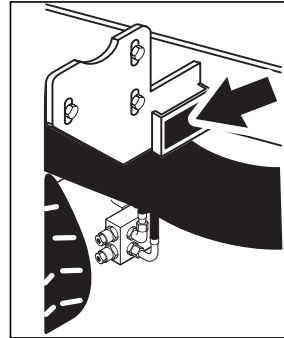


SERVICE

SERIAL NUMBER

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



om0115c.eps

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

SUPPORT PROCEDURE

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

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

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

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

RESOURCES

Publications

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

Ditch Witch Training Center

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

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 JT920/JT920L

Issue No.6.0/OP-4/11
Part Number 054-509

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



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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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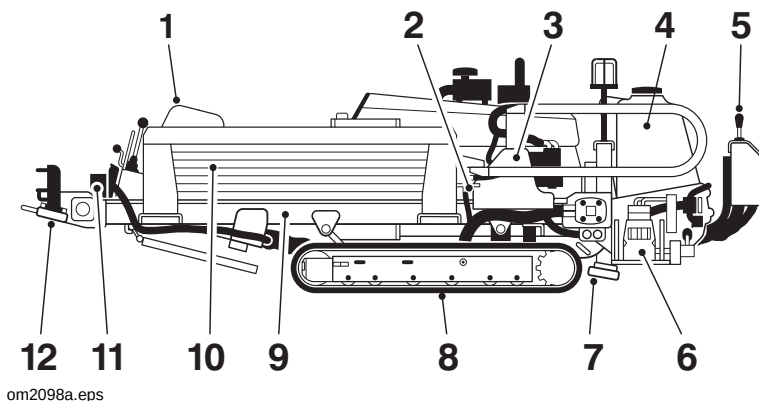
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OVERVIEW

The **JT920** directional drilling unit can be connected to a fluid unit by only one electric line and one fluid hose, or it can have an optional drilling fluid tank mounted directly on the drilling unit.

The JT920 features rubber tracks, simple, precise controls and gauges, and an onboard drilling fluid system. Options include fluid tank, anchoring systems, and remote fluid systems.

Although the JT920 directional drilling unit was designed to provide one-unit drilling, it is compatible with Ditch Witch drilling fluid units. Downhole tools are compatible with Subsite beacons.

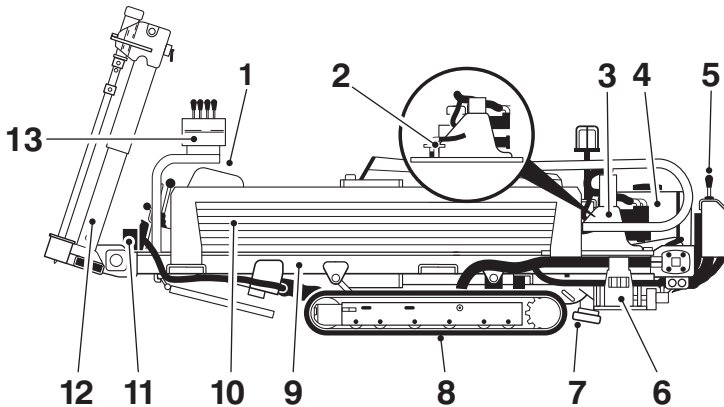


- | | |
|--------------------------|-----------------------|
| 1. Operator station | 7. Rear stabilizer |
| 2. Spindle | 8. Tracks |
| 3. Carriage | 9. Frame |
| 4. Drilling fluid tank | 10. Drill pipe box |
| 5. Set-up/drive controls | 11. Front wrench |
| 6. Drilling fluid pump | 12. Stake mount plate |

The **JT920L** directional drilling unit is a self-contained unit that can be connected to a fluid unit with only one electric line and one fluid hose.

The JT920L features rubber tracks, genuine Ditch Witch pipe, a pipe loader and pipe box, onboard anchoring system, onboard fluid system, cold start kit, and simple, precise controls. Optional equipment includes a Subsite 750 Display that can be mounted beside the control console.

