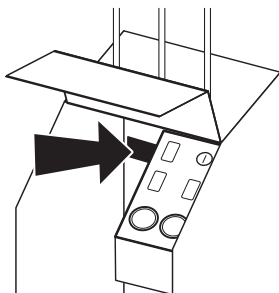


SERVICE

SERIAL NUMBER

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



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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 covering the operation, service, and repair of your equipment.

Ditch Witch Training

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

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.

Operator's Manual JT1720

Issue No. 5.0/OP-4/11
Part Number 054-520

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by The Charles Machine Works, Inc.,
Perry, Oklahoma



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CMW, Power Pipe, The Underground, and The Underground Authority Worldwide are pending 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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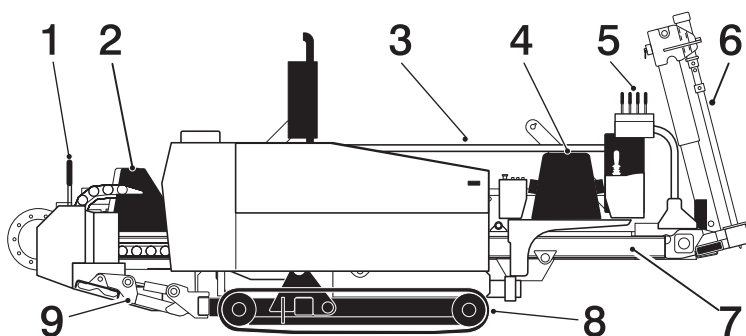
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OVERVIEW

The JT1720 directional drilling unit is a self-contained unit with a tethered ground drive controller.

The JT1720 features rubber tracks, genuine Ditch Witch pipe, a pipe loader and pipe box, onboard anchoring system, onboard fluid system, and simple, precise controls. Optional equipment includes a cold start kit and Subsite 750 Display fully integrated into the control console.

The JT1720 directional drilling unit can be used with Ditch Witch drilling fluid units and Subsite locating equipment.

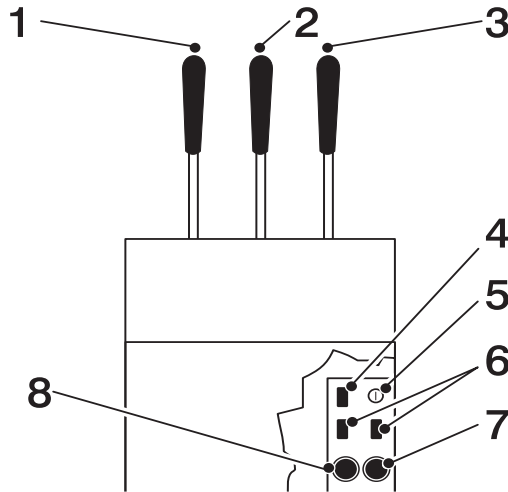


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- | | |
|---|------------------------------|
| 1. Set-up/drive controls and tethered ground drive controller | |
| 2. Carriage | 5. Anchoring system controls |
| 3. Pipe loader | 6. Anchoring system |
| 4. Operator station | 7. Drill frame |
| 5. Anchoring system controls | 8. Tracks |
| 6. Anchoring system | 9. Stabilizers |

CONTROLS

SETUP CONSOLE OVERVIEW



- Left stabilizer control (1)
- Frame tilt control (2)
- Right stabilizer control (3)
- Cold start switch (4)
- Ignition switch (5)
- Auxiliary track drive switches (6)
- Voltmeter (7)
- Hourmeter (8)

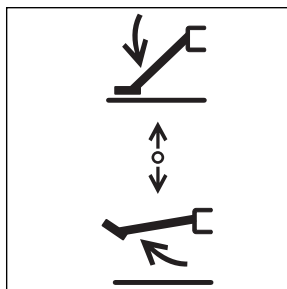
SETUP CONSOLE DESCRIPTIONS

Left Stabilizer Control

This lever controls left rear stabilizer.

- Push to lower.
- Pull to raise.

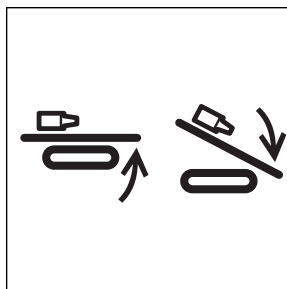
Lower left and right rear stabilizers to the ground together, then adjust individually.



Frame Tilt Control

This lever raises or lowers front end of drill frame.

- Push to lower.
- Pull to raise.

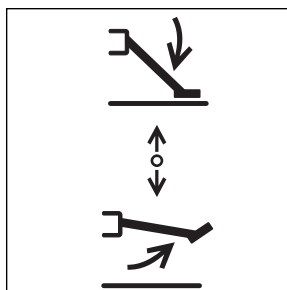


Right Stabilizer Control

This lever controls right rear stabilizer.

- Push to lower.
- Pull to raise.

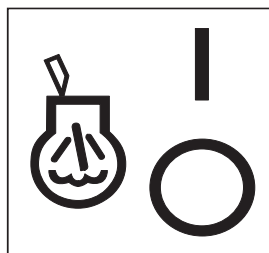
Lower left and right rear stabilizers to the ground together, then adjust individually.



Cold Start Switch

This optional switch helps start cold engine.

- Turn key to on position.
- Press top of switch for 2-3 seconds.
- Start engine.

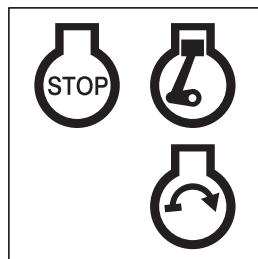


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Ignition Switch

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.

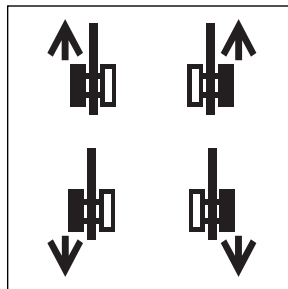


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Auxiliary Track Drive Switches

These switches control movement of left and right tracks.

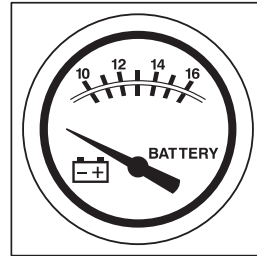
- Press top of right switch to move right track forward.
- Press bottom of right switch to move right track backward.
- Press top of left switch to move left track forward.
- Press bottom of left switch to move left track backward.



Switches only operate when tethered controller is disconnected.

Voltmeter

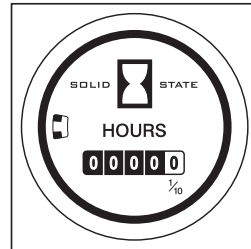
This gauge measures voltage in electric system. Reading should be near 14 volts with engine running. If not, stop engine and investigate.



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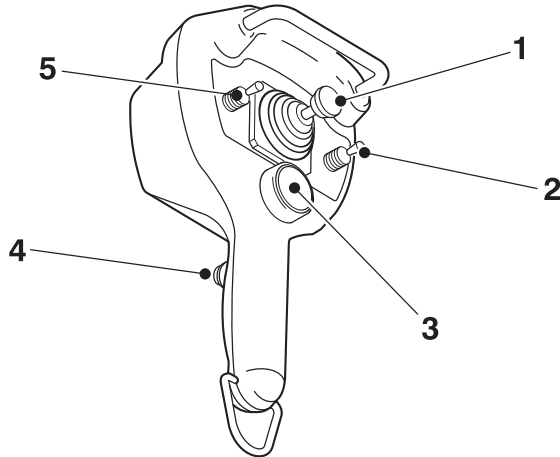
Hourmeter

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



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TETHERED GROUND DRIVE CONTROLLER OVERVIEW



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- Test port (1)
- Speed/direction control (2)
- Power mode switch (3)
- Remote engine stop switch (4)
- Operator presence switch (5)
- Throttle switch (6)

TETHERED GROUND DRIVE CONTROLLER DESCRIPTIONS

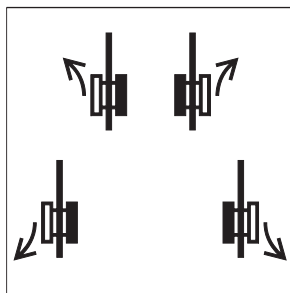
Test Port

This outlet is used to plug in Electronic Diagnostic Terminal (EDT), which is used for troubleshooting purposes. See **Repair Guide** for more information.

Speed/direction Control

This lever controls track direction and speed when operator presence switch is pressed.

- Push to move forward.
- Pull to move backward.
- Move right or left to steer.



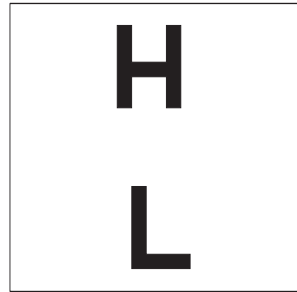
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For more information on this control function, see “Operate Tethered Ground Drive Controller” in **TRANSPORTATION**.

Power Mode Switch

This switch selects ground drive operating mode.

- Push for normal driving mode.
- Pull for loading and unloading mode.
- Return to center to disable controller.



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Remote Engine Stop Switch

This button stops drilling unit engine.

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

Operator Presence Switch

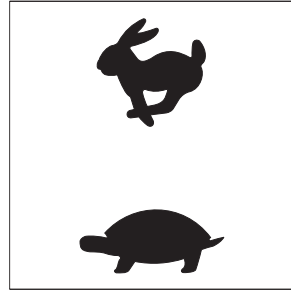
This switch allows tethered controller to function.

- Press to operate ground drive with tethered controller.
- Release to disable controller.

Throttle Switch

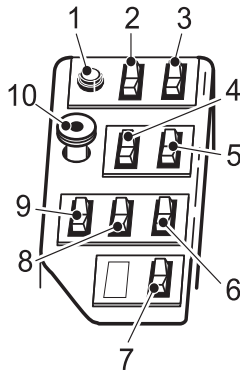
This switch controls engine speed.

- Push to increase speed.
- Pull to decrease speed.



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LEFT CONTROL CONSOLE OVERVIEW



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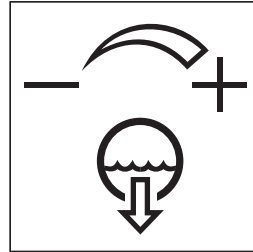
- Drilling fluid flow control (1)
- Back wrench switch (2)
- Front wrench switch (3)
- Pipe lift switch (4)
- Pipe shuttle switch (5)
- Engine throttle switch (6)
- Pipe lubricator switch (7)
- Auxiliary wrench switch (8)
- Pipe autoloader selector (9)
- Pullback speed control (10)

LEFT CONTROL CONSOLE DESCRIPTIONS

Fluid Flow Control

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

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

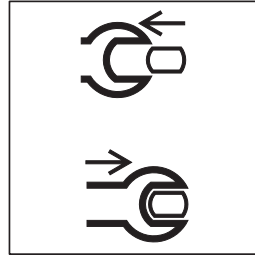


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Back Wrench Switch

This switch controls back wrench which is used to break joint at front wrench.

- Press top to lock wrench onto pipe flats.
- Press bottom to release pipe.

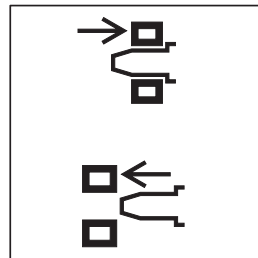


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Front Wrench Switch

This switch controls front wrench which is used to break joint at spindle.

- Press top to release pipe.
- Press bottom to lock wrench onto pipe flats.

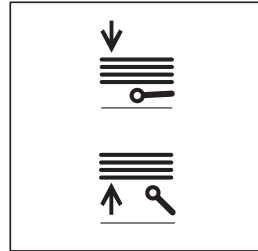


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Pipe Lift Switch

This switch raises and lowers all rows in pipe box.

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

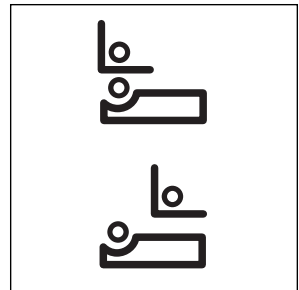


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Pipe Shuttle Switch

This switch moves shuttle to and from pipe box.

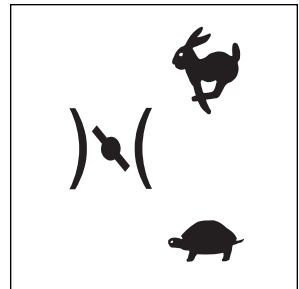
- Press top to move toward pipe box.
- Press bottom to move toward spindle.



Engine Throttle Switch

This switch controls engine speed during drilling and backreaming.

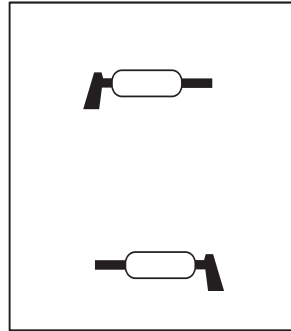
- Press top to increase speed.
- Press bottom to decrease speed.
- Return switch to center position to maintain selected speed.



Pipe Lubricator Switch

This switch controls pipe thread lubricator.

- Press top to apply joint compound to threads at front wrench.
- Press bottom to fill applicator at back of pipe loader.

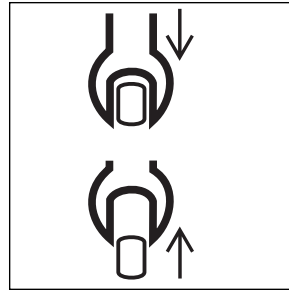


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Auxiliary Wrench Switch

This switch controls auxiliary (back-up) breakout wrench.

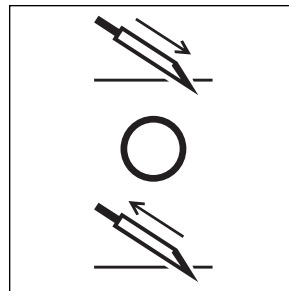
- Press bottom to release pipe.
- Press top to lock wrench onto pipe flats.



Pipe Autoload Selector

This switch selects pipe autoload function.

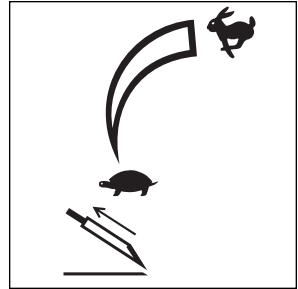
- Press top when drilling.
- Press center to use manual pipe loader controls.
- Press bottom when backreaming.



