shafts to ground to support front of drill frame.
2. Loosen bolts (1).
3. Pump MPG into fitting (2). Do not exceed 3000 psi (206 bar).
4. Frame will move out (A).
5. When chain reaches proper tension, move toothed wedge down and back (B) to brace frame.
6. Tighten bolts to 270 ft•lb (365 N•m).

Thrust Chain Tension



Adjust thrust chain tension as needed.

To adjust:

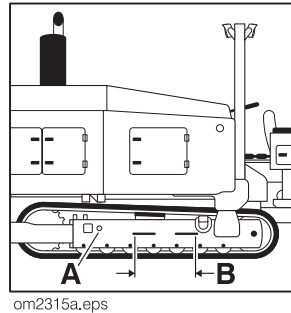
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4. Frame will move out (A).
5. When chain reaches proper tension, move toothed wedge down and back (B) to brace frame.
6. Tighten bolts to 270 ft•lb (365 N•m).

Track Tension

Check track tension and adjust as needed.

To adjust:

1. Pump MPG into fitting (A) until spring height is at least 17.75" (451 mm) and no more than 18" (457 mm) when measured through windows (B).
2. Drive straight forward one machine length and check tension again.

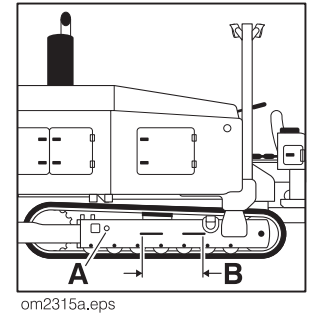


Track Tension

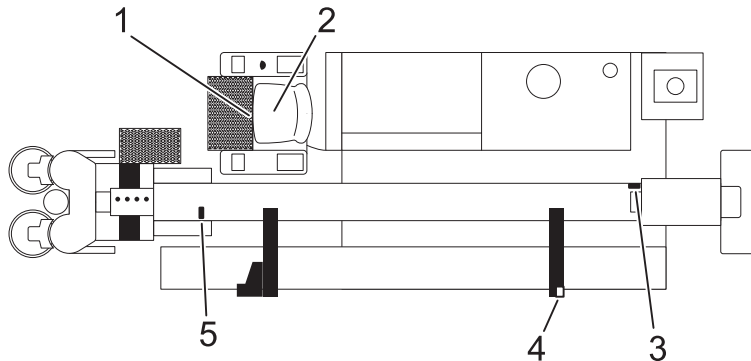
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PIPELOADER CONTROL



om0283c.eps

Proximity Switches

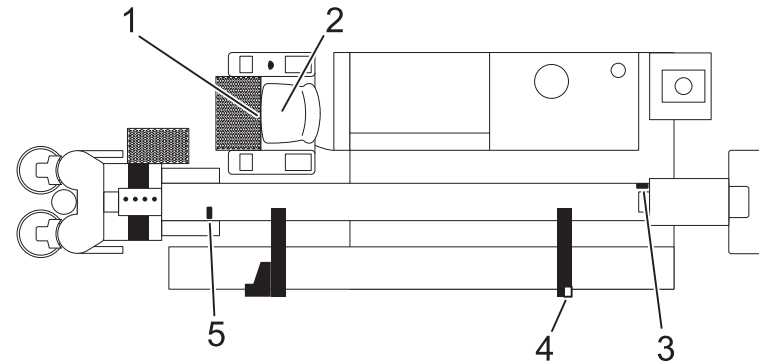
Check proximity switches daily:

1. Pivot switches
2. Operator station switch
3. Rear home switch
4. Shuttle home switch
5. Front home switch

To check:

1. Turn ignition to the on position. Do not start engine.
2. Place metal object above target on each switch.
3. If yellow light on switch comes on, switch sensors are functioning.

PIPELOADER CONTROL



om0283c.eps

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PIPE

Before pipe is used first time:

- Hand-lubricate threads and shoulders with TJC.
- Join pipe and tighten joint.
- Break joint.
- Move pipe back to box and repeat.

Each time pipe is used:

- Keep threads clean and well-lubed with TJC. Lube threads and shoulders of male joints with TJC.
- Keep inside of pipe clean. Drain fluid from pipe.
- Replace damaged pipe.
- Only use TJC available from your Ditch Witch dealer to maintain warranty.
- Follow directions carefully. Screw pipes together correctly. Do not bend pipe beyond recommended bend limit.

Cleaning Threads

Clean threads as needed with high-pressure water and soap. Do not use gasoline or similar solvents.

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TROUBLESHOOT STRIKE SYSTEM

When strike system detects a problem, an error code will be displayed. Anytime this happens, press self test button to retest. If error code is still displayed and does not appear in this chart, have control module checked or replaced.

Other problem situations and their possible causes and solutions are listed in the chart below.

Problem	Possible cause	Possible solution
No lights or readings showing after drilling unit key has been on at least one minute	Problems in startup	Push Status button. If problem goes away, retest strike system
	No power to strike system control module	Check drilling unit electric system
		Check that harness from drilling unit to control module is connected
		Check that cable from drilling unit carries more than 10 volts
	Defective control module	Have control module checked or replaced
Screen is blank	Strike system is not getting adequate power from drilling unit	Check drilling unit electric system
		Check that harness from drilling unit to control module is connected
		Check that harness from drilling unit carries more than 10 volts
	Defective control module	Have control module checked or replaced
System OK light is on, but battery power light is off	Strike system is not getting adequate power from drilling unit	Check drilling unit electric system
		Check that harness from drilling unit to control module is connected
		Check that harness from drilling unit carries more than 10 volts
	Defective control module	Have control module checked or replaced

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		Check that harness from drilling unit to control module is connected
		Check that cable from drilling unit carries more than 10 volts
	Defective control module	Have control module checked or replaced
Screen is blank	Strike system is not getting adequate power from drilling unit	Check drilling unit electric system
		Check that harness from drilling unit to control module is connected
		Check that harness from drilling unit carries more than 10 volts
	Defective control module	Have control module checked or replaced
System OK light is on, but battery power light is off	Strike system is not getting adequate power from drilling unit	Check drilling unit electric system
		Check that harness from drilling unit to control module is connected
		Check that harness from drilling unit carries more than 10 volts
	Defective control module	Have control module checked or replaced