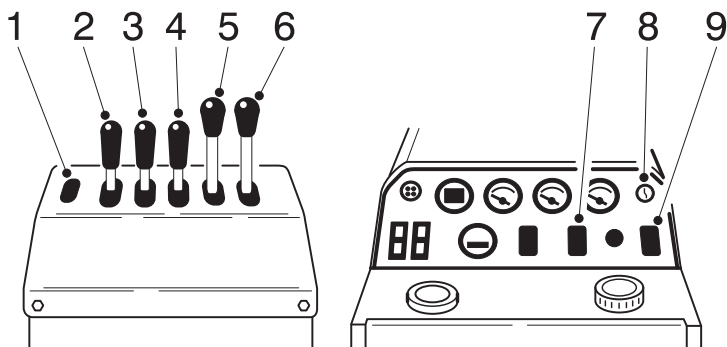
The JT920L directional drilling unit can be used with Ditch Witch drilling fluid units and Subsite locating equipment.



- | | |
|--------------------------|------------------------|
| 1. Operator station | 8. Tracks |
| 2. Spindle | 9. Frame |
| 3. Carriage | 10. Drill pipe box |
| 4. Water tank | 11. Front wrench |
| 5. Set-up/drive controls | 12. Anchoring system |
| 6. Drilling fluid pump | 13. Anchoring controls |
| 7. Rear stabilizer | |

CONTROLS

SETUP CONSOLE OVERVIEW



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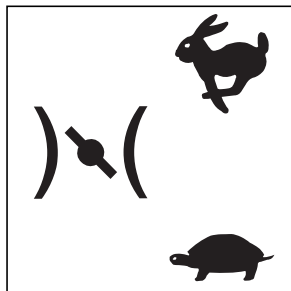
1. Throttle switch
2. Track width control (JT920 only)
3. Stabilizer lift control
4. Frame tilt control
5. Left track control
6. Right track control
7. Autobore select switch
8. Ignition switch
9. Cold start switch

SETUP CONSOLE DESCRIPTIONS

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.



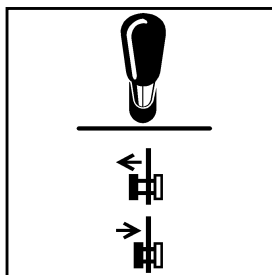
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Track Width Control (JT920 only)

This lever controls track width by moving left track toward or away from right track.

IMPORTANT: Lower drill frame and rear stabilizer to raise tracks off ground before adjusting track.

- Push to move left track out.
- Pull to move left track in.

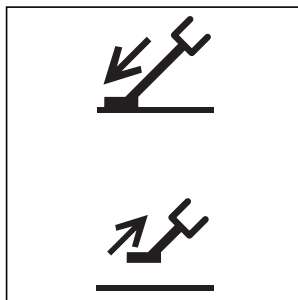


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Stabilizer Lift Control

This lever controls rear stabilizer.

- Push to lower.
- Pull to raise.

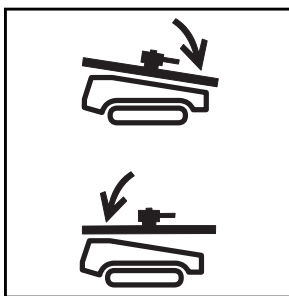


ic0054c.eps

Frame Tilt Control

This lever raises or lowers drill frame.

- Push to lower.
- Pull to raise.

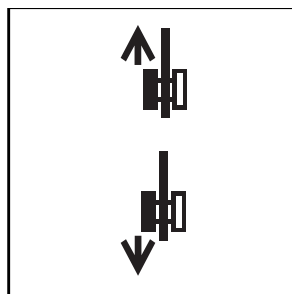


ic0056c.eps

Left Track Control

This lever controls speed and direction of left track.

- Push to move forward.
- Pull to move backward.
- Move to center to stop.

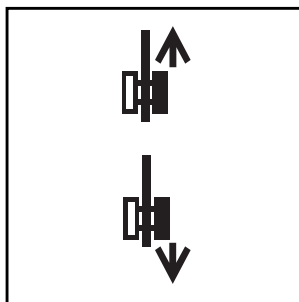


ic0143h.eps

Right Track Control

This lever controls speed and direction of right track.