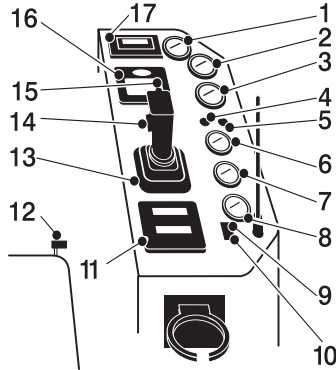
Pullback Speed Control

This knob controls maximum pullback speed.

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



RIGHT CONTROL CONSOLE OVERVIEW



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- Fluid pressure gauge (1)
- Thrust pressure gauge (2)
- Rotation pressure gauge (3)
- Remote start switch (4)
- Remote engine stop switch (5)
- Water temperature gauge (6)
- Engine oil pressure gauge (7)
- Fuel gauge (8)
- Hydraulic oil temperature indicator (9)
- Hydraulic oil filter service indicator (10)
- Electric strike system (11)*
- Seat slide control (12)
- Thrust/rotation control (13)
- Drilling fluid pump switch (14)
- Dual speed carriage travel switch (15)
- Subsite 750 Display (16)*
- Drilling fluid flow gauge (17)

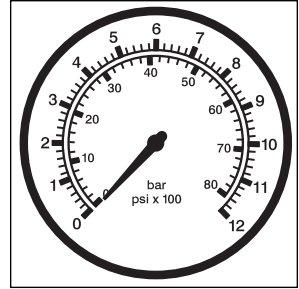
* Called out later in this chapter

RIGHT CONTROL CONSOLE DESCRIPTIONS

Fluid Pressure Gauge

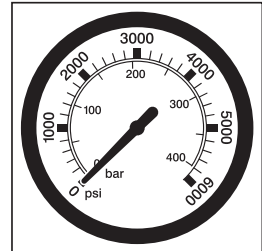
This gauge displays drilling fluid system pressure.

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



Thrust Pressure Gauge

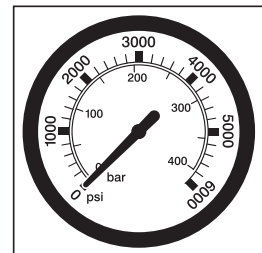
This gauge displays hydraulic fluid pressure to thrust motor during thrust and pullback.



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Rotation Pressure Gauge

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



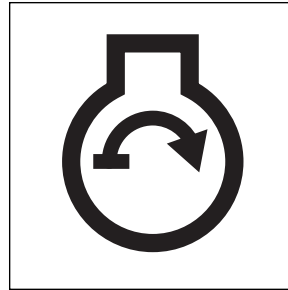
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Remote Start Switch

This button starts drilling unit engine from operator's station.

- Push button.
- Release when engine starts.

This button only works when key on setup console is on.

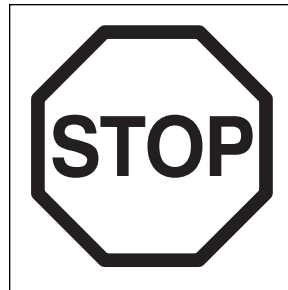


Remote Engine Stop Switch

This button stops drilling unit engine from operator's station.

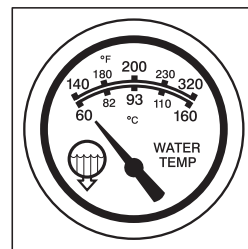
- Press red button on operator's station to stop engine.

Use ignition or remote start switch to restart engine.



Water Temperature Gauge

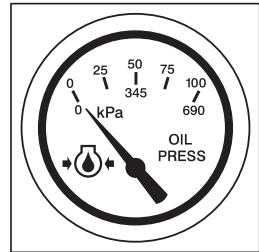
This gauge displays engine water temperature.



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Engine Oil Pressure Gauge

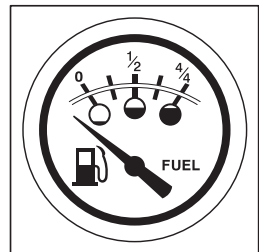
This gauge displays engine oil pressure.



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Fuel Gauge

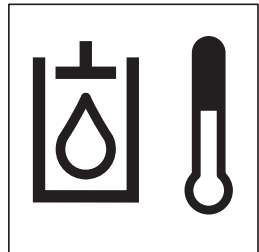
This gauge indicates fuel level in tank. Use only diesel fuel. Tank holds 33 gal (125 L).



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Hydraulic Oil Temperature Indicator

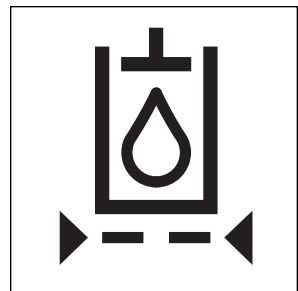
This indicator lights if hydraulic oil overheats.



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Hydraulic Oil Filter Service Indicator

This indicator lights if hydraulic oil pressure is too high.



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.

Thrust/rotation Control

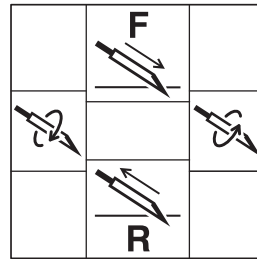
This joystick controls thrust direction and rotation.

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).

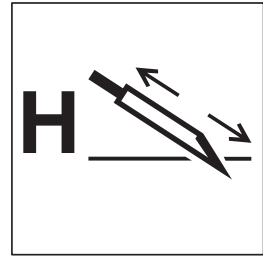


For more information on this control function, see “Operate Thrust/rotation Control” in **TRANSPORTATION**.

Dual Speed Carriage Travel Control

This button increases carriage travel speed forward and backward. 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.

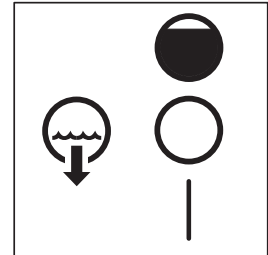


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Fluid Pump Switch

This switch controls fluid pump.

- Press and hold top for full pump flow to fill pipe with fluid. Switch will return to center when released.
- Move to center position to turn off.
- Press bottom to turn on.

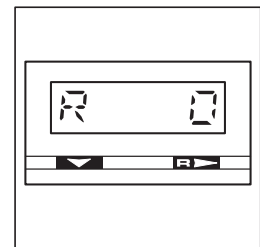


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Drilling Fluid Flow Gauge

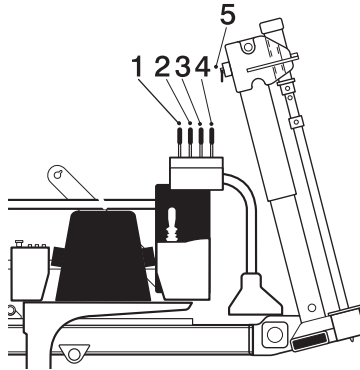
This gauge displays approximate rate of drilling fluid flow at pump.

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



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ANCHORING SYSTEM CONSOLE OVERVIEW



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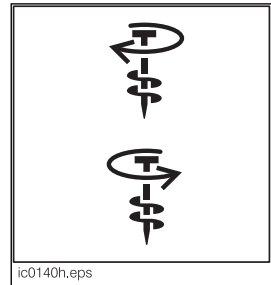
- Left rotation control (1)
- Left thrust control (2)
- Right rotation control (3)
- Right thrust control (4)
- Anchor slide locks (5)

ANCHORING SYSTEM CONSOLE DESCRIPTIONS

Left Rotation Control

This lever controls rotation of left anchor.

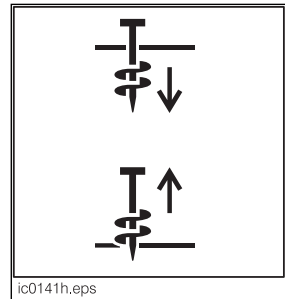
- Push to drive anchor.
- Pull to remove anchor.



Left Thrust Control

This lever controls thrust of left anchor.

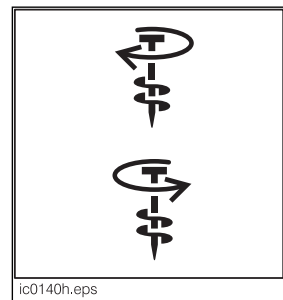
- Push to move down.
- Pull to move up.



Right Rotation Control

This lever controls rotation of right anchor.

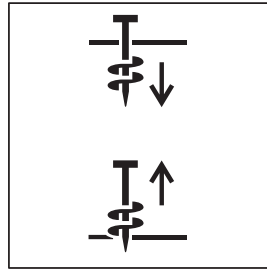
- Push to drive anchor.
- Pull to remove anchor.



Right Thrust Control

This lever controls thrust of right anchor.

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

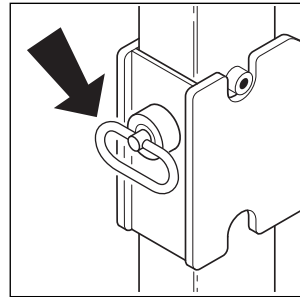


ic0141h.eps

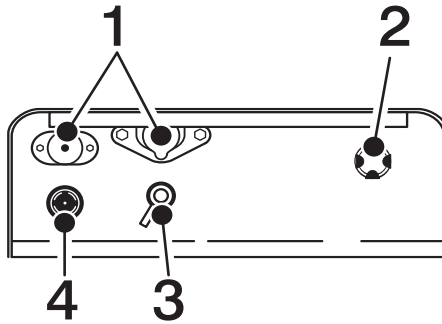
Anchor Slide Locks

These knobs lock and unlock anchor driver into hole in center of anchor frame.

- Turn handle parallel to frame to lock.
- Turn handle perpendicular to frame to unlock.



AUXILIARY CONSOLE OVERVIEW



ic0268a.eps

- Auxiliary outlets (1)
- Hydraulic oil sight glass (2)
- Battery disconnect switch (3)
- Warning horn (4)

AUXILIARY CONSOLE DESCRIPTIONS

Auxiliary Outlets

Two auxiliary outlets can be used to provide power for cellular phones, work lights, or other devices.

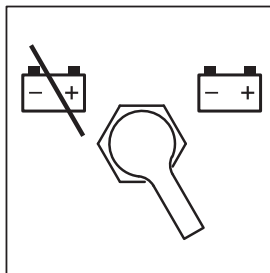
Hydraulic Oil Sight Glass

See **LUBRICATION** for information about this sight glass.

Battery Disconnect Switch

This switch disconnects battery when servicing, welding, and during long-term storage.

- Move to right to connect.
- Move to left to disconnect.

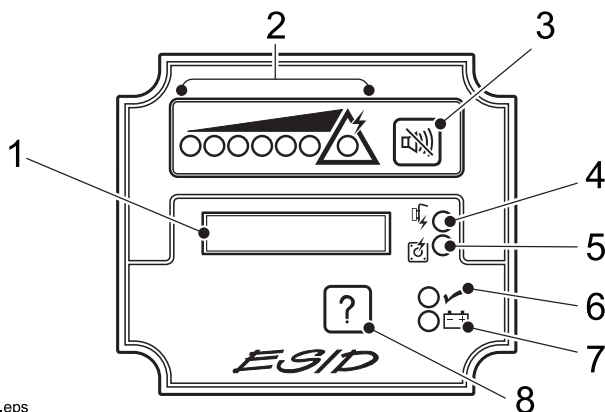


ic1331a.eps

Warning Horn

This horn sounds when hydraulic oil temperature is too high and when engine water temperature is too high.

ESID OVERVIEW



Om0203c.eps

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

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**.

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.

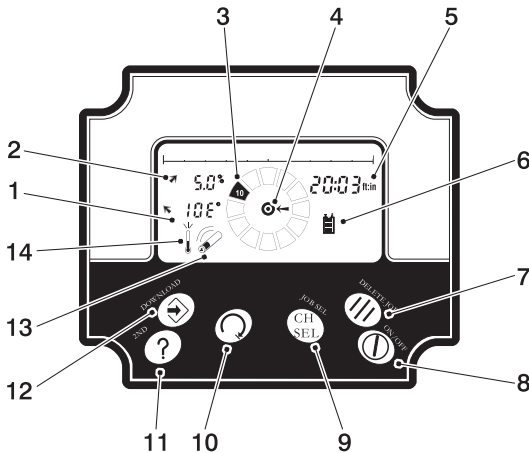
Electrical Power Supply Indicator

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



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

SUBSITE 750D 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).

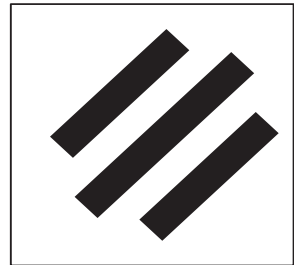
Beacon Temperature Indicator

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

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.



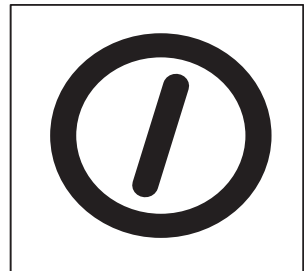
si1055a.eps

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

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.



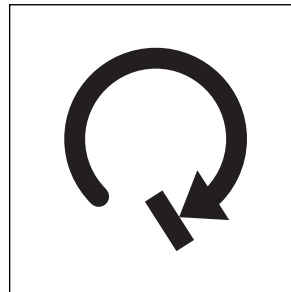
si1058a.eps

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.



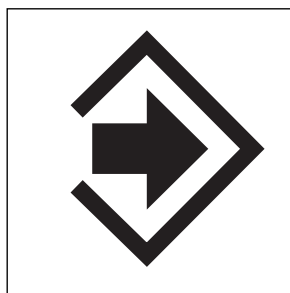
si1066a.eps

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

Store Button

This button allows operator to store currently displayed data.

- Press 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. Connect display to PC running Trac Management System software.

SAFETY

Follow these guidelines before operating any jobsite equipment:

- Complete proper training and read operator's manual before using equipment.
- Contact your local One-Call (811 in USA) or the One-Call referral number (888-258-0808 in USA and Canada) to have underground utilities located before digging. Also contact any utilities that do not participate in the One-Call service.
- 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.

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

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.

If an Electric Line is Damaged

If you suspect an electric line has been damaged and you are **on tractor**, DO NOT MOVE. Remain on tractor and take the following actions. The order and degree of action will depend upon the situation.