Battery power light is on, but system OK light is off	Problem detected during test	Check for error code and have control module checked or replaced
	Defective control module	Have control module checked or replaced
Strobe light on drilling unit does not work during total test	Improper connections with control module	Check connections and wiring harness
	Defective strobe light	Disconnect strobe and connect to external 12 volt power source. If strobe does not work, replace
	Defective control module	Have control module checked or replaced
Alarm on drilling unit does not work during total test	Improper connections with control module	Check connections and wiring harness
	Defective alarm	Disconnect alarm and connect to external 12 volt power source. If alarm does not work, replace
	Defective control module	Have control module checked or replaced
Strobe light and alarm on drilling unit do not work during total test	Improper connections with control module	Check connections and wiring harness
	Defective control module	Have control module checked or replaced
EC2 and current problem light on	Improper connections with control module	Check cable connections on control module and current transformer
	Defective current transformer	Disconnect current transformer. Check that resistance pin 1 to pin 4 is 20-40 ohms, pin 1 to pin 2 is 20-40 ohm, and pin 2 to pin 4 is less than 1 ohm
	Defective current transformer cable	Disconnect cable from transformer and control module. Check continuity of cable. If continuity is zero or cable is damaged, replace
	Defective control module	Have control module checked or replaced
EV2 and voltage problem light on	Improper connections with control module	Check cable connection on control module
	Defective voltage limiter	Have voltage limiter checked or replaced
	Defective control module	Have control module checked or replaced

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Strobe light and alarm on drilling unit do not work during total test	Improper connections with control module	Check connections and wiring harness
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	Defective current transformer	Disconnect current transformer. Check that resistance pin 1 to pin 4 is 20-40 ohms, pin 1 to pin 2 is 20-40 ohm, and pin 2 to pin 4 is less than 1 ohm
	Defective current transformer cable	Disconnect cable from transformer and control module. Check continuity of cable. If continuity is zero or cable is damaged, replace
	Defective control module	Have control module checked or replaced
EV2 and voltage problem light on	Improper connections with control module	Check cable connection on control module
	Defective voltage limiter	Have voltage limiter checked or replaced
	Defective control module	Have control module checked or replaced

USE ELECTRIC STRIKE SIMULATOR

The Electric Strike Simulator (p/n 259-506) can be used to test voltage and current sensors on strike indicator. If readings are less than indicated here, replace 9 volt battery in simulator and retest.

Current Test

To test for current at normal levels:

1. Thread one lead wire through current transformer.
2. Clip ends of lead wires together to make one loop.
3. Move simulator switch to "current" and press test button.
4. Watch screen and lights above display on strike system.
 - Three or four lights should turn on.
 - Current "A" should show 30-50% in display.

To test for current at strike levels:

1. Put two or three loops through current transformer.
2. Follow steps above to test.
3. Display should show the following:
 - All lights should turn on.
 - Alarm and strobe should turn on.

With two loops,

- Current "A" should be 80-110%.
- Strike indication might go on and off.

With three loops,

- Current should be 130-160%.
- Strike indication should be continuous.

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With three loops,

- Current should be 130-160%.
- Strike indication should be continuous.

Voltage Test

1. Place voltage limiter on something insulated from ground and drilling unit (such as dry board or tire), but near frame of drilling unit.
2. Clip one lead to frame.
3. Clip other lead to one voltage limiter mount.
4. Move simulator switch to "voltage" and press test button.
5. Watch screen and lights above display on strike system.
 - All lights should turn on.
 - Alarm and strobe should turn on.
 - Voltage "V" should show 90-110%.

It is normal for simulator voltage levels to drift below strike level. When this happens, light in triangle should go off and alarm and strobe should stop working. If the level drifts above strike level again, light, alarm, and strobe should be turned on again.

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TROUBLESHOOT DRILLING UNIT

Diagnostic Light

Use the red diagnostic light to learn the condition of the diagnostic system. Under normal operating conditions, the diagnostic light will light steadily for two seconds after ignition is turned on to indicate light is working. It will then go out and remain out unless a diagnostic code is recorded.

If diagnostic codes are detected, the diagnostic light will either flash on and off for 10 seconds to indicate a non-essential code or remain on to indicate an essential code.

Code Severity Levels

Diagnostic codes are given one of two levels of severity.

- A **non-essential** code affects non-essential functions of the unit. If the system detects a non-essential problem, a diagnostic code will be recorded and the diagnostic light will flash for 10 seconds and then go out. Each time ignition is turned on, full operation will be available until the diagnostic system detects a problem.
- An **essential** code affects rotation, thrust, drilling fluid, or ground drive. If the system detects an essential problem, a diagnostic code will be recorded and the diagnostic light will cycle on for three seconds and off for 1/2 second. Some machine functions may not work until the problem is corrected. Each time ignition is turned on, full operation will be available until the diagnostic system detects a problem.

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Review Mode

To see diagnostic codes that have been detected:

1. Ensure that engine is running and no one is sitting in operator's seat.
2. Press and hold the resume button for two seconds.
IMPORTANT: Do not turn off ignition. Diagnostic codes are cleared each time ignition is turned off.
3. Diagnostic light will flash code 12 (flash, pause, flash, flash, longer pause) to indicate review mode is operational.
4. After flashing code 12, all diagnostic codes detected since the last time the ignition was turned on are flashed three times each.
5. To save diagnostic codes, continue normal operation. Do not turn ignition off.
6. Once the problem has been corrected, clear all codes by turning ignition off.

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1. Ensure that engine is running and no one is sitting in operator's seat.
2. Press and hold the resume button for two seconds.
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5. To save diagnostic codes, continue normal operation. Do not turn ignition off.
6. Once the problem has been corrected, clear all codes by turning ignition off.

Diagnostic Code Interpretation

Diagnostic codes are displayed through a series of light flashes and pauses. Count number of flashes and pauses to interpret code.

Example: "Flash, flash, flash, pause, flash, flash, longer pause" represents code 32.

Tips for interpreting codes:

- The green control cycle light will come on the first time the red diagnostic light flashes a code. The green control cycle light will then go off and the red diagnostic light will flash the code two more times.
- Codes are displayed from lower to higher numbers.
- Only numbers 1-5 are used in codes.
- Code 11 is not used.
- Code 12 signals successful entry into and exit from review mode.

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- Code 11 is not used.
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Diagnostic Codes

The following table lists the attributes of each diagnostic code. Information presented includes: code number, condition causing code to be sent, resulting action, and level of severity.