- Push to move forward.
- Pull to move backward.
- Move to center to stop.



ic0142h.eps

Autobore Select Switch

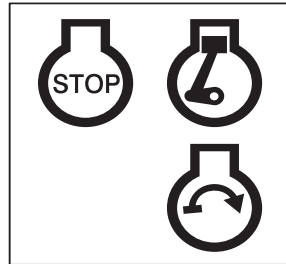
This switch selects between autobore and manual modes.

- Press top for autobore control.
- Press bottom for manual control.

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.

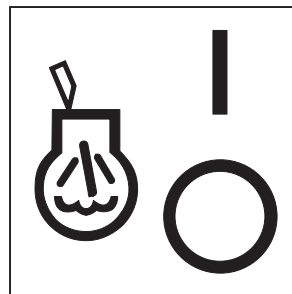


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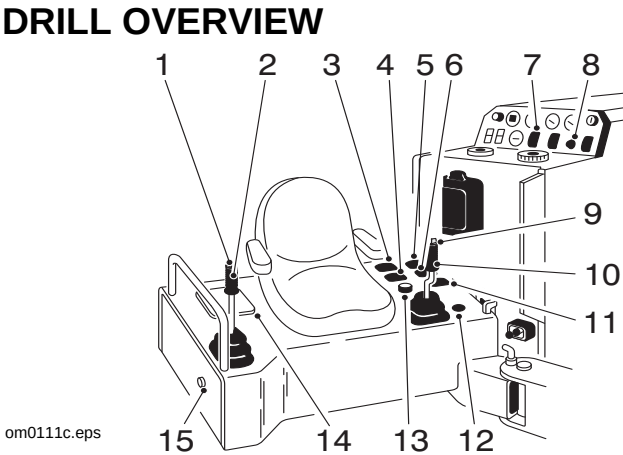
Cold Start Switch

This optional switch helps start cold engine.

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



ic0137h.eps



1. Fluid pump switch
2. Spindle control
3. Pipe lift switch (JT920L only)
4. Pipe shuttle switch (JT920L only)
5. Pipe autoloader selector (JT920L only)
6. Auxiliary wrench switch
7. Fluid source selector switch
8. Remote start switch
9. Throttle switch
10. Wrench control
11. Remote throttle switch
12. Remote engine stop switch
13. Fluid flow control
14. ESID *
15. Remote display mounting bracket

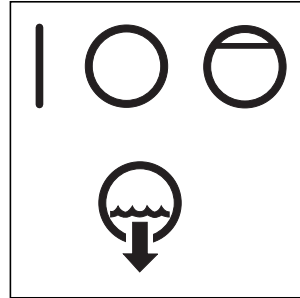
* called out later in chapter

DRILL DESCRIPTIONS

Fluid Pump Switch

This switch controls fluid pump.

- Press left to turn on.
- Move to center position to turn off.
- Press right for full pump flow to fill pipe with fluid. Switch will return to center when released.



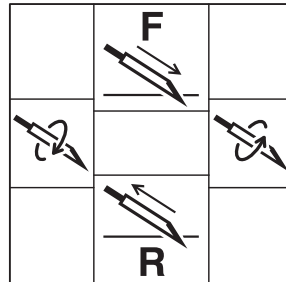
ic0059c.eps

Spindle Control

This lever controls thrust direction and rotation.

Pull or push to control thrust direction.

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



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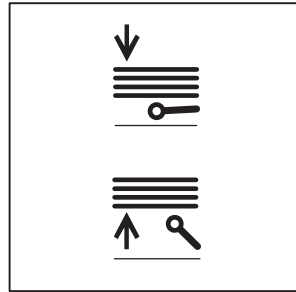
Move to right or left to control rotation.

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

Pipe Lift Switch (JT920L only)

This switch raises and lowers all rows in pipe box.

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

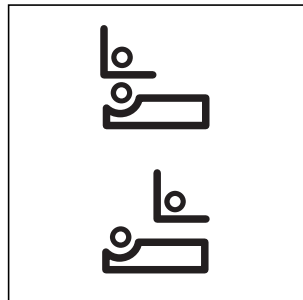


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Pipe Shuttle Switch (JT920L only)

This switch moves shuttle to and from pipe box.

- Press top to move toward pipe box.
- Press bottom to move away from pipe box.