- Warn people nearby that an electric strike has occurred. Instruct them to leave the area and contact utility.
- Raise attachments and drive from immediate area.
- Contact utility company to shut off power.
- Do not return to jobsite or allow anyone into area until given permission by utility company.

If you suspect an electric line has been damaged and you are **off tractor**, DO NOT TOUCH TRACTOR. Take the following actions. The order and degree of action will depend upon the situation.

- LEAVE AREA.
- Contact utility company to shut off power.
- Do not return to jobsite or allow anyone into area until given permission by utility company.

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.

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.

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 trench bore path. Verify previously marked line and cable locations.
- Mark location of all buried utilities and obstructions.
- 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, granite, or concrete 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.

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, uUse 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.

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.

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.

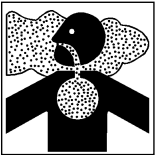
SAFETY ALERTS

**⚠ DANGER**

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

**⚠ DANGER**

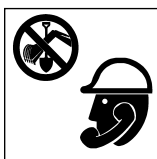
Electric shock. Contacting electric lines will cause death or serious injury. Know location of lines and stay away.

**⚠ WARNING**

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

**⚠ WARNING**

Moving tools will kill or injure. Shut off drill string power when anyone can be struck by thrown or moving tools. Never use pipe wrenches on drill string.



⚠ 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.

Fall possible. Riders can fall from machine and be injured or killed. Only operator is allowed on machine.

**⚠ 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**

Pressurized fluid or air 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.



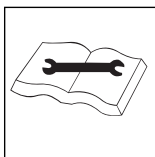
⚠ WARNING

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.

**⚠ WARNING**

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

**⚠ WARNING**

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

**⚠ WARNING**

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

**⚠ WARNING**

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

**⚠ WARNING**

Battery acid may cause burns. Avoid contact.

**⚠ WARNING**

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).

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 into account bore enlargement during backreaming and pullback. 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 (888-258-0808) 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.

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.

Identify Hazards

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



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.

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 ft (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.

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 it can be 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.

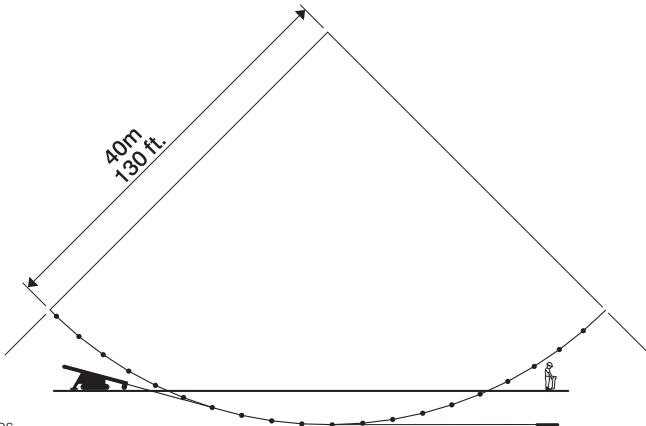
Recommended Bend Limit

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.

JT1720 drill pipes have a tested bend radius of 130 ft (39.6 m), meaning a 90 degree bend, whether during entry and exit or when turning, requires 130 ft (39.6 m) of forward distance and approximately 204 ft (62 m) of pipe.

Use **APPENDIX**, sections A and B, to keep bends within safe limits and make sure pitch changes no more than 8% per pipe.

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



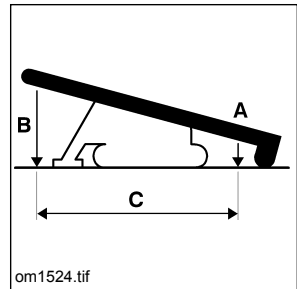
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Entry Pitch

Entry pitch is drilling unit slope compared to level ground.

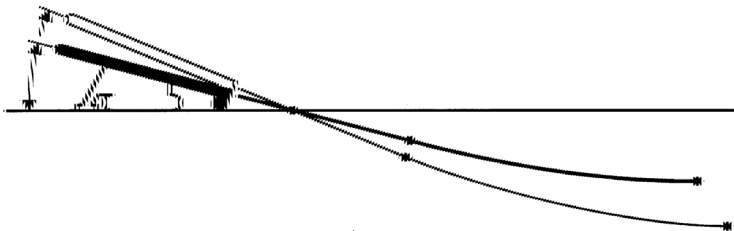
Entry pitch can be determined two ways:

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.



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

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

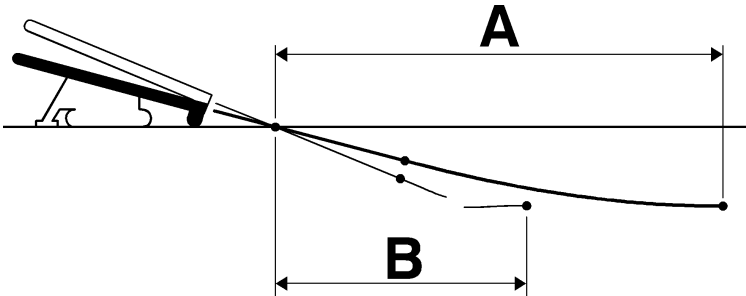


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Minimum Setback

Setback is the distance from entry to horizontal. If setback is too small, 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.



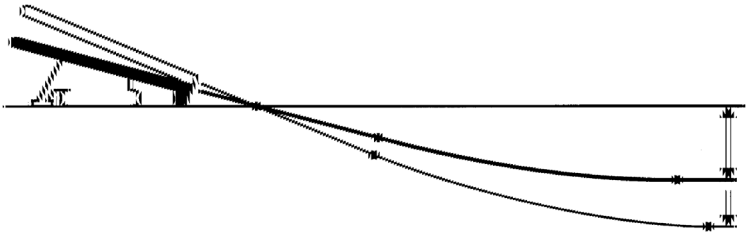
A. Proper setback B. Setback too small

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.



CHECK SUPPLIES AND PREPARE EQUIPMENT

Check Supplies:

- Receiver/transmitter or tracker with two sets charged batteries
- Beacons with new and spare batteries
- Two way radios with new and spare batteries
- Wrenches
- Anchoring equipment and accessories
- Bolts and wrenches
- Bits, screens, nozzles
- Adapters, pipe, beacon housings
- Marking flags or paint
- Water and additional hoses
- Fuel
- Bentonite, polymer, water conditioner, and other additives
- Fuses
- Keys
- Backreamers, swivels, pulling devices
- Wash down hose and spray gun
- Duct tape
- Spray lubricant
- Joint compound and brush
- Electrically insulating boots and gloves
- Notepad and pencil

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
- Relief valve
- Centrifugal pump
- Mud mixer
- Hoses and valves
- Water tanks

PREPARE JOBSITE

**⚠ WARNING**

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

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

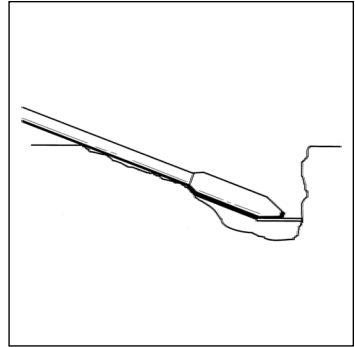
Mark your planned bore path and all located utility lines with flags or paint.

Entry Point

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

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

Dig a small starting hole so first length is drilled into a vertical surface to help ensure first pipe is not bent.



RECORD BORE PATH

As job is completed, record actual bore path. List pitch and depth of each joint and a brief description of 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 66TKRW tracker, 90D remote display, a tracking beacon, and special software. The system can be run in the field using a laptop computer equipped with the Windows® 95 operating system. See your Ditch Witch dealer for details.

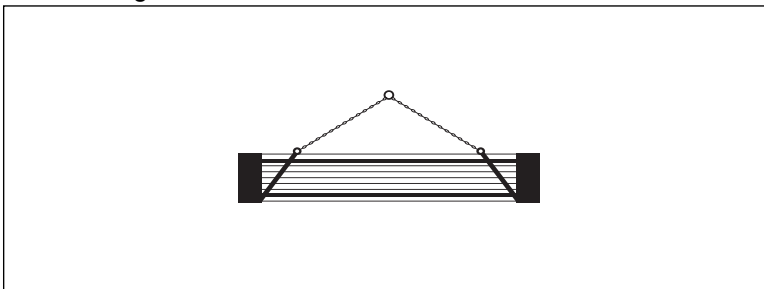
TRANSPORTATION

LIFT

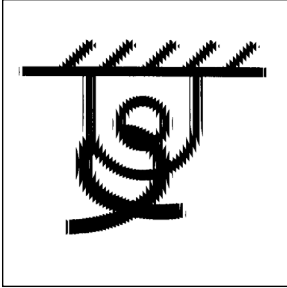
This machine is not configured for lifting. If the machine must be lifted, load machine into a container or onto a platform appropriate for lifting. For weight of machine, see specifications in this manual.

Pipe Box

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



TIEDOWN

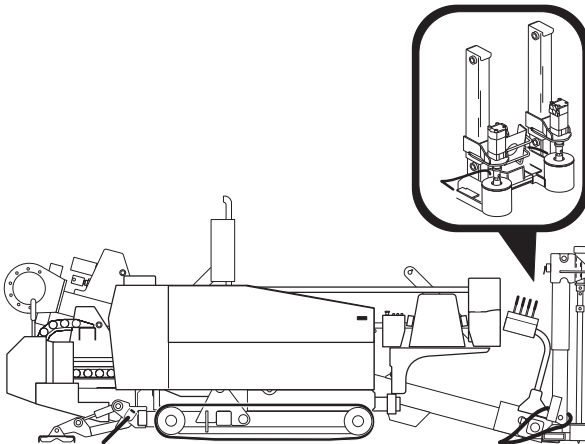


Points

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

Procedure

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

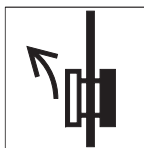


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OPERATE TETHERED GROUND DRIVE CONTROLLER

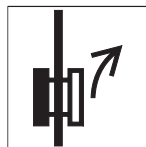
The track control has eight positions. The chart below summarizes movement that occurs when control is put at a combined position.

Drives drilling unit forward and to the left.



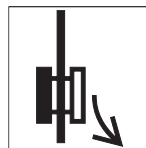
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Drives drilling unit forward and to the right.



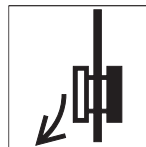
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Drives drilling unit backward and to the right.



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Drives drilling unit backward and to the left.



Ic0079c.eps

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. Move drilling unit to rear of trailer and align with ramps or center of trailer bed.
4. Using load/unload mode on tethered controller, slowly drive unit onto trailer.
5. Lower stabilizers to trailer floor.
6. Stop engine when unit is safely positioned on trailer bed.
7. Attach tiedowns to drilling unit where tiedown decals are located.

Unloading from Trailer

1. Lower trailer or ramps.
2. Start engine.
3. Remove tiedowns.
4. Raise stabilizers.
5. Using load/unload mode on tethered controller, slowly back unit down trailer or ramps.

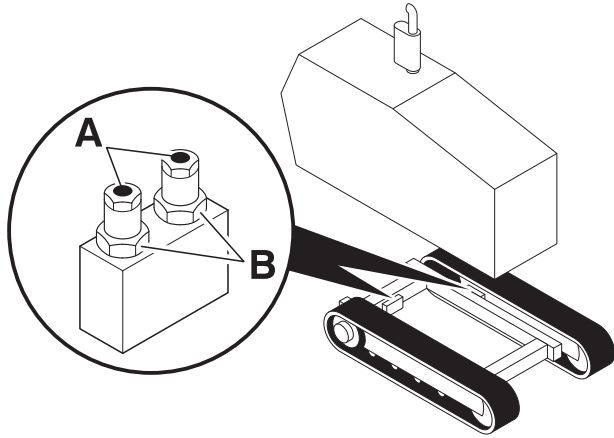
TOW

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

- Tow for short distances at less than 1 mph (1.6 kph).
- Attach chains to all available tiedown points facing towing vehicle.
- Use maximum towing force of 1.5 times unit weight, disengage hydraulic power to tracks.

IMPORTANT: When hydraulics are disengaged, unit has no brakes.

To disengage track hydraulics:



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1. Loosen locknut (B).
2. Turn screw (A) on each counterbalance valve clockwise until it stops. Be sure to count number of turns.
3. Repeat on other track.

To engage track hydraulics:

1. Turn screw (A) on counterbalance exactly same number of turns counterclockwise.
2. Tighten locknut (B).
3. Repeat on other track.

SETUP

UNLOAD

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

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.

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 control box, strike system includes bonding cables, barriers and protective boots and gloves meeting 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.

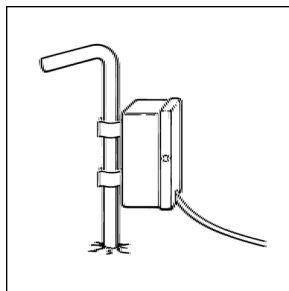
FCC Statement

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.

Assemble Bonding Equipment

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



Test Control Box

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

1. Turn on drilling unit.
2. Control box will perform internal tests which check everything but horns and strobes.
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
 - horns and strobes on both units should sound
4. If this test is successful, OK indicator and electrical power supply indicator lights will remain on.

ANCHOR



WARNING

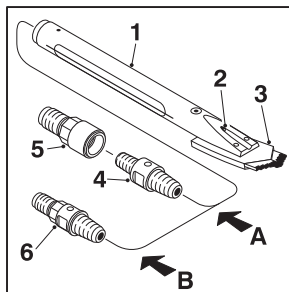
Crushing weight. If load falls or moves, it could kill or crush you. Use proper procedures and equipment or stay away.

NOTICES:

- Drive anchors properly before drilling.
 - If you are not driving two anchors to full depth, drive optional ground rod into soil away from drilling unit.
-
1. Extend cylinder to raise anchor driver to top of anchor frame.
 2. Bolt collar at appropriate hole in anchor shaft for desired depth setting.
 3. Rotate anchor while fully retracting cylinder to lower anchor into ground.
 4. Disengage anchor slide lock.
 5. Fully extend cylinder to place anchor driver at bottom of anchor frame.
 6. Engage anchor slide lock.
 7. Rotate anchor while retracting cylinder until collar rests firmly on centering cap.
 8. Repeat process for other anchor.

ASSEMBLE DRILL HEAD

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.