Code	Condition	Result	Severity
12	normal review mode entry	code is not stored	n/a
13	no 12V power to controller	drill and drive are blocked	essential
14	no 5V power from controller	drill and drive are blocked	essential
15	unknown output driver continuity problem	code is stored	non-essential
21	no continuity to front wrench clamp solenoid	code is stored	non-essential
23	no continuity to rear wrench clamp solenoid	code is stored	non-essential
25	no continuity to wrench cw rotate solenoid	code is stored	non-essential
31	no continuity to wrench ccw rotate solenoid	code is stored	non-essential
32	no continuity to shuttle extend solenoid	add pipe and remove pipe are blocked	non-essential
33	no continuity to shuttle retract solenoid	add pipe and remove pipe are blocked	non-essential
34	no continuity to pipe lift solenoid	add pipe and remove pipe are blocked	non-essential
35	no continuity to pipe lower solenoid	add pipe and remove pipe are blocked	non-essential
41	no continuity to pipe grip solenoid	add pipe and remove pipe are blocked	non-essential
42	no continuity to pipe release solenoid	add pipe and remove pipe are blocked	non-essential
43	no continuity to lube rear solenoid	add pipe and remove pipe are blocked	non-essential
44	no continuity to lube front solenoid	add pipe and remove pipe are blocked	non-essential
45	no continuity to carriage two speed solenoid	code is stored	non-essential
51	no continuity to rotation cw solenoid	cruise control is blocked	essential

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23	no continuity to rear wrench clamp solenoid	code is stored	non-essential
25	no continuity to wrench cw rotate solenoid	code is stored	non-essential
31	no continuity to wrench ccw rotate solenoid	code is stored	non-essential
32	no continuity to shuttle extend solenoid	add pipe and remove pipe are blocked	non-essential
33	no continuity to shuttle retract solenoid	add pipe and remove pipe are blocked	non-essential
34	no continuity to pipe lift solenoid	add pipe and remove pipe are blocked	non-essential
35	no continuity to pipe lower solenoid	add pipe and remove pipe are blocked	non-essential
41	no continuity to pipe grip solenoid	add pipe and remove pipe are blocked	non-essential
42	no continuity to pipe release solenoid	add pipe and remove pipe are blocked	non-essential
43	no continuity to lube rear solenoid	add pipe and remove pipe are blocked	non-essential
44	no continuity to lube front solenoid	add pipe and remove pipe are blocked	non-essential
45	no continuity to carriage two speed solenoid	code is stored	non-essential
51	no continuity to rotation cw solenoid	cruise control is blocked	essential

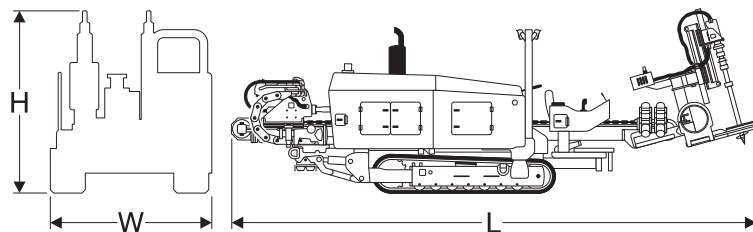
Code	Condition	Result	Severity
52	no continuity to rotation ccw solenoid	cruise control is blocked	essential
53	no continuity to thrust forward solenoid	cruise control is blocked	essential
54	no continuity to thrust backward solenoid	cruise control is blocked	essential
55	no continuity to left track forward solenoid	drive is blocked	essential
111	no continuity to left track reverse solenoid	drive is blocked	essential
112	no continuity to right track forward solenoid	drive is blocked	essential
113	no continuity to right track reverse solenoid	drive is blocked	essential
114	no continuity to drilling fluid pump solenoid	code is stored	essential
115	no continuity to variable rotation solenoid	code is stored	non-essential
122	no continuity to check valve solenoid	code is stored	non-essential
131	no continuity to thrust rear home switch	add pipe and remove pipe are blocked	non-essential
132	no continuity to thrust front home switch	add pipe and remove pipe are blocked	non-essential
133	no continuity to shuttle home switch	add pipe and remove pipe are blocked	non-essential
134	no continuity to front wrench switch	add pipe and remove pipe are blocked	non-essential
144	drive joystick left/right out of range	drive is blocked	essential
145	drive joystick forward/backward out of range	drive is blocked	essential
151	drill joystick left/right out of range	rotation and cruise control are blocked	essential
152	drill joystick forward/backward out of range	thrust and cruise control are blocked	essential
154	drilling fluid potentiometer out of range	code is stored	essential
155	rotation potentiometer is out of range	code is stored	non-essential
233	drill and drive inputs both on	drill and drive are blocked	essential

Code	Condition	Result	Severity
52	no continuity to rotation ccw solenoid	cruise control is blocked	essential
53	no continuity to thrust forward solenoid	cruise control is blocked	essential
54	no continuity to thrust backward solenoid	cruise control is blocked	essential
55	no continuity to left track forward solenoid	drive is blocked	essential
111	no continuity to left track reverse solenoid	drive is blocked	essential
112	no continuity to right track forward solenoid	drive is blocked	essential
113	no continuity to right track reverse solenoid	drive is blocked	essential
114	no continuity to drilling fluid pump solenoid	code is stored	essential
115	no continuity to variable rotation solenoid	code is stored	non-essential
122	no continuity to check valve solenoid	code is stored	non-essential
131	no continuity to thrust rear home switch	add pipe and remove pipe are blocked	non-essential
132	no continuity to thrust front home switch	add pipe and remove pipe are blocked	non-essential
133	no continuity to shuttle home switch	add pipe and remove pipe are blocked	non-essential
134	no continuity to front wrench switch	add pipe and remove pipe are blocked	non-essential
144	drive joystick left/right out of range	drive is blocked	essential
145	drive joystick forward/backward out of range	drive is blocked	essential
151	drill joystick left/right out of range	rotation and cruise control are blocked	essential
152	drill joystick forward/backward out of range	thrust and cruise control are blocked	essential
154	drilling fluid potentiometer out of range	code is stored	essential
155	rotation potentiometer is out of range	code is stored	non-essential
233	drill and drive inputs both on	drill and drive are blocked	essential