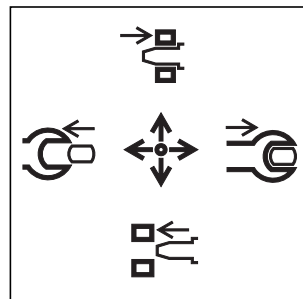


ic1280a.eps

Pipe Autoload Selector (JT920L only)

This switch selects pipe autoload function.

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

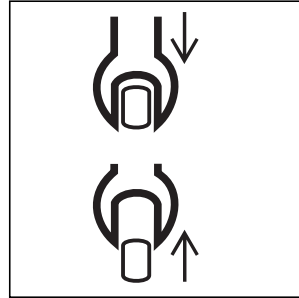


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Auxiliary Wrench Switch

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

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

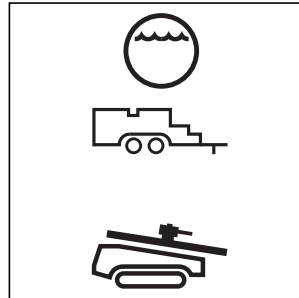


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Fluid Source Selector Switch

This switch selects fluid source.

- Press top to use remote fluid system.
- Press bottom to use on-board fluid system.



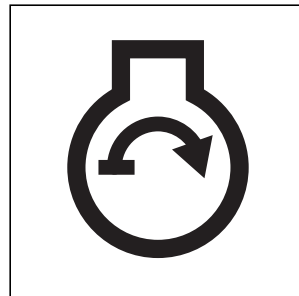
ic0048c.eps

Remote Start Switch

This button starts remote fluid unit from drilling unit.

- Push switch.
- Release when engine starts.

This button only works when ignition switch on fluid unit is on.



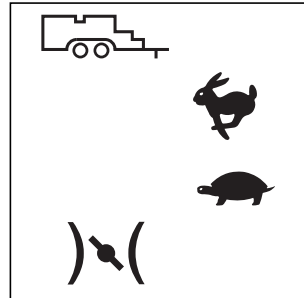
ic1272a.eps

Throttle Switch

This switch controls remote fluid unit engine speed.

- Press top to run engine at maximum speed.
- Press bottom to run engine at idle speed.

This switch only works when fluid unit throttle switch is in idle position.



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Wrench Control

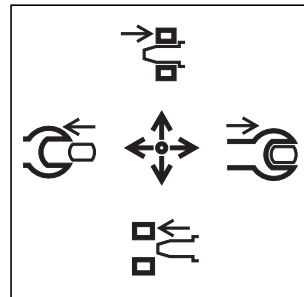
This lever controls front wrench (near pipe guide) and back wrench (at spindle).

Pull or push lever to control back wrench.

- Pull to release pipe.
- Push to lock onto pipe flats.

Move lever to right or left to control front wrench.

- Move right to lock onto pipe flats.
- Move left to release pipe.



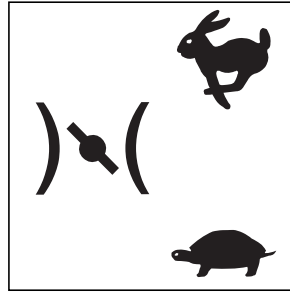
ic1057c.eps

Remote Throttle Switch

This switch controls engine speed during drilling and backreaming.

- Press top to increase speed.
- Press bottom to decrease speed.

This switch only works if throttle switch is in neutral position.

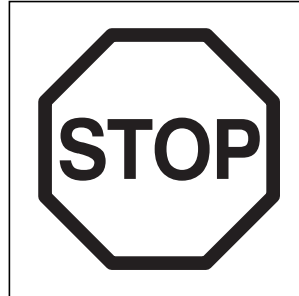


ic0136h.eps

Remote Engine Stop Switch

This button stops drilling unit and remote fluid unit (if used) engines from operator station.

- Press red button on operator's station to stop engine(s).
- Use ignition or remote restart switch(es) to restart engine(s).