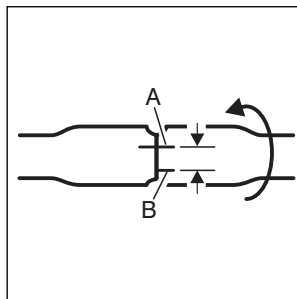


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Scribe Line Technique

Both EZ-Connect options use scribe line technique to achieve proper torque. To use this technique:

1. Remove all slack from wrench and joint.
2. Scribe straight line across joint on both sides of separating line (A).
3. Scribe second line (B) on moveable side of joint in the opposite direction of tightening action $\frac{3}{8}$ in (9.5 mm) away from first line.
4. Turn handle to tighten joint until second line meets first.

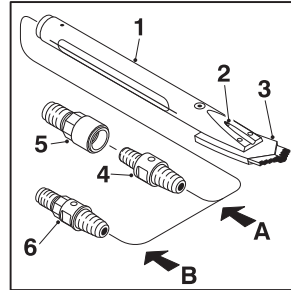


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ATTACH EZ-CONNECT TO DRILL HEAD

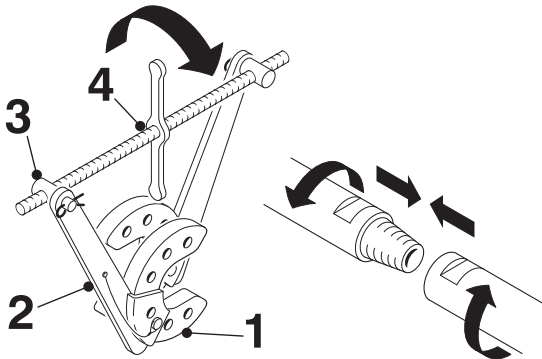
Option A

1. Apply tool joint compound to threads and hand tighten pin-to-pin adapter (4) to beacon housing (1).



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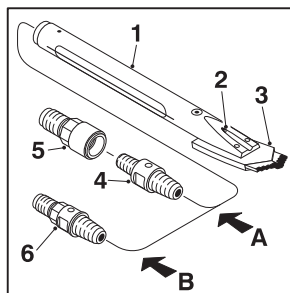
2. Attach quick wrench in joint position.



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- Place jaws (1) on wrench flats on both sides of joint.
- Pin handles (2) to wrench jaws. Be sure handles are both up.
- Attach pivoting nut heads (3) so that screw (4) is over joint.
- Turn screw to pull handles together.

3. Tighten joint.
4. Turn screw opposite way two turns to relieve pressure and remove quick wrench components.
5. Hand tighten EZ-Connect pin (5) to pin-to-pin adapter (4).
6. Attach quick wrench in join position.
7. Tighten joint using scribe line distance technique to achieve proper preload.
8. Turn screw opposite way two turns to relieve pressure and remove quick wrench components.



Option B

1. Apply tool joint compound to threads and hand tighten pin to EZ-Connect pin adapter (6).
2. Attach quick wrench in join position.
3. Tighten joint using scribe line distance technique to achieve proper preload.
4. Turn screw opposite way two turns to relieve pressure and remove quick wrench components.

ATTACH TRANSITION SUB

1. Apply tool joint compound to threads and thread transition sub onto saver sub.
2. Align drill pipe flats of EZ-Connect box with front wrench of drill frame.
3. Start drilling unit engine.
4. Use machine power to slowly rotate spindle and transition sub onto EZ-Connect box.
5. Tighten to full machine torque.

CONNECT DRILL PIPE

1. Start drilling unit engine.
2. Align transition sub in front wrench.
3. Load pipe.
 - Make sure row 1 is selected on pipe loader.
 - Press top of pipe lubricator switch to lubricate threads in front wrench.
 - Press bottom of pipe lubricator switch to fill applicator at back of pipeloader.
 - Use loader shuttle switch to move pipe to spindle.
4. Connect pipe to saver sub.
 - Move carriage forward until saver sub nears male pipe thread.
 - Continue to lower carriage and rotate spindle until pipe screws into saver sub.
 - Use loader shuttle switch to move shuttle under selected row.
 - Use pipe lift switch to lower pipe completely into shuttle.
5. Move carriage forward until front end of pipe is aligned with transition sub male thread.
6. Use machine power to slowly rotate spindle and drill pipe onto transition sub male thread.
7. Tighten to full machine torque.
8. Disengage front wrench and move carriage back to top of frame.
9. Turn off engine.

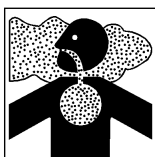
ENGAGE EZ-CONNECT

1. Apply tool joint compound to threads and align hole in EZ-Connect collar with tapped hole in EZ-Connect box.
2. Slide collar onto octagonal barrel and push toward wrench flats.
3. Thread drill head EZ-Connect pin into EZ-Connect box until shoulders are touching.
4. Back drill head off one flat and slide collar onto pin until retainer bolt hole is visible.
5. Install retainer bolt and tighten.

OPERATION

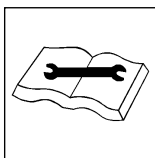
START SYSTEM

This section covers basic operation. 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.

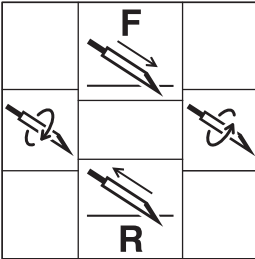


WARNING Crushing weight. If load falls or moves, it could kill or crush you. Use proper procedures and equipment or stay away.

NOTICE: Anchor drilling unit properly before drilling.

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

OPERATE THRUST/ROTATION CONTROL



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The thrust/rotation control has eight positions which allow the four basic functions to be combined. The chart below summarizes functions that occur when control is put at a combined position. Operator must be in seat for control to function.



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Moves carriage forward
Rotates pipe clockwise (makeup)



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Moves carriage forward
Rotates pipe counterclockwise (breakout)



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Moves carriage backward
Rotates pipe counterclockwise (breakout)



ic1105a.eps

Moves carriage backward
Rotates pipe clockwise (makeup)

1. Start drilling unit and remote fluid unit, if used.
2. Press top of drilling unit throttle switch until engine is at full throttle.
3. Adjust fluid pressure.
 - Press and hold top of fluid pump switch until pipe fills and fluid pressure begins to rise.
 - Adjust fluid flow control to set pressure to appropriate level. Do not exceed maximum pump setting.

DRILL FIRST PIPE



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.



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

1. Rotate spindle clockwise, full-speed.
2. Move carriage forward slowly. Drill first pipe as straight as possible.
3. Monitor gauges.
 - If thrust/pullback pressure reaches maximum, slow carriage travel.
 - If rotation pressure reaches maximum, slow carriage travel.
 - If rotation stalls, stop carriage thrust. If rotation does not resume, pull pipe back.

Break Joint at Saver Sub

1. When joint flats are aligned with front wrench, release joystick.
2. Engage front wrench.
3. Rotate spindle clockwise slowly until wrench flats engage pipe flats.
4. Reverse rotation and, using a slow rotation speed, slowly move carriage back as threads unscrew.
5. Stop rotation and use dual speed carriage control to move carriage to back of frame.

ADD PIPE



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

Option A: Use Manual Pipeloader Controls

1. Load pipe.
 - Make sure correct row is selected on pipe loader.
 - Press top of pipe lubricator switch to lubricate threads in front wrench.
 - Press bottom of pipe lubricator switch to fill applicator at back of pipeloader.
 - Use loader shuttle switch to move pipe to spindle.

IMPORTANT: Ensure that automatic pipe thread lubricator is functioning. If not, see **LUBRICATION**. Unlubricated threads can decrease pipe life.

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

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

3. Connect new pipe.
 - Slowly move carriage forward and rotate spindle slowly until pipe screws together.
 - Rotate joint slowly until spindle stops turning, then fully torque joint.
 - Lift pipe that is in pipe box.
 - Use loader shuttle switch to move shuttles under selected row.
 - Lower pipe onto shuttles.
4. Press top of drilling unit throttle switch until engine is at full throttle.
5. Adjust fluid flow.
 - Press and hold top of fluid pump switch until pipe fills and fluid pressure begins to rise.
 - Adjust fluid flow control to set flow to appropriate level.
6. Rotate spindle clockwise, and move carriage forward slowly.
7. Adjust joystick and rotation speed control according to bit size and soil conditions.
8. Monitor gauges.
 - If thrust pressure reaches 3000 psi (205 bar), slow carriage travel.
 - If rotation pressure reaches 3650 psi (250 bar), slow carriage travel.
 - If rotation stalls, stop carriage thrust. If rotation does not resume, pull pipe back.
9. Locate drill head at least every half-length of pipe.

Option B: Use Autoload Function

1. Position carriage between pipeloader shuttles.
2. Move pipe autoload selector to bore mode. Pipe lift arms will lower.

NOTICE: Do not attempt to use manual pipeloader controls with pipe autoload selector in bore mode. If pipeloading is interrupted:

- Move pipe autoload selector to manual mode.
 - Finish the cycle using manual pipeloading controls.
 - Position carriage between shuttles.
 - Move pipe autoload selector to bore mode and restart cycle.
3. Close front wrench.
 4. Lubricate pipe threads.
 - Press top of pipe lubricator switch to lubricate threads in front wrench.
 - Press bottom of pipe lubricator switch to fill applicator at back of pipeloader.
 5. Move carriage to back of drill frame. Shuttles will extend and pipe lift will raise.

IMPORTANT: Ensure that automatic pipe thread lubricator is functioning. Unlubricated threads can decrease pipe life.

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

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

7. Connect new pipe.
 - Slowly move carriage forward and rotate spindle slowly until pipe screws together.
 - Rotate joint slowly until spindle stops turning, then fully torque joint.
8. Open front wrench. Shuttles will retract and pipe lift arms will lower.
9. Press top of drilling unit throttle switch until engine is at full throttle.
10. Adjust fluid flow.
 - Press and hold top of fluid pump switch until pipe fills and fluid pressure begins to rise.
 - Adjust fluid flow control to set fluid flow to appropriate level.
11. Rotate spindle clockwise and move carriage forward slowly.
12. Adjust joystick and rotation speed control according to bit size and soil conditions.
13. Monitor gauges.
 - If travel pressure reaches 3000 psi (205 bar), slow carriage travel.
 - If rotation pressure reaches 3650 psi (250 bar), slow carriage travel.
 - If rotation stalls, stop carriage thrust. If rotation does not resume, pull pipe back.
14. Locate drill head at least every half-length of pipe.

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.

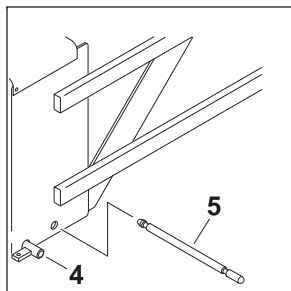
Use hoist capable of supporting the equipment's size and weight. See **SPECIFICATIONS** or measure and weigh equipment before lifting.

NOTICES:

- Always walk around unit and check for obstructions before moving load.
- Do not take your eyes off moving load. Always look in the direction load is moving.
- Never swing a load over people.
- Never remove pins (4) from ends of pipe box until you have attached lifting device. Box may fall if pipe lift switch is pressed without end pins in place.

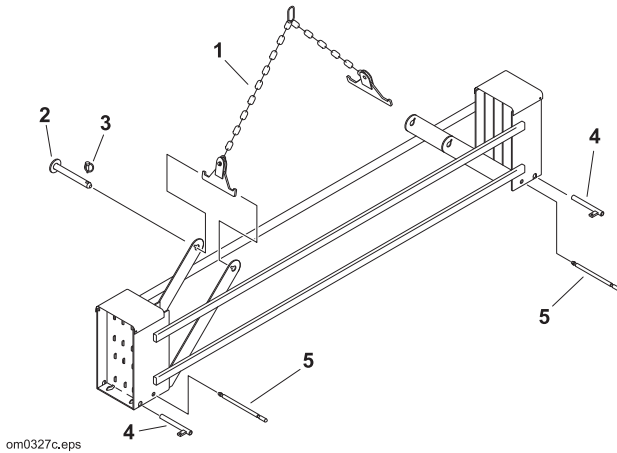
Prepare

If you are removing a pipe box with pipes in it, raise pipes with pipe lifter, install storage pin (5) on each end of pipe box, and lower pipes before beginning procedure.



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Remove



1. Remove lynch pins and pipe box pins (2, 3).
2. Position lift plate assembly (1) into notches on pipe box arm holes.
3. Attach lifting device to ring on lift plate assembly.
4. Remove pins (4).
5. Move pipe box off of drill frame.

Load

1. Move pipe box over pipeloader and lower into position.
2. Install pins (4).
3. Raise pipe off storage pins (5).
4. Remove storage pins from pipe box.
5. Lower pipe onto shuttles.
6. Disconnect lifting device from lift plate assembly (1).
7. Remove lift plate assembly from pipe box.
8. Replace pipe box pins and lynch pins (2, 3).

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.

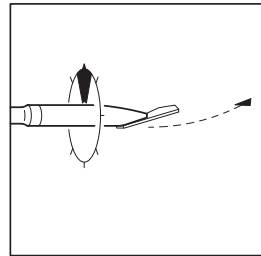
Corrections are made by tracking the drill head, comparing current position to bore plan, and steering drill head as needed. To steer, the head is positioned then pushed, rather than rotated, a few feet at a time.

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 use maximum pushing force until carriage is halfway down frame.

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. If drill head is rotated to a roll position and pushed, drill head will move forward and in clock face direction.



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To position drill head:

- Read beacon roll.
- Rotate pipe slowly until locator displays appropriate beacon roll.

To move forward without changing direction, rotate pipe as it is pushed.

4. Push pipe.
 - Adjust fluid flow.
 - Move carriage forward slowly.
 - Monitor gauges.
5. Continue to move carriage forward and rotate spindle.

SURFACE DRILL HEAD

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. Turn fluid flow control to off position and remote throttle switch to idle position as soon as drill head emerges.

PULLBACK AND BACKREAMING

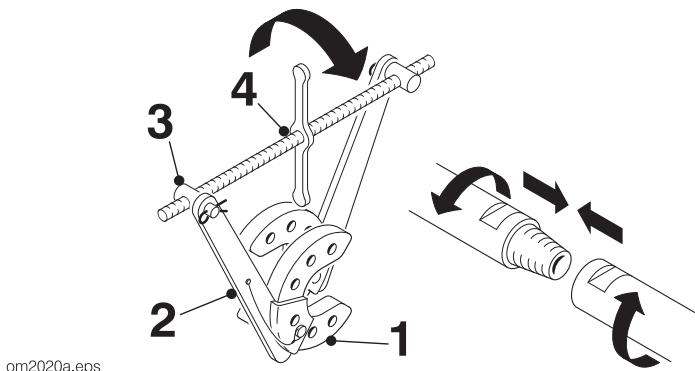
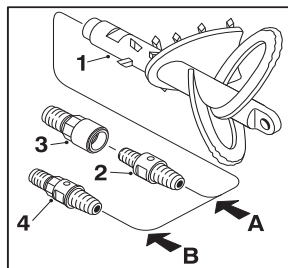
When the bore is completed, bore can be enlarged by backreaming or material can be pulled back.