Code	Condition	Result	Severity
234	add pipe and remove pipe inputs both on	add pipe and remove pipe are blocked	non-essential
235	front and rear home switch inputs both on	add pipe or remove pipe are blocked	non-essential
241	shuttles not responding correctly	add pipe or remove pipe aborted and code stored	non-essential
242	front wrench not responding correctly	add pipe or remove pipe aborted and code stored	non-essential
254	error reading setup table information	add pipe and remove pipe are blocked	essential
255	undefinable diagnostic code	code is stored	non-essential
300	total number of power cycle counts	for information only	n/a
301	total number of add pipe cycles	for information only	n/a
302	total number of remove pipe cycles	for information only	n/a
303	total number of hours run in tenths of an hour	for information only	n/a
305	total number of cruise hours in tenths of an hour	for information only	n/a
306	total number of drilling fluid hours in tenths of an hour	for information only	n/a

Code	Condition	Result	Severity
234	add pipe and remove pipe inputs both on	add pipe and remove pipe are blocked	non-essential
235	front and rear home switch inputs both on	add pipe or remove pipe are blocked	non-essential
241	shuttles not responding correctly	add pipe or remove pipe aborted and code stored	non-essential
242	front wrench not responding correctly	add pipe or remove pipe aborted and code stored	non-essential
254	error reading setup table information	add pipe and remove pipe are blocked	essential
255	undefinable diagnostic code	code is stored	non-essential
300	total number of power cycle counts	for information only	n/a
301	total number of add pipe cycles	for information only	n/a
302	total number of remove pipe cycles	for information only	n/a
303	total number of hours run in tenths of an hour	for information only	n/a
305	total number of cruise hours in tenths of an hour	for information only	n/a
306	total number of drilling fluid hours in tenths of an hour	for information only	n/a

SPECIFICATIONS

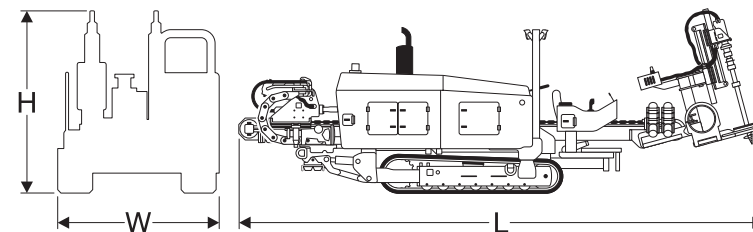


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Dimensions	U.S.	Metric
Length	313 in	7.9 m
Width	87 in	2.2 m
Height	96 in	2.4 m
Set-up angle, min.	10°	10°
Set-up angle, max.	26°	26°
Angle of approach	17°	17°
Angle of departure	17°	17°
Weight (with 32 lined drill pipe, pipeloader, anchoring system and anchors)	27,500 lb	12 474 kg

Power Pipe drill pipe	U.S.	Metric
Length	177 in	4.5 m
Joint diameter	3.5 in	89 mm
Tubing diameter	2.81 in	71 mm
Minimum bend radius	190 ft	58 m
Weight (lined)	158 lb	72 kg
Weight (large pipe box w/ 32 pipes)	6000 lb	2722 kg
Weight (small pipe box w/16 pipes)	3100 lb	1406 kg

SPECIFICATIONS



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Length	313 in	7.9 m
Width	87 in	2.2 m
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Minimum bend radius	190 ft	58 m
Weight (lined)	158 lb	72 kg
Weight (large pipe box w/ 32 pipes)	6000 lb	2722 kg
Weight (small pipe box w/16 pipes)	3100 lb	1406 kg

Operational		U.S.	Metric
Spindle speed, max		240 rpm	240 rpm
Spindle torque, max		5000 ft•lb	6779 N•m
Pullback, actual		40,000 lb	178 kN
Thrust, actual		36,000 lb	160 kN
Min bore diameter			
Backream diameter (soil dependent)		variable	
Ground drive speed	forward	0-2.5 mph	0-4 km/h
	reverse	0-2.5 mph	0-4 km/h

Engine		U.S.	Metric
Engine: John Deere Model 6068TF250 (Turbocharged)			
Fuel: diesel			
Cooling medium: John Deere Cool-Gard 50/50 pre-mixed coolant			
Number of cylinders: 6			
Engine angle	fore/aft, continuous	30°	30°
	side to side, continuous	30°	30°
Displacement		414 cu in	6.8 L
Bore		4.2 in	106 mm
Stroke		5 in	127 mm
Intermittent power @ 2400 rpm		185 hp	138 kW
Maximum governed speed (no load)		2450 rpm	2450 rpm
Continuous power @ 2400 rpm		166 hp	124 kW

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Spindle speed, max		240 rpm	240 rpm
Spindle torque, max		5000 ft•lb	6779 N•m
Pullback, actual		40,000 lb	178 kN
Thrust, actual		36,000 lb	160 kN
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Continuous power @ 2400 rpm		166 hp	124 kW

Fluid capacities		U.S.	Metric
Fuel tank		55 gal	208 L
Hydraulic reservoir		36 gal	136 L
Engine cooling system		30 qt	28 L
Engine oil with filter		24 qt	23 L
Fluid system (on-board)		U.S.	Metric
Fluid pressure, max		1300 psi	90 bar
Flow rate	free flow, max	120 gpm	454 L/min
	@ 1000 psi (69 bar)	100 gpm	379 L/min
Fluid tank (antifreeze/freshwater)		8 gal	30 L
Battery			
SAE reserve capacity 120 min, SAE cold crank @ 0° F (-18° C) two 12 Volt, negative ground batteries @ 800 amps each			

Noise Level:

Operator 91 dBA sound pressure per ISO 6394.

Exterior 113 dBA sound power per ISO 6393.

Specifications are called out according to SAE recommended practices. Specifications are general and subject to change without notice. If exact measurements are required, equipment should be weighed and measured. Due to selected options, delivered equipment may not necessarily match that shown.

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APPENDIX

A. BEND LIMITS

Turns in the bore path should be made gradually. All Ditch Witch pipes have recommended bend limits. JT4020 Mach 1 drill pipes have a tested bend radius of 190' (57.9 m), meaning a 90 degree bend requires 190' (57.9 m) of forward distance and approximately 298' (90.8 m) of pipe. Make sure pitch changes no more than 7% per pipe.

NOTICE: Bending pipe more sharply than recommended will damage pipe and cause failure over time. Changes in pitch must be equally distributed over the length of a pipe. Maximum percent changes in pitch in 1-2' (30-60 cm) of pipe create sharp bends and will damage pipe.