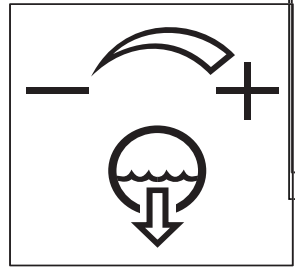


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Fluid Flow Control

This knob adjusts drilling fluid flow from zero to maximum.

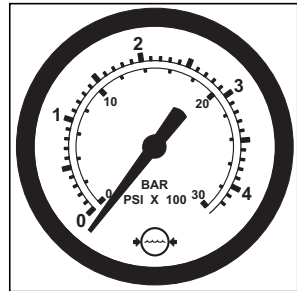
- Turn clockwise to increase flow.
- Turn counterclockwise to decrease flow.



ic1289a.eps

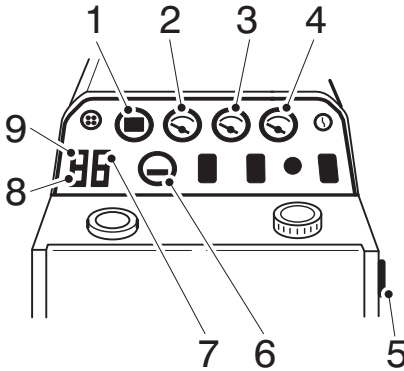
Fluid Pressure Gauge

This gauge displays drilling fluid system pressure.



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GAUGES AND INDICATORS OVERVIEW



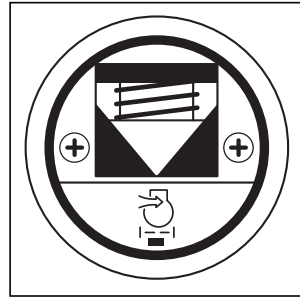
om2095a.eps

1. Air filter service indicator
2. Fuel gauge
3. Voltmeter
4. Engine temperature gauge
5. Hydraulic oil sight glass
6. Hourmeter
7. Hydraulic oil filter service indicator
8. Hydraulic oil temperature indicator
9. Engine oil pressure indicator

GAUGES AND INDICATORS DESCRIPTIONS

Air Filter Service Indicator

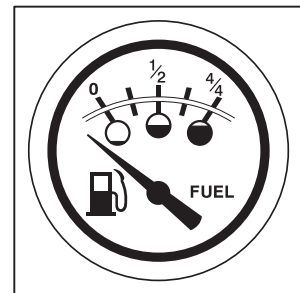
This gauge shows level of vacuum in air filter. Change air filter when yellow band reaches red line. Reset after replacing filter.



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Fuel Gauge

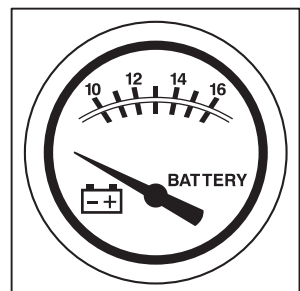
This gauge indicates fuel level in tank. Use only diesel fuel. Tank holds 33 gal (125 L).



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Voltmeter

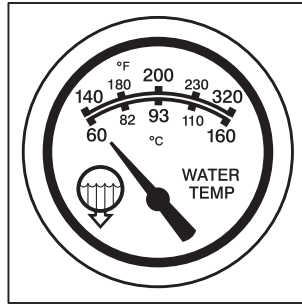
This gauge measures voltage in electric system. Reading should be 13 volts with engine running. If not, stop engine and investigate.



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Engine Temperature Gauge

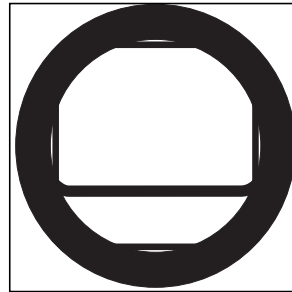
This gauge displays engine coolant temperature.



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Hydraulic Oil Sight Glass

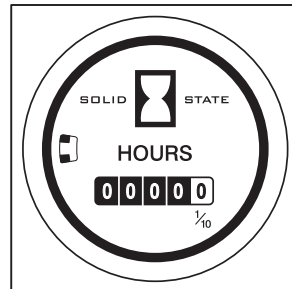
This indicator shows level of hydraulic oil in reservoir. Fluid should be slightly visible in glass when oil is cool.



om1675c.eps

Hourmeter

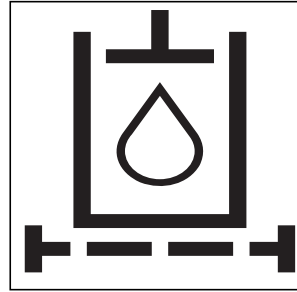
This gauge records engine operating time. Use these times to schedule lubrication and maintenance.