Attaching EZ-Connect to Backreamer

Option A

1. Apply tool joint compound to threads and hand tighten pin-to-pin adapter to backreamer.
2. Attach quick wrench in joint position.

NOTICE: Never use machine torque to tighten or loosen any joint. Use quick wrench only.



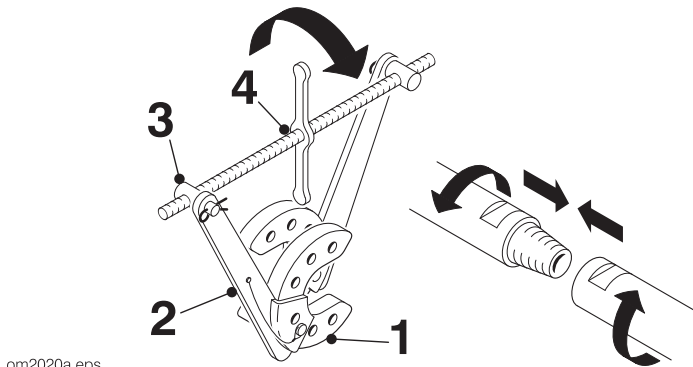
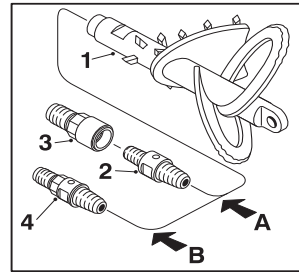
- Place jaws (1) on wrench flats on both sides of joint.
- Pin handles (2) to wrench jaws. Be sure handles are both up.
- Attach pivoting nut heads (3) so that screw (4) is over joint.
- Turn screw to pull handles together.

3. Tighten joint using scribe line technique to achieve proper preload. See **SETUP** for scribe line technique instructions.
4. Turn screw opposite way two turns to relieve pressure and remove quick wrench components.
5. Hand tighten EZ-Connect pin to pin-to-pin adapter.
6. Attach quick wrench in join position.
7. Tighten joint using scribe line technique to achieve proper preload. See **SETUP** for scribe line technique instructions.
8. Turn screw opposite way two turns to relieve pressure and remove quick wrench components.

Option B

1. Apply tool joint compound to threads and hand tighten pin to EZ-Connect pin adapter.
2. Attach quick wrench in joint position.

NOTICE: Never use machine torque to tighten or loosen any joint. Use quick wrench only.



- Place jaws (1) on wrench flats on both sides of joint.
 - Pin handles (2) to wrench jaws. Be sure handles are both up.
 - Attach pivoting nut heads (3) so that screw (4) is over joint.
 - Turn screw to pull handles together.
3. Tighten joint using scribe line technique to achieve proper preload. See **SETUP** for scribe line technique instructions.
 4. Turn screw opposite way two turns to relieve pressure and remove quick wrench components.

Connecting Pullback Device

Pullback devices are available for a wide variety of soil types and pullback material. To determine the best pullback combination for your job, contact your Ditch Witch dealer.

1. Move remote throttle switch to idle position.
2. Press bottom of drilling unit throttle switch until engine is at low throttle.
3. Move fluid pump switch to off position.
4. Ensure that engine temperature has dropped below 190-200° F (88-93° C), then turn drilling unit off.
5. Clean drill head, especially around threads.
6. Loosen and remove EZ-Connect retaining bolt.
7. Slide collar back toward transition sub.
8. Hand loosen and remove drill head.
9. Hand tighten EZ-Connect pin of backreamer into EZ-Connect box of transition sub until shoulders are touching.
10. Back backreamer off one flat and slide collar onto pin until retainer bolt hole is visible.
11. Install retainer bolt and tighten.

Backreaming

To backream, the drill head is surfaced and a variety of devices are attached to the pipe. As the pipe is pulled back, the devices enlarge the bore.

Backreaming Devices

1. Swivel - attached to pullback material through pullback device; allows pipe, cutter, and expander to rotate without twisting pullback material.
2. Nozzle - controls fluid flow from pipe to bore.

Backreaming 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.

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.

Determine Fluid Requirements

Backreaming is only successful when enough fluid reaches the bore. The amount of fluid needed depends on size of bore 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. Use **APPENDIX**, section C, to find amount of fluid needed for your backreamer.

For example, you find that a 6" (15.2 cm) backreamer requires at least 1.5 gal/ft (19 L/m).

2. Multiply this amount 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 3 gal (11.4 L) for each minute of backreaming.

3. Estimate pressure you will be using.
4. Using **APPENDIX**, section D, 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.

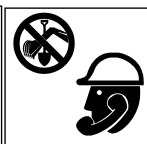
Backreaming Procedure

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.

**⚠ DANGER**

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

NOTICE: Keep everyone away from material being installed.

**⚠ WARNING**

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

NOTICE: Continue to use strike system during backreaming.

1. Select backreaming devices.
2. Determine fluid rate requirements.
3. Attach backreaming devices. If bore will be enlarged further, attach pipe to trailing end of backreamer as it is pulled into the bore.
4. Start remote fluid unit, if used.

5. Press top of drilling unit throttle switch until engine is at full throttle.
6. Set drilling fluid flow.
7. Check that fluid flows through all nozzles.
8. Slowly rotate until backreamer is fully engaged in soil.
9. Pull pipe through bore.

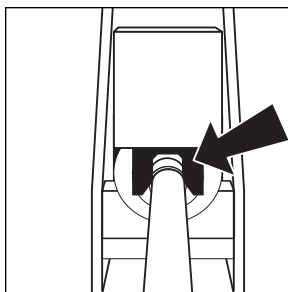
Removing Pipe

Option A: Use Manual Pipeloader Controls

1. When pipe joint is between front wrench and pipe wiper, release joystick.
2. Engage front wrench.
3. Slowly rotate spindle clockwise until wrench flats engage into pipe flats.
4. Rotate counterclockwise until upper joint breaks.

If joint does not break at spindle, use auxiliary wrench.

- Engage auxiliary wrench.
- Rotate spindle counterclockwise until wrench flats engage into pipe flats.
- Turn spindle counterclockwise until joint breaks.
- Disengage auxiliary wrench.



5. Engage breakout wrench.
6. Rotate spindle clockwise until wrench flats align with pipe flats.
7. Move shuttles out.

8. Slowly rotate pipe counterclockwise to unscrew bottom joint.
9. Disengage breakout wrench to release pipe.
10. Slowly rotate spindle counterclockwise and move carriage back slightly to unscrew pipe from saver sub.
11. Move spindle away from pipe.
12. Load pipe into pipe box.
 - Ensure that pipe is aligned with pipe box.
 - Move loader shuttle under selected row in box and raise lift arms to place pipe in box.
13. Attach next pipe to saver sub.
 - Press top of pipe lubricator switch to lubricate threads in front wrench.
 - Use dual speed carriage control and move carriage forward until saver sub touches pipe.
 - Slowly rotate spindle and slowly move carriage forward to allow pipe to screw into saver sub. Use full machine torque.
14. Disengage front wrench to release pipe.

Option B: Use Autoload Function

1. Ensure that front wrench is open.
2. Position carriage between pipeloader shuttles.
3. Move pipe autoload selector to backream mode. Pipe lift arms will raise.

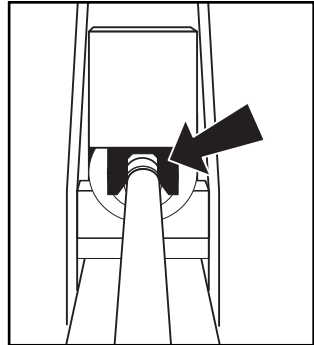
NOTICE: Do not attempt to use manual pipeloader controls with pipe autoload selector in backream mode. If pipeloading is interrupted:

- Move pipe autoload selector to manual mode.
 - Finish the cycle using manual pipeloading controls.
 - Position carriage between shuttles.
 - Move pipe autoload selector to backream mode and restart cycle.
4. Move carriage back until pipe joint is between front wrench and pipe wiper.
 5. Release joystick.
 6. Engage front wrench. Shuttles will extend and pipe lift arms will lower.
 7. Rotate spindle clockwise until wrench flats engage into pipe flats.

8. Rotate counterclockwise until upper joint breaks.

If joint does not break at spindle, use auxiliary wrench.

- Engage auxiliary wrench.
- Rotate spindle counterclockwise until wrench flats engage into pipe flats.
- Turn spindle counterclockwise until joint breaks.
- Disengage auxiliary wrench.



9. Engage breakout wrench.
10. Slowly rotate spindle clockwise until wrench flats align with pipe flats.
11. Slowly rotate pipe counterclockwise to unscrew bottom joint.
12. Disengage breakout wrench to release pipe.
13. Slowly move carriage back until automation stops pullback.
IMPORTANT: Pullback will stop for approximately 1.5 seconds.
14. Release joystick.
15. Slowly rotate spindle counterclockwise and move carriage back slightly to unscrew pipe from saver sub.
16. Move spindle away from pipe.

17. Move carriage to back of drill frame. Pipe will automatically be loaded into selected row in pipe box.



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

18. Attach next pipe to saver sub.

- Press top of pipe lubricator switch to spray joint compound on the threads in the front wrench.
- Use dual speed carriage control and move carriage forward until saver sub touches pipe.
- Rotate spindle and move carriage forward just enough to allow pipe to screw into saver sub. Use full machine torque.

19. Disengage front wrench to release pipe.

Removing Pullback Device

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

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

Reverse steps outlined in “Attaching Pullback Device” to remove pullback device.

Automation Troubleshooting Tips

Backream Mode

The most common reason for pipeloader automation cycle interruption in this mode is incorrect positioning of pipe.

When carriage is moved to back of drill frame, shuttles should retract and pipe lift arms should raise. If shuttles do not retract, pipe may not be positioned correctly.

- Adjust pipe so that it is between the mounting plates on the pipeloader.
- Press pipe shuttle switch to manually retract shuttles. This will restart automation cycle.

If automation is interrupted at any other point in the cycle, refer to "Troubleshooting" section of Repair Guide, or contact your local Ditch Witch dealer.

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. Rotate anchor out of ground while fully extending cylinder.
2. When cylinder is fully extended, disengage anchor slide lock.
3. Fully retract cylinder to place anchor driver at top of anchor frame.
4. Engage anchor slide lock.
5. Continue to rotate anchor out of ground while fully extending cylinder.
6. 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.

DISCONNECT

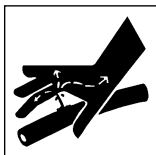
Disconnect and store the following hoses and cables (if used):

- electric cable
- electric strike system ground stake
- fluid hose

STOW TOOLS

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

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.

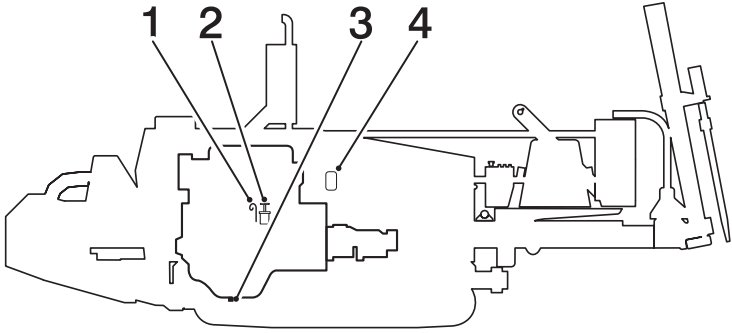
OVERVIEW

Interval	Task	Page no.
4	lube water swivel	129
10	check engine oil	127
	check hydraulic oil	132
	lube pipe guide bearings	129
50	change engine oil and filter (initial)	127
	check rotation gearbox oil	135
	check carriage travel gearbox oil	135
	check ground drive gearbox oil	135
	check fluid pump oil (initial)	137
100	change engine oil and filter	127
250	change hydraulic oil and filters (initial)	136
	lube thrust chain flange bearing	129
	lube thrust chain	129
750	change fluid pump oil	136
1000	change hydraulic oil and filters	136
	change rotation gearbox oil	135
	change carriage travel gearbox oil	135
	change ground drive gearbox oil	135
As needed	lube carriage slide bracket	130
	lube pipe loader shuttle slide	130
	change pipe auto lubricator pail	132

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 (P/N 256-031), or artic grade TJC (P/N 259-858)

ENGINE OIL



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Ref.	Task	Hours	Lubricant
1	check oil	10	DEO
2, 3, 4	change oil and filter (initial)	50	DEO
2, 3, 4	change oil and filter	100	DEO

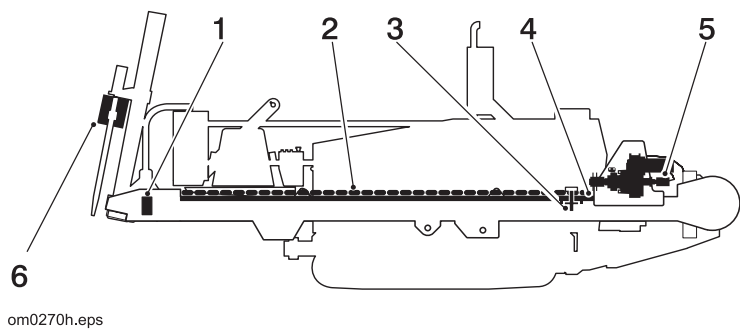
Check

Check engine oil every 10 hours at dipstick (1). If low, fill with DEO at oil fill (2).

Change

Change engine oil and filter (4) after first 50 hours. After that, change every 100 hours. Drain oil (3), change filter (4), and refill with DEO (2).