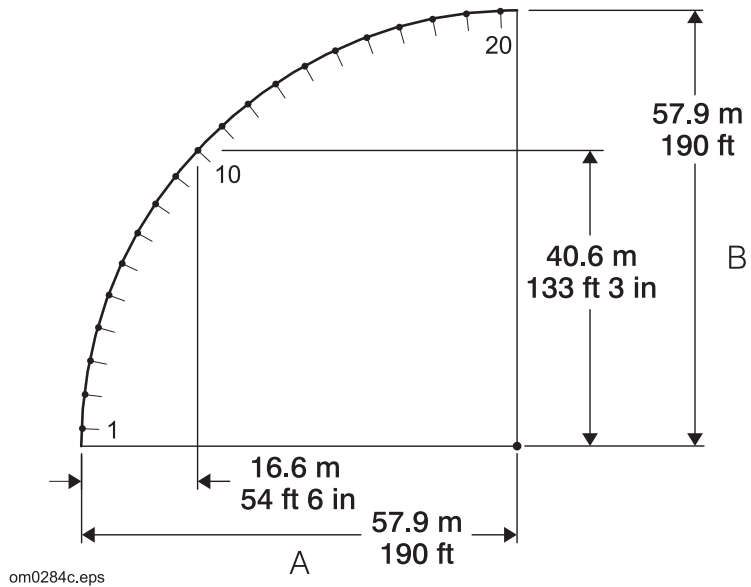
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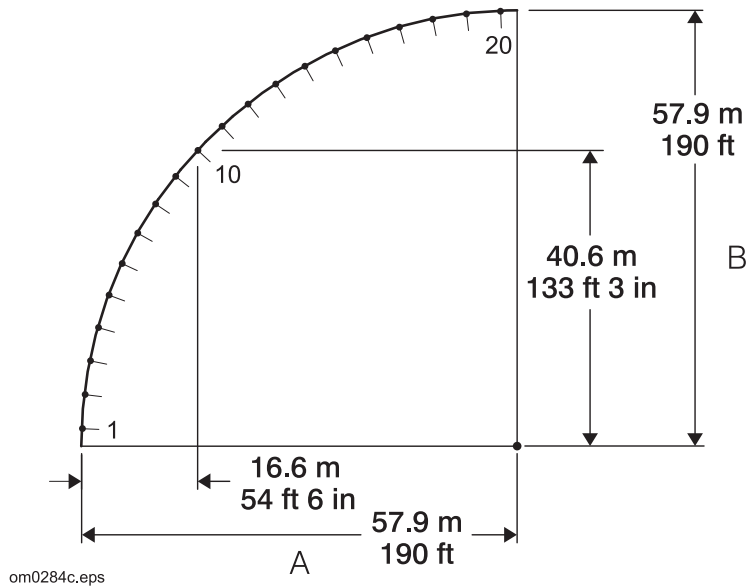
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See table on next page for lateral (A) and forward (B) dimensions.

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See table on next page for lateral (A) and forward (B) dimensions.

Pipe No.	U.S.		Metric	
	Forward (B)	Lateral (A)	Forward (B)	Lateral (A)
1	14 ft 9 in	7 in	4.5 m	.2 m
2	29 ft 5 in	2 ft 6 in	9 m	.7 m
3	43 ft 11 in	5 ft 2 in	13.4 m	1.6 m
4	58 ft 1 in	9 ft 1 in	17.7 m	2.8 m
5	72 ft 0 in	14 ft 2 in	21.9 m	4.3 m
6	85 ft 5 in	20 ft 3 in	26 m	6.2 m
7	98 ft 4 in	27 ft 5 in	30 m	8.4 m
8	110 ft 8 in	35 ft 7 in	33.7 m	10.8 m
9	124 ft 4 in	44 ft 7 in	37.3 m	13.6 m
10	133 ft 3 in	54 ft 6 in	40.6 m	16.6 m
11	143 ft 4 in	65 ft 3 in	43.7 m	19.9 m
12	152 ft 7 in	76 ft 9 in	46.5 m	23.4 m
13	160 ft 11 in	89 ft 0 in	49.1 m	27.1 m
14	168 ft 3 in	101 ft 9 in	51.3 m	31 m
15	174 ft 7 in	115 ft 1 in	53.2 m	35.1 m
16	179 ft 11 in	128 ft 11 in	54.8 m	39.3 m
17	184 ft 1 in	143 ft 0 in	56.1 m	43.6 m
18	187 ft 2 in	157 ft 6 in	57 m	48 m
19	189 ft 2 in	172 ft 1 in	57.7 m	52.5 m
20	189 ft 11 in	186 ft 10 in	57.9 m	57 m
21	190 ft 0 in	190 ft 0 in	57.9 m	57.9 m

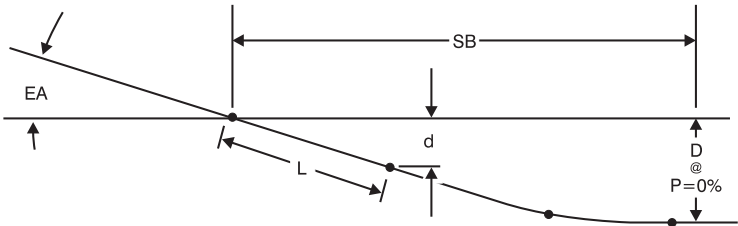
Dimensions given at minimum bend radius--175' (53.3 m)

Pipe No.	U.S.		Metric	
	Forward (B)	Lateral (A)	Forward (B)	Lateral (A)
1	14 ft 9 in	7 in	4.5 m	.2 m
2	29 ft 5 in	2 ft 6 in	9 m	.7 m
3	43 ft 11 in	5 ft 2 in	13.4 m	1.6 m
4	58 ft 1 in	9 ft 1 in	17.7 m	2.8 m
5	72 ft 0 in	14 ft 2 in	21.9 m	4.3 m
6	85 ft 5 in	20 ft 3 in	26 m	6.2 m
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Dimensions given at minimum bend radius--175' (53.3 m)

B. ENTRY PITCH, SETBACK, AND DEPTH

Entry pitch, setback, and depth work together with bend limits to determine bore path. Entry pitch is drilling unit slope compared to level ground. Setback is distance from entry to horizontal. Minimum depth is measured at point bore becomes horizontal.