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Hydraulic Oil Filter Service Indicator

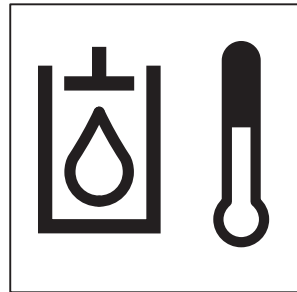
This indicator lights if hydraulic oil pressure is too high.



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Hydraulic Oil Temperature Indicator

This indicator lights if hydraulic oil overheats.



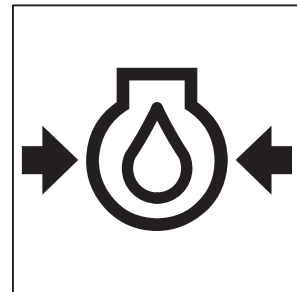
ic1295a.eps

Engine Oil Pressure Indicator

This light glows, horn sounds, and engine shuts down if oil pressure is too low.

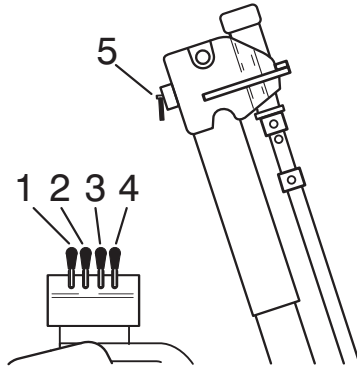
If indicator lights and sounds:

- turn unit off,
- check engine oil level, and
- check for leaks.



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ANCHORING SYSTEM CONSOLE OVERVIEW



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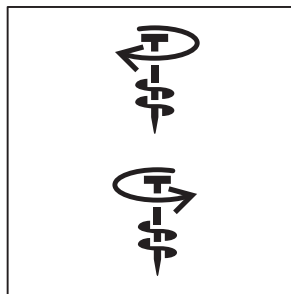
1. Left rotation control
2. Left thrust control
3. Right rotation control
4. Right thrust control
5. Anchor slide locks

ANCHORING SYSTEM CONSOLE DESCRIPTIONS

Left Rotation Control

This lever controls rotation of left anchor.

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

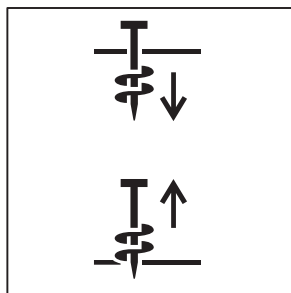


ic0140h.eps

Left Thrust Control

This lever controls thrust of left anchor.

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

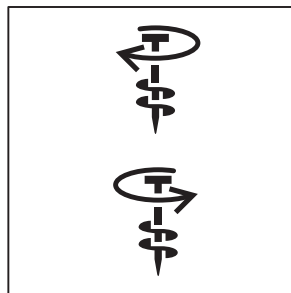


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Right Rotation Control

This lever controls rotation of right anchor.

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

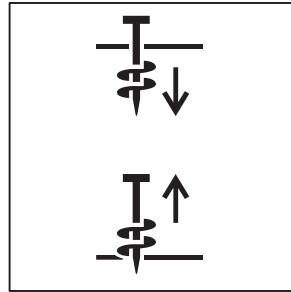


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Right Thrust Control

This lever controls thrust of right anchor.