FRAME

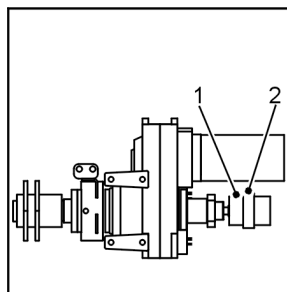


Ref.	Task	Hours	Lubricant
5	lube water swivel	4	MPG
	lube pipe guide bearings	250	MPG
2	lube thrust chain	250	MPG
1	lube thrust chain flange bearing	250	MPG
4	lube carriage slide bracket	as needed	MPG
3	lube pipe loader shuttle slide	as needed	MPG
6	change pipe auto lubricator pail	as needed	TJC

Water Swivel

Lube fitting 1 with molybdenum based MPG every four hours.

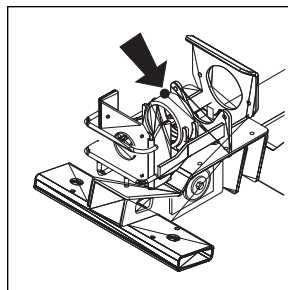
Using more than one stroke of grease gun can lead to seal failure. Do not lube fitting 2.



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Pipe Guide Bearings

Lube fittings with MPG every 250 hours.

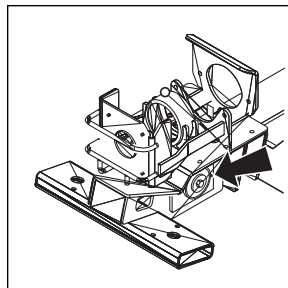


Thrust Chain

Lube thrust chain with DEO every 250 hours.

Thrust Chain Flange Bearing

Lube fittings (one on each side of front sprocket) with MPG every 250 hours.



Carriage Slide Bracket

Lube slide bracket with MPG as needed.

Pipe Loader Shuttle Slide

Lube shuttle slide with MPG as needed.

Pipe Auto Lubricator



WARNING Fluid under pressure can 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.

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

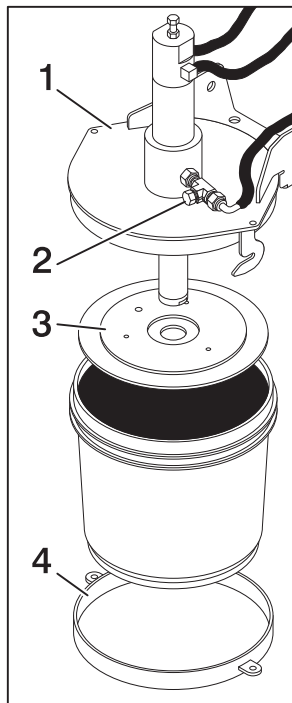
In operating temperatures below freezing, nozzle may not spray in “fan” pattern. To ensure proper protection, manually apply TJC to pipe tool joints.

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:

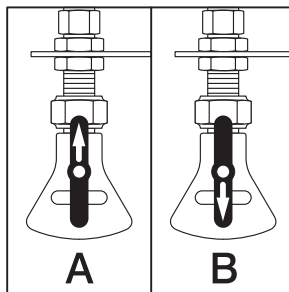
1. Remove wingnuts and capscrews attaching clamp ring (4) to pump bracket (1).
2. Rotate clamp ring slightly to clear hooks on bracket and remove pail from pump.
3. Remove follower plate (3) from empty pail and install into new pail. Press firmly on plate until TJC comes up center circle.
4. Remove clamp 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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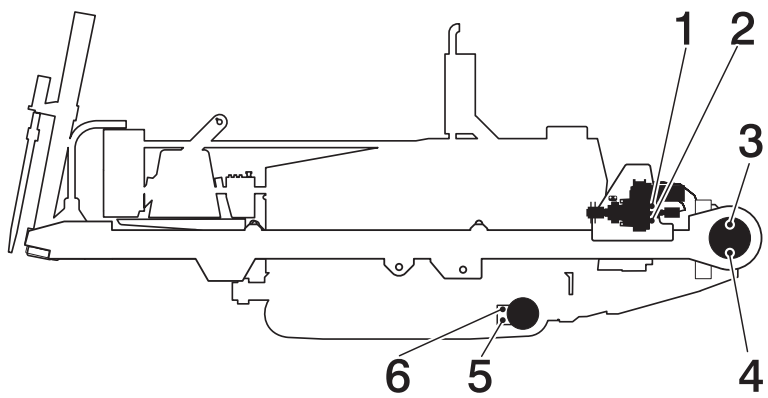
To clean nozzle:

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.



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GEARBOXES

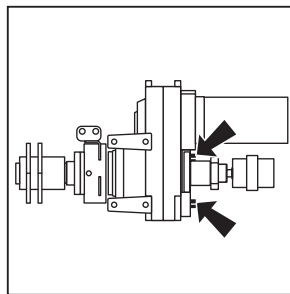


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Ref.	Task	Hours	Lubricant
1	check rotation gearbox oil	50	MPL
3	check carriage travel gearbox oil	50	MPL
5	check ground drive gearbox oil	50	MPL
2	change rotation gearbox oil	1000	MPL
4	change carriage travel gearbox oil	1000	MPL
5, 6	change ground drive gearbox oil	1000	MPL

Rotation Gearbox

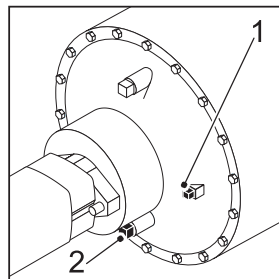
Check gearbox every 50 hours.
Oil should be level with plug. Fill with MPL at fill plug as needed.
Drain oil at gearbox oil drain every 1000 hours.



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Carriage Travel Gearbox

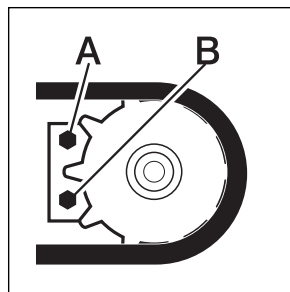
Check gearbox every 50 hours.
Oil should be level with fill plug (1). Fill with MPL as needed.
Drain oil at gearbox oil drain (2) every 1000 hours.



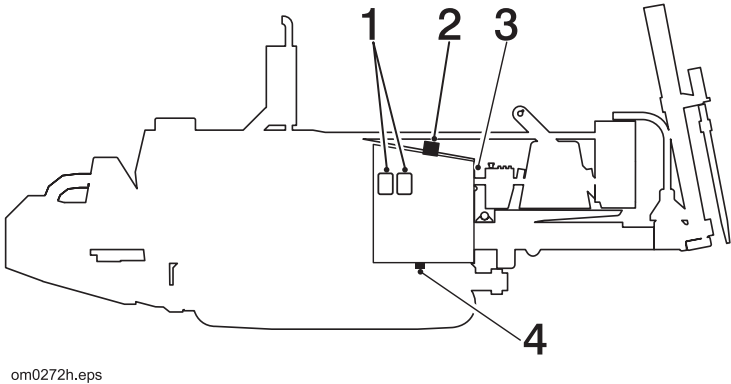
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Ground Drive Gearbox

Check gearbox every 50 hours.
Open plug (B). If oil does not come out, fill plug (A) with MPL until level with plug (B), then add 1 qt (.9 L).
Never fill more than halfway.
Drain oil at plug (B) every 1000 hours.



HYDRAULIC OIL



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

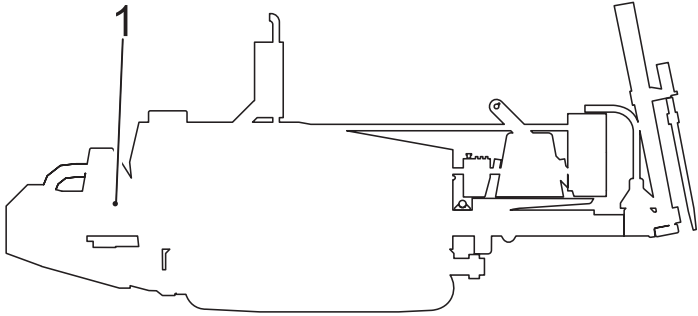
Check

Check hydraulic oil every 10 hours. Maintain fluid level at halfway point on sight glass (3), when engine is off and fluid is cool. Refill with THF at hydraulic oil fill (2).

Change

Change two hydraulic oil filters at 50 hours. Drain hydraulic oil (4), change filters (1), and refill with THF at hydraulic oil fill (2) every 1000 hours.

FLUID PUMP

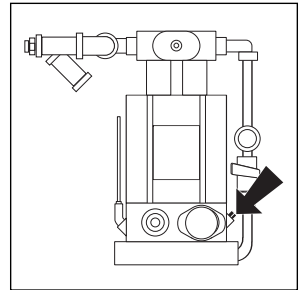


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Ref.	Task	Hours	Lubricant
1, 2	check fluid pump oil	50	SAE30W
1, 2	change fluid pump oil	2000	SAE30W

Check

Check oil level in crankcase every 50 hours. Refill as needed with SAE 30W engine oil.



Change

Drain and refill crankcase every 750 hours. Pump holds 1 qt (.9 L). See pump manufacturer's handbook for additional information.

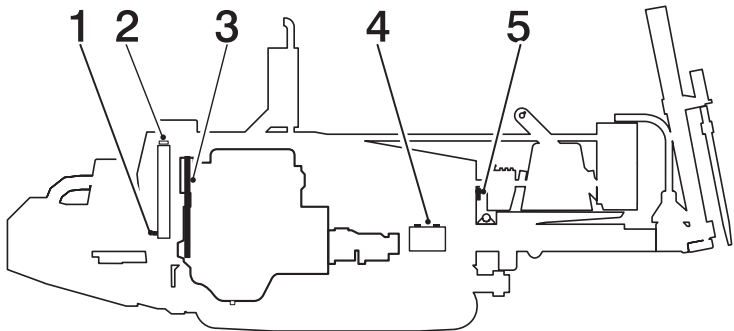
MAINTENANCE

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

OVERVIEW

Interval	Task	Page no.
10	inspect hoses	140
	check fluid pump y-strainer	145
	check pipe loader proximity switches	149
	check pipe loader shuttle switches	150
	check pipe presence switches	151
50	check batteries	141
	check radiator	142
	check belts	142
500	check SCA level of coolant	142
1000	change fuel filter	146
2000 or 5000	change coolant (depending on coolant used)	142
as needed	replace saver sub	144
	check muffler	146
	check air filter	146
	check thrust chain tension	148
	check track tension and condition	147
	replace pipe loader gripper inserts	141
	replace pipe loader shuttle inserts	141
	clean pipe	152
	repair pipe threads	152
	troubleshoot Electric Strike System	153

GENERAL COMPONENTS



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Ref	Task	Frequency
	inspect hoses	10
4, 5	check batteries	50
3	check belts	50
2	check radiator	50
2	check radiator SCA level	500
1, 2	change coolant (depending on coolant used)	2000 or 5000
	replace saver sub	as needed
	replace pipe loader gripper	as needed
	replace pipe loader shuttle inserts	as needed

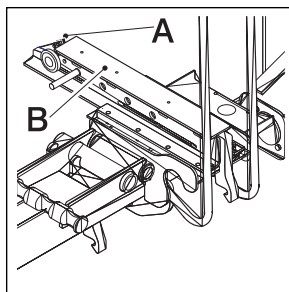
NOTICE: Before disconnecting any hydraulic line, turn engine off and operate all controls to relieve pressure. Lower, block or support any raised component. Cover connection with heavy cloth and loosen connector nut slightly to relieve residual pressure. Catch all fluid in container.

Inspect Hoses

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

Pipe Loader

Check pipe loader gripper inserts (A) and pipe loader shuttle inserts (B) for wear. Replace as needed. See your Ditch Witch dealer for replacement inserts.



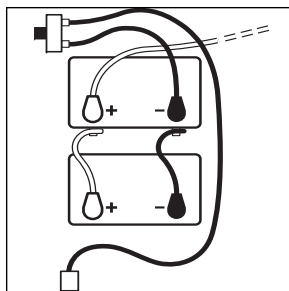
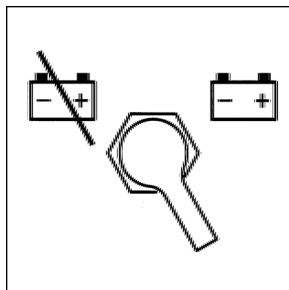
Batteries

IMPORTANT: Use battery disconnect switch (5) when servicing, welding, and during long-term storage.

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

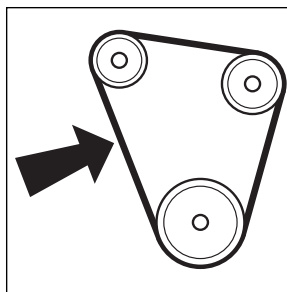
In cold weather, batteries lose some starting ability. Closely watch voltmeter for signs of battery discharge.

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



Alternator Belt

Check tension of alternator belt every 50 hours. Belt is properly tensioned when long span moves about 0.6" (15 mm) when pushed. If needed, loosen idler pulley bolts and adjust idler pulley. Tighten bolts and torque to 27-30 lb•ft (36-40 N•m). Replace belts if necessary.



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. Be careful not to damage fins with high-pressure air or water. Check more often if operating in dusty or grassy conditions.

Approved Coolant

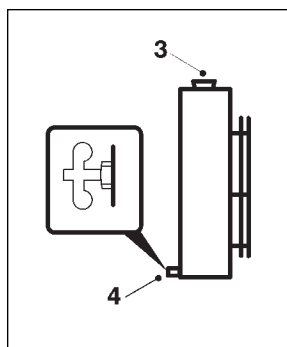
This unit was filled with John Deere Cool-Gard coolant before shipment from factory. Add only John Deere Cool-Gard (p/n 255-006) or any fully-formulated, ethylene glycol based, low-silicate, heavy-duty diesel engine coolant meeting ASTM specification D5345 (prediluted) or D4985 (concentrate) and containing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

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.



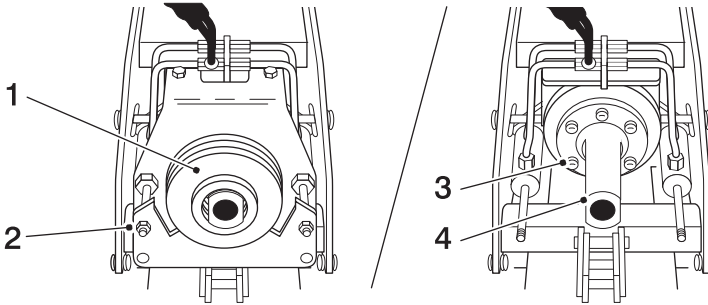
Drain cooling system at drain (4) and refill (3) with approved coolant as indicated below.

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.