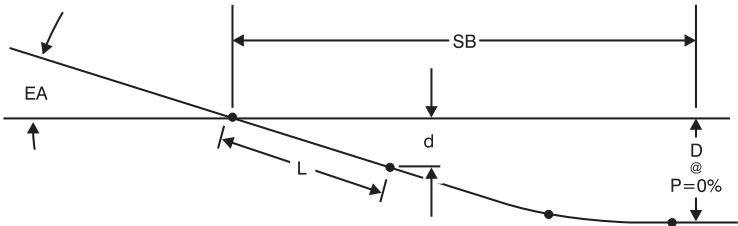


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EA	SB	d	D
-20	49 ft 6 in (15.1 m)	2 ft 5 in (.75 m)	6 ft 2 in (1.9 m)
-22	53 ft (16.2 m)	2 ft 8 in (.82 m)	7 ft 2 in (2.2 m)
-24	56 ft 6 in (17.2 m)	2 ft 11 in (.89 m)	8 ft 2 in (2.5 m)
-26	59 ft 11 in (18.3 m)	3 ft 2 in (.96 m)	9 ft 3 in (2.8 m)
-28	63 ft 3 in (19.3 m)	3 ft 4 in (1.03 m)	10 ft 5 in (3.2 m)
-30	66 ft 7 in (20.3 m)	3 ft 7 in (1.09 m)	11 ft 6 in (3.5 m)
-32	69 ft 10 in (21.3 m)	3 ft 10 in (1.16 m)	12 ft 10 in (3.9 m)
Based on: 1. 190' (57.9 m) minimum bend radius 2. Beacon housing, EZ-Connect, adapter, and transition sub, and 1/3 of first drill pipe (totaling 12' 6" [3.8 m]) in the ground before steering			

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C. DRILLING FLUID REQUIREMENTS

Backreaming is only successful when enough fluid reaches the bore. The amount of fluid needed depends on sizes of bore, pullback material, and nozzles.

The chart on the next page can be used to determine the minimum amount of fluid needed in perfect conditions. **Use more than amount indicated or bore might be dry and unsuccessful.**

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The chart on the next page can be used to determine the minimum amount of fluid needed in perfect conditions. **Use more than amount indicated or bore might be dry and unsuccessful.**

Backreamer/product diameter		Gallons per foot	Liters per meter
.5 in	1.27 cm	.01	.13
1 in	2.54 cm	.04	.51
1.5 in	3.81 cm	.09	1.14
2 in	5.08 cm	.16	2.03
2.5 in	6.35 cm	.25	3.17
3 in	7.62 cm	.37	4.56
3.5 in	8.89 cm	.5	6.21
4 in	10.16 cm	.65	8.11
4.5 in	11.43 cm	.83	10.26
5 in	12.70 cm	1.02	12.67
5.5 in	13.97 cm	1.23	15.33
6 in	15.24 cm	1.47	18.24
6.5 in	16.51 cm	1.72	21.41
7 in	17.78 cm	2	24.83
7.5 in	19.05 cm	2.29	28.50
8 in	20.32 cm	2.61	32.43
8.5 in	21.59 cm	2.95	36.61
9 in	22.86 cm	3.30	41.04
9.5 in	24.13 cm	3.68	45.73
10 in	25.40 cm	4.08	50.67
10.5 in	26.67 cm	4.5	55.86
11 in	27.94 cm	4.94	61.31
11.5 in	29.21 cm	5.4	67.01
12 in	30.48 cm	5.88	72.97
12.5 in	31.75 cm	6.37	79.17
13 in	33.02 cm	6.9	85.63
13.5 in	34.29 cm	7.44	92.35
14 in	35.56 cm	8	99.31
14.5 in	36.83 cm	8.58	106.54
15 in	38.1 cm	9.18	114.01
15.5 in	39.37 cm	9.8	121.74
16 in	40.64 cm	10.44	129.72
16.5 in	41.91 cm	11.11	137.95
17 in	43.18 cm	11.79	146.44
17.5 in	44.45 cm	12.49	155.18
18 in	45.72 cm	13.22	164.17

Backreamer/product diameter		Gallons per foot	Liters per meter
.5 in	1.27 cm	.01	.13
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3.5 in	8.89 cm	.5	6.21
4 in	10.16 cm	.65	8.11
4.5 in	11.43 cm	.83	10.26
5 in	12.70 cm	1.02	12.67
5.5 in	13.97 cm	1.23	15.33
6 in	15.24 cm	1.47	18.24
6.5 in	16.51 cm	1.72	21.41
7 in	17.78 cm	2	24.83
7.5 in	19.05 cm	2.29	28.50
8 in	20.32 cm	2.61	32.43
8.5 in	21.59 cm	2.95	36.61
9 in	22.86 cm	3.30	41.04
9.5 in	24.13 cm	3.68	45.73
10 in	25.40 cm	4.08	50.67
10.5 in	26.67 cm	4.5	55.86
11 in	27.94 cm	4.94	61.31
11.5 in	29.21 cm	5.4	67.01
12 in	30.48 cm	5.88	72.97
12.5 in	31.75 cm	6.37	79.17
13 in	33.02 cm	6.9	85.63
13.5 in	34.29 cm	7.44	92.35
14 in	35.56 cm	8	99.31
14.5 in	36.83 cm	8.58	106.54
15 in	38.1 cm	9.18	114.01
15.5 in	39.37 cm	9.8	121.74
16 in	40.64 cm	10.44	129.72
16.5 in	41.91 cm	11.11	137.95
17 in	43.18 cm	11.79	146.44
17.5 in	44.45 cm	12.49	155.18
18 in	45.72 cm	13.22	164.17

Backreamer/product diameter		Gallons per foot	Liters per meter
18.5 in	46.99 cm	13.96	173.42
19 in	48.26 cm	14.73	182.92
19.5 in	49.53 cm	15.51	192.68
20 in	50.8 cm	16.32	202.68
20.5 in	52.07 cm	17.15	212.94
21 in	53.34 cm	17.99	223.46
21.5 in	54.61 cm	18.86	234.23
22 in	55.88 cm	19.75	245.25
22.5 in	57.15 cm	20.65	256.52
23 in	58.42 cm	21.58	268.05
23.5 in	59.69 cm	22.53	279.83
24 in	60.96 cm	23.5	291.86
24.5 in	62.23 cm	24.49	304.15
25 in	63.5 cm	25.5	316.69
25.5 in	64.77 cm	26.53	329.49
26 in	66.04 cm	27.58	342.53

Backreamer/product diameter		Gallons per foot	Liters per meter
18.5 in	46.99 cm	13.96	173.42
19 in	48.26 cm	14.73	182.92
19.5 in	49.53 cm	15.51	192.68
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20.5 in	52.07 cm	17.15	212.94
21 in	53.34 cm	17.99	223.46
21.5 in	54.61 cm	18.86	234.23
22 in	55.88 cm	19.75	245.25
22.5 in	57.15 cm	20.65	256.52
23 in	58.42 cm	21.58	268.05
23.5 in	59.69 cm	22.53	279.83
24 in	60.96 cm	23.5	291.86
24.5 in	62.23 cm	24.49	304.15
25 in	63.5 cm	25.5	316.69
25.5 in	64.77 cm	26.53	329.49
26 in	66.04 cm	27.58	342.53

D. NOZZLE FLOW

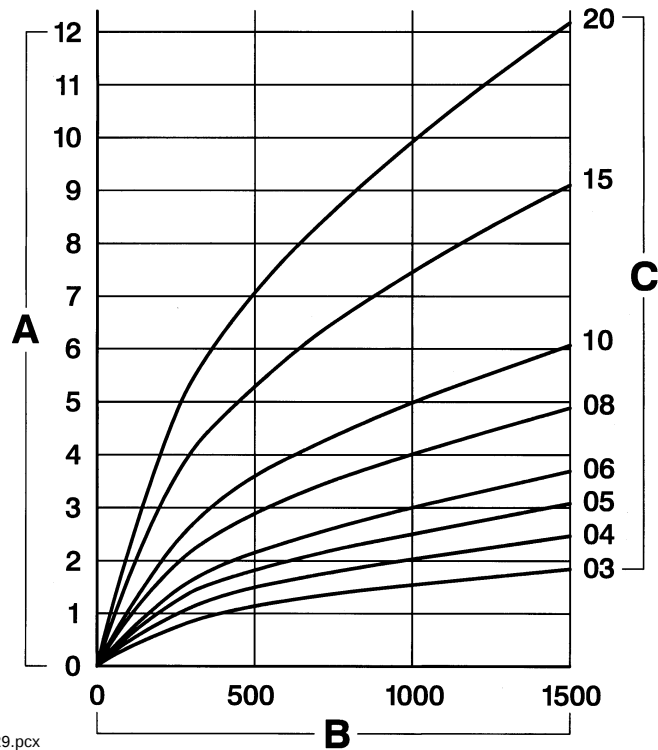
Select nozzles that will supply **at least** the amount of fluid per minute needed for the flow and pressure you will be using. A nozzle that will supply more fluid per minute is recommended.

U.S. Nozzle Flow

A - Flow per nozzle, gallons/minute

B - Nozzle pressure, psi

C - Nozzle size



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D. NOZZLE FLOW

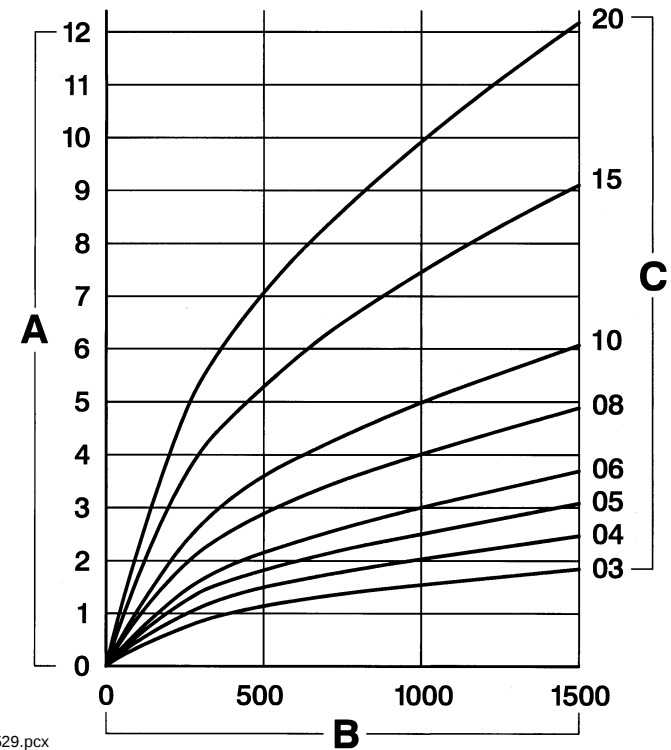
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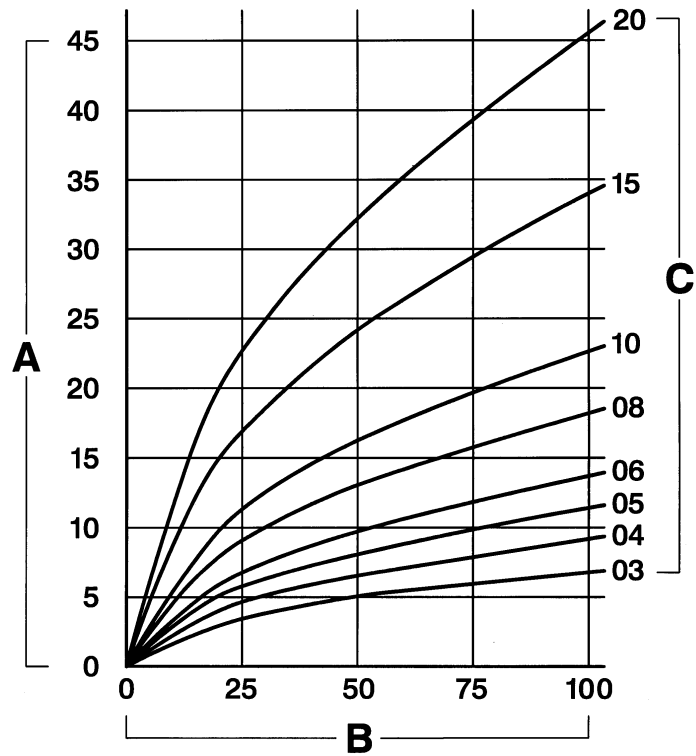
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Metric Nozzle Flow