Saver Sub



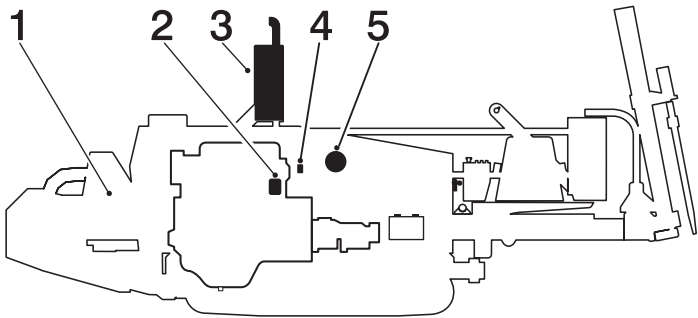
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As needed, replace saver sub on spindle.

To replace:

1. Smooth end of sub with file.
2. Remove two nuts on rod end of cylinders (2).
3. Remove wrench collar (1).
4. Remove six screws (3) and saver sub (4).
5. Remove and replace o-ring if necessary.

FILTERS

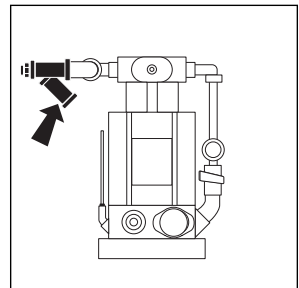


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Ref	Task	Frequency
1	check drilling fluid pump y-strainer	10
2	change fuel filter (initial)	50
2	change fuel filter	150
3	check muffler	as needed
4, 5	check air filter	as needed

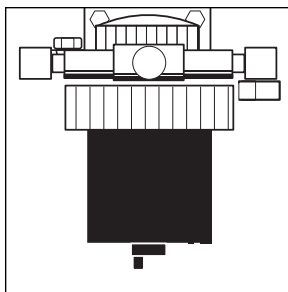
Drilling Fluid Pump Y-Strainer

Check fluid pump y-strainer every 10 hours or daily. Remove cap and strainer. Clean strainer if necessary.



Fuel Filter

Replace fuel filter every 1000 hours or yearly. If you refuel from cans, replace filter more often. See "Parts Manual" or contact your Ditch Witch dealer for correct replacement filter.

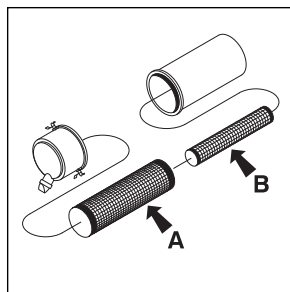


Air Filter

Change air filter when red band fills window on air filter service indicator.

To change:

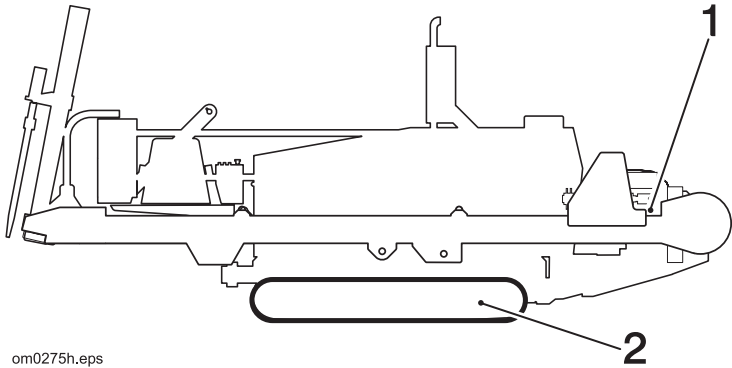
1. Open air filter case.
2. Remove paper element (A) and precleaner (B).
3. Wipe inside of housing and wash end cup.
4. Insert new paper element.
5. Close air filter case.
6. Reset air filter service indicator.



Muffler

Change muffler as needed.

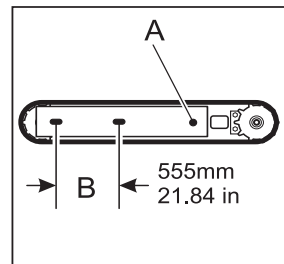
POWER COMPONENTS



Ref	Task	Frequency
1	check thrust chain tension	as needed
2	check track tension and condition	as needed

Track Tension

Check track tension as needed. To adjust track tension, pump MPG into fitting (A) until dimension (B) is 21.84" (555 mm).

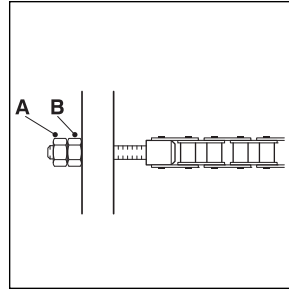


Thrust Chain Tension

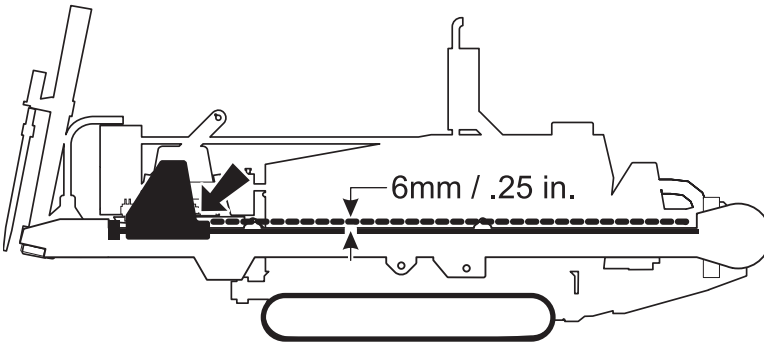
Adjust thrust chain tension as needed.

To adjust:

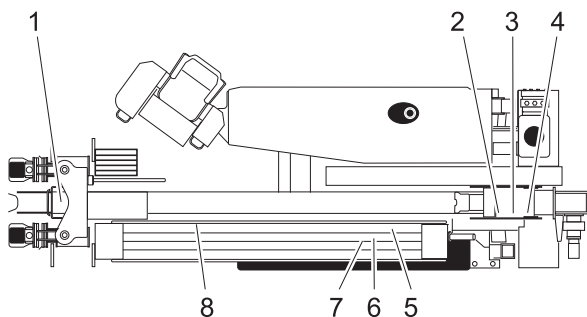
1. Move carriage to front of frame.
2. Loosen jam nut (A).
3. Turn nut (B) clockwise to tighten and counterclockwise to loosen chain.



Chain is properly adjusted when bottom of chain is .25" (6 mm) above frame when pulled with approximately 20 lb (9 kg) of force.



PIPE LOADER AUTOMATION



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Proximity Switches

Check the following proximity switches daily.

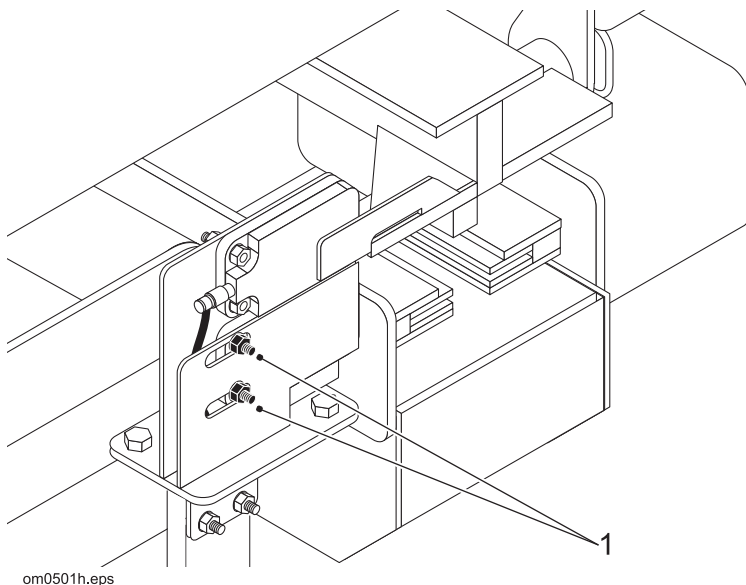
- Front wrench switch (1)
- Slow zone switch (2)
- Stop zone switch (3)
- Full back switch (4)
- Rear pipe presence switch (5)*
- Rear shuttle extended switch (6)*
- Rear shuttle retracted switch (7)*
- Front pipe presence switch (8)*

To check:

1. Turn drilling unit key 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.

*Called out later in chapter.

Shuttle Switches



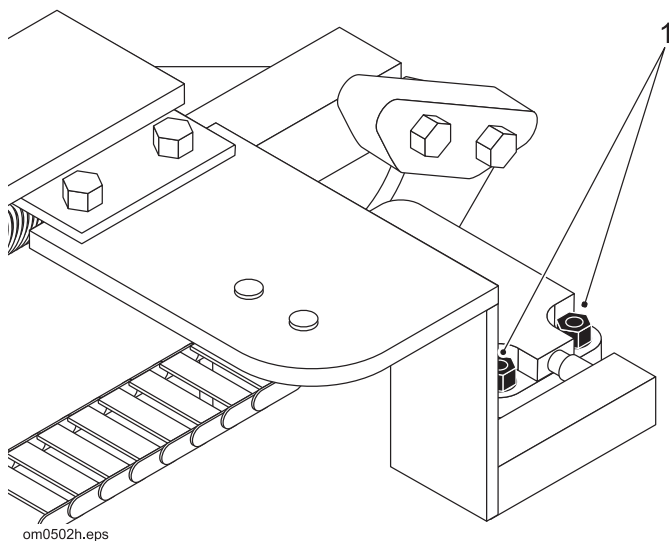
Check position of shuttle extended and retracted switches daily.

- If light does not come on, object switch is sensing is out of range.

To adjust switch position:

1. Loosen nuts and screws (1).
2. Adjust switch until both lights come on.
3. Tighten screws and nuts.

Pipe Presence Switches



Check position of front and rear pipe presence switches daily.

- If switch is positioned correctly, both lights will come on when pipe is in shuttle.

To adjust switch position:

1. Loosen nuts and screws (1).
2. Adjust switch with shims (p/n 107-450 or 107-451) as needed.
3. Tighten screws and nuts.

PIPE

Before pipe is used first time:

1. Move pipe back and forth over automated pipe lubricator.
2. Join pipe and tighten joint.
3. Break joint.
4. Move pipe back to box and repeat.

Each time pipe is used:

- Keep threads clean and well-lubed with joint compound. Lube threads and shoulders of male joints with joint compound.
- Keep inside of pipe clean. Drain fluid from pipe.
- Replace damaged pipe.
- Only use tool joint compound available from your Ditch Witch dealer.
- 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.

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 LCD showing after drilling unit key has been on at least one minute	Problems in start-up	Push Status button. If problem goes away, retest strike system
	No power to strike system control module	Check drilling unit electric system
		Check that cable from drilling unit to strike system control module is connected
		Check that cable from drilling unit carries more than 10 volts
	Defective control module	Have control module checked or replaced
LCD is blank	Strike system is not getting adequate power from drilling unit	Check drilling unit electric system
		Check that cable from drilling unit to strike system control module is connected
		Check that cable 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 cable from drilling unit to strike system control module is connected
		Check that cable from drilling unit carries more than 10 volts
Battery power light is on, but system OK light is off	Defective control module	Have control module checked or replaced
	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
	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
Strobe light on fluid unit does not work during total test	Improper connections with control module, relay, or strobe light	Check connections and wiring
	Defective fluid unit relay	Disconnect strobe and check that relay carries more than 12 volts
	Defective control module	Have control module checked or replaced
Horn on drilling unit does not work during total test	Improper connections with control module	Check connections and wiring
	Defective fluid unit relay	Disconnect strobe and check that relay carries more than 12 volts
	Defective control module	Have control module checked or replaced
Strobe light and horn on drilling unit do not work during total test	Improper connections with control module	Check connections, wiring and fuse
	Defective fluid unit relay	Disconnect strobe and check that relay carries more than 12 volts

EC2 and current problem light on	Improper connections with control module	Check connections and color code at current transformer (X1-white, X2-black, X3-red)
	Defective current transformer	Disconnect current transformer. Check that resistance X1 to X2 is 40-70 ohms and X2 to X3 is 1-10 ohms. If not, replace
	Defective control module	Have control module checked or replaced

USE ELECTRIC STRIKE SIMULATOR

The Electric Strike Simulator (Part Number 259-506) can be used to test voltage and current sensors on strike indicator. If LCD 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 LCD and lights above display on strike system.
 - three or four lights should turn on
 - current "A" should show 40-60% in display

To test for current at strike levels:

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

In addition, with 2 loops,

- current "A" should be 90-130%
- strike indication might go on and off

With 3 loops,

- current should be 140-190%
- strike indication should be continuous

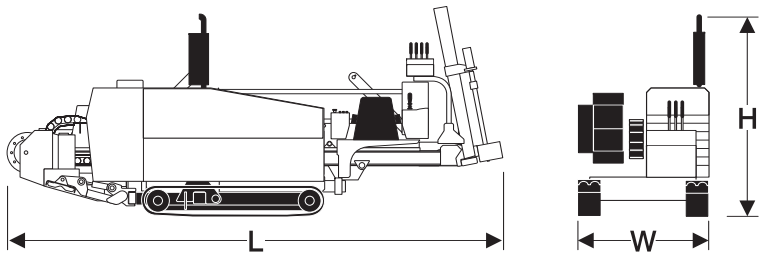
Voltage Test

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 LCD and lights above display on strike system.
 - all lights should turn on
 - horn and strobe should turn on
 - voltage "V" should show 90-130%

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

SPECIFICATIONS

DRILLING UNIT



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Dimensions		U.S.	Metric
Length		200 in	5.1 m
Height		86 in	2.2 m
Width		54 in	1.4 m
Operating weight	with 40 lined drill pipe, pipe loader, anchoring system and anchors	10, 500 lb	4763 kg
Drill pipe		U.S.	Metric
Length		118.1 in	3 m
Joint diameter		2.5 in	64 mm
Tubing diameter		2.1 in	52 mm
Min. bend radius		130 ft	40 m
Weight (lined)		64 lb	29 kg

Operational		U.S.	Metric
Spindle	Speed	0-200 rpm	0-200 rpm
	Torque	1800 ft•lb	2440N•m
Carriage speed		130 fpm	40 mpm
Thrust		17,000 lb	7710 kg
Pullback		17,000 lb	7710 kg
Bore diameter		3-5 in	76-127 mm
Backreamed diameter		soil dependent	
Ground drive speed	forward	0-2 mph	0-3.2 km/h
	reverse	0-2 mph	0-3.2 km/h
Engine		U.S.	Metric
Engine: John Deere model #4045D			
Fuel: diesel			
Cooling medium: liquid			
Aspiration: natural			
Number of cylinders: 4			
Displacement		276 cu in	4.5 L
Bore		4.19 in	106 mm
Stroke		5 in	127 mm
Gross power @2500 rpm		85 hp	63 kW
Maximum governed speed (no load)		2500 rpm	2500 rpm
Operating power @ 2500 rpm		76 hp	57 kW

Hydraulic system		U.S.	Metric
Flow rate	Thrust/auxiliary pump	7 gpm	26 L/min
	Rotation/ground drive pump	45 gpm	170 L/min
	Drilling fluid pump	12 gpm	45 L/min
Relief setting	Thrust/auxiliary pump	3000 psi	210 bar
	Rotation/ground drive pump	3000 psi	210 bar
	Drilling fluid pump	2500 psi	170 bar
Fluid capacities		U.S.	Metric
Fuel tank		33 gal	125 L
Hydraulic reservoir		20 gal	76 L
Engine oil with filter		9 qt	8.5 L
Drilling fluid system (onboard)		U.S.	Metric
Fluid pressure		1250 psi	86 bar
Flow rate (variable)		0-18 gpm	0-68.1 L/min
Fluid pressure		700 psi	48 bar
Flow rate (variable)		0-25 gpm	0-94.6 L/min
Battery			
SAE reserve capacity 120 min, SAE cold crank @ 0° F (-18° C) 800 amps			

Noise Level:

Operator: 85 dbA sound pressure per ISO 6394.