A - Flow per nozzle, liters/minute

B - Nozzle pressure, bar

C - Nozzle size



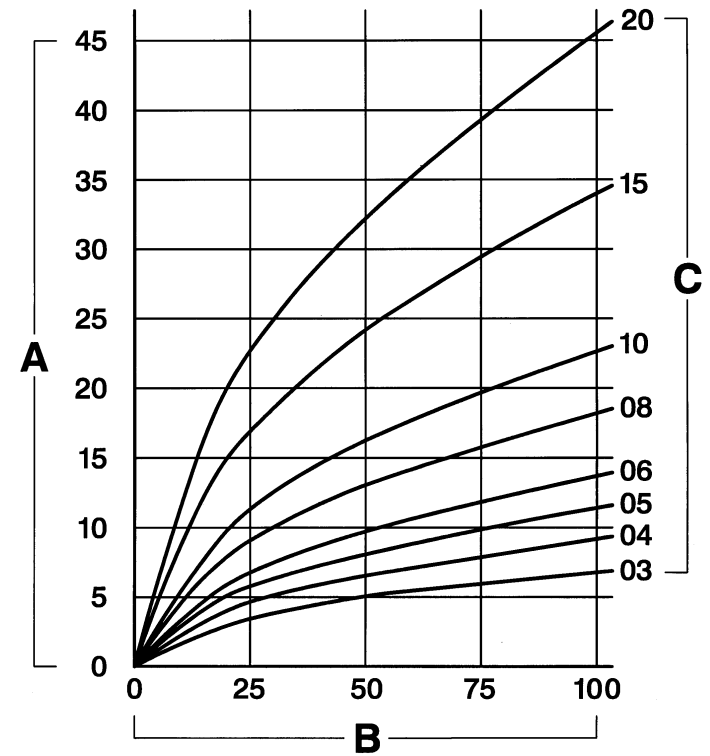
om1528.pcx

Metric Nozzle Flow

A - Flow per nozzle, liters/minute

B - Nozzle pressure, bar

C - Nozzle size



om1528.pcx

WARRANTY

Ditch Witch Equipment and Parts Limited Warranty Policy

Subject to the limitations and exclusions herein, free replacement parts will be provided at any authorized Ditch Witch dealership for any Ditch Witch equipment or parts manufactured by The Charles Machine Works, Inc. (CMW) that fail due to a defect in material or workmanship within one (1) year of first commercial use (Exception: 2 years for all SK500 attachments). Free labor will be provided at any authorized Ditch Witch dealership for installation of parts under this warranty during the first year following initial commercial use of the serial-numbered Ditch Witch equipment on which it is installed.

Exclusions from Product Warranty

- Wear-related failure of parts subject to ground contact including, but not limited to, digging teeth, digging chains, sprockets, backhoe buckets, plow blades, drill pipe, drill bits, backreamers, and swivels.
- All incidental or consequential damages.
- All defects, damages, or injuries caused by misuse, abuse, improper installation, alteration, neglect, or uses other than those for which products were intended.
- All defects, damages, or injuries caused by improper training, operation, or servicing of products in a manner inconsistent with manufacturer's recommendations.
- All engines and engine accessories (these are covered by original manufacturer's warranty).
- Tires, belts, and other parts which may be subject to another manufacturer's warranty (such warranty will be available to purchaser).
- All implied warranties not expressly stated herein, including any warranty of fitness for a particular purpose and merchantability.

IF THE PRODUCTS ARE PURCHASED FOR COMMERCIAL PURPOSES AS DEFINED BY THE UNIFORM COMMERCIAL CODE, THEN THERE ARE NO WARRANTIES WHICH EXTEND BEYOND THE FACE HEREOF AND THERE ARE NO IMPLIED WARRANTIES OF ANY KIND WHICH EXTEND TO A COMMERCIAL BUYER. ALL OTHER PROVISIONS OF THIS LIMITED WARRANTY APPLY INCLUDING THE DUTIES IMPOSED.

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Ditch Witch products have been tested to deliver acceptable performance in most conditions. This does not imply they will deliver acceptable performance in all conditions. Therefore, to assure suitability, products should be operated under anticipated working conditions prior to purchase.

Defects will be determined by an inspection within thirty (30) days of the date of failure of the product or part by CMW or its authorized dealer. CMW will provide the location of its inspection facilities or its nearest authorized dealer upon inquiry. CMW reserves the right to supply remanufactured replacements parts under this warranty as it deems appropriate.

Extended warranties are available upon request from your local Ditch Witch dealer or CMW.

Some states do not allow exclusion or limitation of incidental or consequential damages, so above limitation of exclusion may not apply. Further, some states do not allow exclusion of or limitation of how long an implied warranty lasts, so the above limitation may not apply. This limited warranty gives product owner specific legal rights and the product owner may also have other rights which vary from state to state.

For information regarding this limited warranty, contact CMW's Product Support department, P.O. Box 66, Perry, OK 73077-0066, or contact your local Ditch Witch dealer.

First version: 1/91; Latest version: 1/03

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First version: 1/91; Latest version: 1/03

**A Note To
Ditch Witch
Equipment Owners:**

If your equipment was purchased through a Ditch Witch dealer, there is no need to read further.

However, if you purchased from any other source, please fill out the form on the reverse side and return it to us.

This will enable you to receive updates on this equipment as well as information on new products of interest.

Thanks for using Ditch Witch equipment.

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(Please Fold Along This Line And Seal At Bottom With Tape)

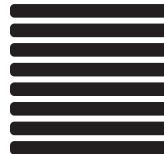


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IN THE
UNITED STATES

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FIRST CLASS PERMIT NO 23 PERRY OKLAHOMA

POSTAGE WILL BE PAID BY



**The Charles Machine Works, Inc.
P.O. Box 66
Perry, Oklahoma 73077-9989**



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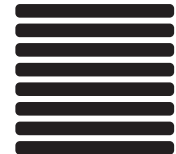


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**The Charles Machine Works, Inc.
P.O. Box 66
Perry, Oklahoma 73077-9989**



Ditch Witch® Registration Card

Please Type or Print All Information

Purchaser's Company Name

Attention

Street Address or P.O. Box

City

County

State

Zip

Nation

()

Phone Number With Area Code

Model

Serial Number

Attachments/Accessories

Serial Numbers

Attachments/Accessories

Serial Numbers

Attachments/Accessories

Serial Numbers

Name of Ditch Witch Dealership

Your Signature

Ditch Witch® Registration Card

Please Type or Print All Information

Purchaser's Company Name

Attention

Street Address or P.O. Box

City

County

State

Zip

Nation

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Attachments/Accessories

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