Exterior: 106 dbA sound power per ISO 6393.

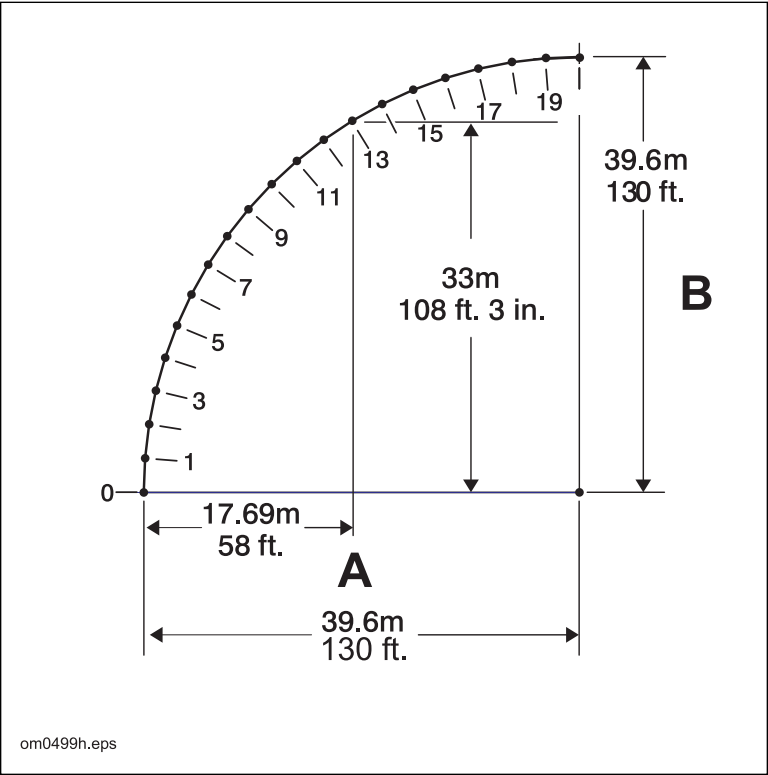
APPENDIX

A. BEND LIMITS

Turns in the bore path should be made gradually. All Ditch Witch pipes have recommended bend limits. JT1720 drill pipes have a tested bend radius of 130' (39.6 m), meaning a 90 degree bend requires 130' (39.6 m) of forward distance and approximately 204' (62.2 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 % changes in pitch with 1-2' of pipe create sharp bends and will damage pipe.

Bending pipe tighter than recommended limits will over-stress pipe and cause damage that cannot be seen. This damage adds up and can later lead to sudden pipe failure. Use the following charts to keep bends within safe limits.

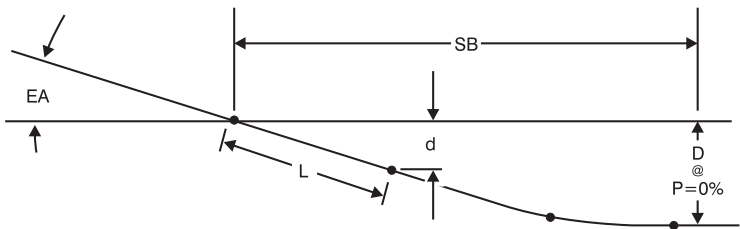


See table on next page for lateral (A) and forward (B) dimensions.

Pipe No.	U.S.		Metric	
	Forward (B)	Lateral (A)	Forward (B)	Lateral (A)
1	9 ft 10 in	0 ft 5 in	3 m	.1 m
2	19 ft 7 in	1 ft 6 in	6 m	.5 m
3	29 ft 3 in	3 ft 4 in	8.9 m	1 m
4	38 ft 9 in	5 ft 11 in	11.8 m	1.8 m
5	48 ft 0 in	9 ft 3 in	14.6 m	2.8 m
6	57 ft 0 in	13 ft 2 in	17.4 m	4 m
7	65 ft 9 in	17 ft 10 in	20 m	5.4 m
8	74 ft 0 in	23 ft 2 in	22.6 m	7 m
9	81 ft 11 in	29 ft 0 in	25 m	8.8 m
10	89 ft 3 in	35 ft 6 in	27.2 m	10.8 m
11	96 ft 2 in	42 ft 7 in	29.3 m	13 m
12	102 ft 6 in	50 ft 0 in	31.2 m	15.3 m
13	108 ft 3 in	58 ft 0 in	33 m	17.7 m
14	113 ft 5 in	66 ft 5 in	34.6 m	20.3 m
15	117 ft 11 in	75 ft 2 in	35.9 m	22.9 m
16	121 ft 8 in	84 ft 3 in	37.1 m	25.7 m
17	124 ft 10 in	93 ft 7 in	38 m	28.5 m
18	127 ft 2 in	103 ft 2 in	38.8 m	31.4 m
19	128 ft 10 in	112 ft 10 in	39.3 m	34.4 m
20	129 ft 10 in	122 ft 8 in	39.6 m	37.4 m
21	130 ft 0 in	130 ft 0 in	39.6 m	39.6 m
Dimensions given at minimum bend radius--130 ft (39.6 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	33 ft 4 in (10.16 m)	1 ft 7 in (.48 m)	4 ft 1 in (1.25 m)
-22	35 ft 9 in (10.90 m)	1 ft 9 in (.52 m)	4 ft 9 in (1.45 m)
-24	38 ft 1 in (11.62 m)	1 ft 10 in (.57 m)	5 ft 6 in (1.66 m)
-26	40 ft 5 in (12.33 m)	2 ft 0 in (.61 m)	6 ft 2 in (1.89 m)
-28	42 ft 9 in (13.03 m)	2 ft 2 in (.66 m)	7 ft 0 in (2.13 m)
-30	45 ft 0 in (13.72 m)	2 ft 4 in (.70 m)	7 ft 9 in (2.37 m)
-32	47 ft 3 in (14.40 m)	2 ft 5 in (.74 m)	8 ft 7 in (2.63 m)

Based on:
1. 130' (39.6 m) minimum bend radius.
2. L=Beacon housing, EZ-Connect, and transition sub, and 1/3 of first drill pipe (totalling 8' 0" [2.4 m]) in the ground before steering.

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.**

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
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

D. NOZZLE FLOW

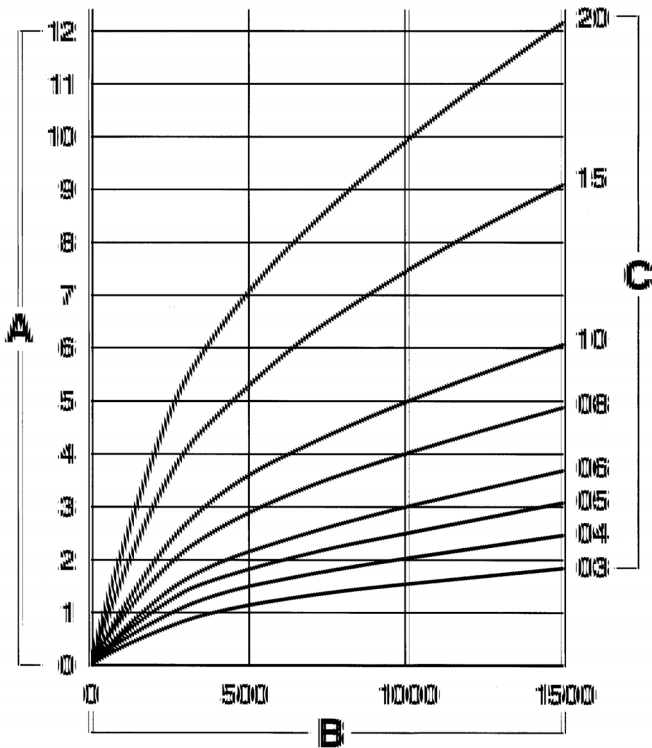
Select nozzles that will supply **at least** the amount of fluid per minute needed for the flow and pressure you will be using. A nozzle that will supply more fluid per minute is recommended.

U.S. Nozzle Flow

A - Flow per nozzle, gallons/minute

B - Nozzle pressure, psi

C - Nozzle size

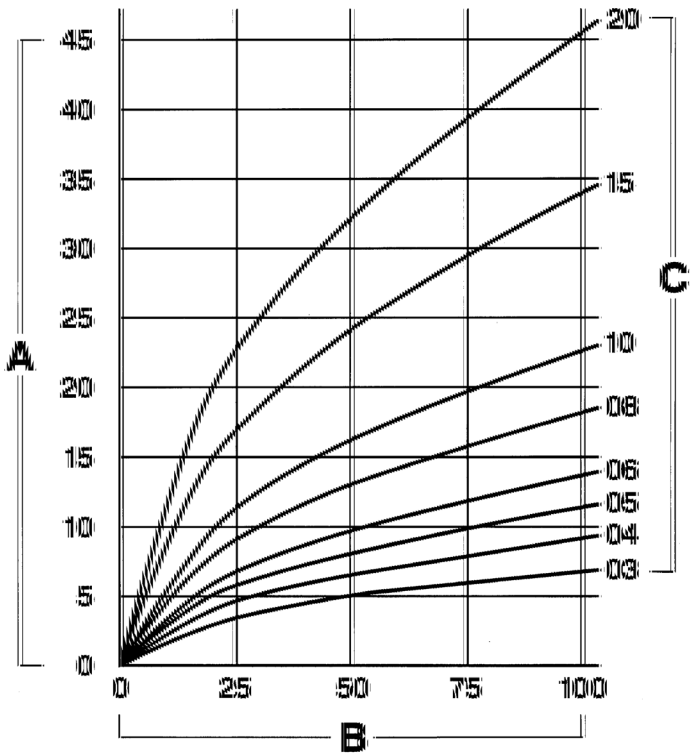


Metric Nozzle Flow

A - Flow per nozzle, liters/minute

B - Nozzle pressure, bar

C - Nozzle size



WARRANTY

Ditch Witch Equipment and Replacement Parts North American* Limited Warranty Policy

Major Component Limited Warranty

Major components are warranted for a period of 1000 hours of use or one year, whichever occurs first, beginning on date of delivery of any such new product. The Major Component Limited Warranty covers only Major Components listed under Major Component Limited Warranty that are manufactured and distributed by The Charles Machine Works, Inc. ("CMW"). Replacement parts and other serial numbered products ("Products") that are not listed under Major Component Limited Warranty, and non-major components are covered under Product Limited Warranty.

Major Components are defined as:

- Frames.
- Differentials and parts contained within.
- Mechanical transmissions.
- Drive gearboxes and parts contained within.
- Hydraulic, hydrostatic, and fluid pumps, motors and components that control or protect pumps and motors.
- Auxiliary hydraulic control valves and electrical components used for controlling hydraulic components.
- Hydraulic cylinders and components excluding repair kits.
- Batteries, alternators, instruments, gauges, and protection components for electrical systems.
- Pierce Arrow bodies, strikers, and tailpieces.

Free replacement parts and labor will be provided at any authorized dealership for any part of Major Component which has a defect in material or workmanship within warranty period. Defects will be determined by an inspection of major component or part by CMW or its authorized dealer. The product containing a major component or part must be presented to CMW or its authorized dealer for inspection within 30 days of the date major component or part fails. CMW will provide the location of its inspection facilities or its nearest authorized dealer upon inquiry. CMW reserves the right to supply remanufactured replacement parts as it deems appropriate.

* Equipment owners in countries other than U.S., Canada, Mexico, and Puerto Rico should refer to Ditch Witch International Warranty Policy.

Product Limited Warranty

Products are warranted for 90 days from date of delivery of any new product. Free replacement parts and labor will be provided at any authorized dealership for any product which has a defect in material or workmanship within warranty period. Replacement parts are warranted for 90 days from date of delivery of any such replacement part. Any part of a product subject to ground contact is warranted only for defects in material or workmanship and only for the period of operational life of such part, which period shall not in any event exceed 90 days. Defects will be determined by an inspection of the product or part by CMW or its authorized dealer. The product or part must be presented to CMW or its authorized dealer for inspection within 30 days of the date of failure. CMW will provide the location of its inspection facilities or its nearest authorized dealer upon inquiry. CMW reserves the right to supply remanufactured replacement parts as it deems appropriate.

Exclusions

from Major Component and Product Limited Warranty

Specifically excluded from Major Component and Product Limited Warranty are:

- Transportation charges related to repair, replacement, or inspection of products, major components, or parts.
- Parts subject to ground contact (including but not limited to drill pipe, downhole tools, digging chain, teeth and sprockets).
- 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).
- 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.

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.

This limited warranty applies to the owner of the product. 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 owner specific legal rights and the 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 revision: 4/99

**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.

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

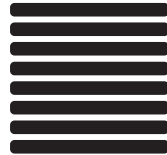


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Model

Serial Number

Attachments/Accessories

Serial Numbers

Attachments/Accessories

Serial Numbers

Attachments/Accessories

Serial Numbers

Name of Ditch Witch Dealership

Your Signature