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

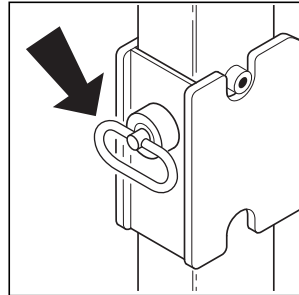


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Anchor Slide Locks

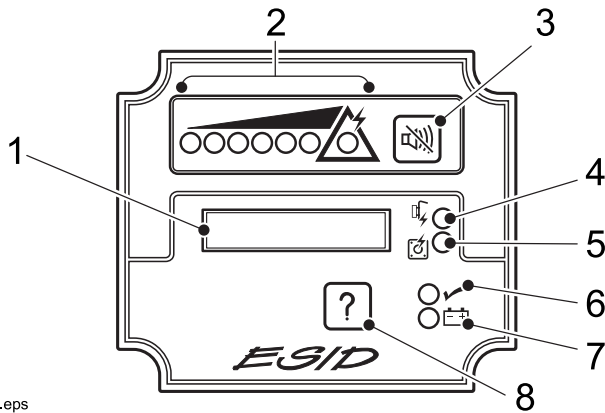
These knobs lock and unlock anchor driver into hole in center of anchor frame.

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



om2165a.eps

ESID OVERVIEW



Om0203c.eps

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

ESID DESCRIPTIONS

Alphanumeric Display

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

This area also displays error codes (see "Troubleshoot 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 Strike System" in **MAINTENANCE**.

Current Problem Indicator

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

OK Indicator

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

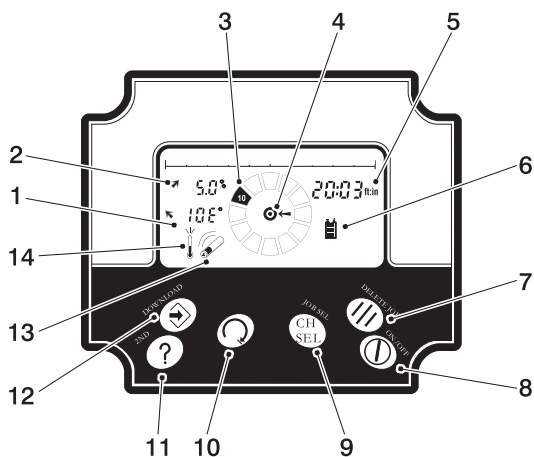
Electrical Power Supply Indicator

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

Self Test Button

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

SUBSITE 750 DISPLAY OVERVIEW



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

SUBSITE 750 DISPLAY 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).

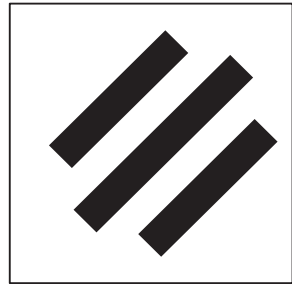
Beacon Temperature Indicator

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.



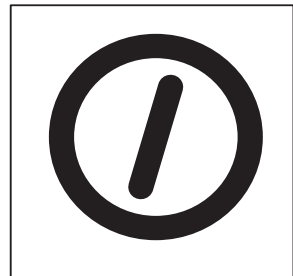
si1055a.eps

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.



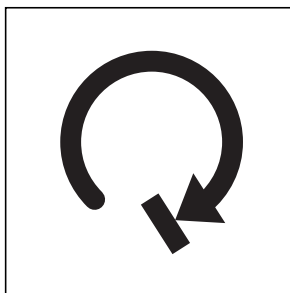
si1058a.eps

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.

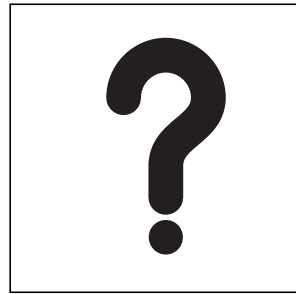


si1069a.eps

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.



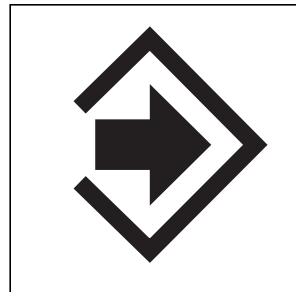
si1066a.eps

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

Store Button

This button allows operator to store currently displayed data.

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



si1064a.eps

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

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 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, use one or both of these methods.

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

Natural Gas Jobsite Precautions

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

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

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.

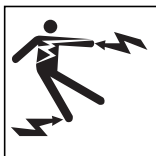
IMPORTANT can help you do a better job or make your job easier in some way.

SAFETY ALERTS



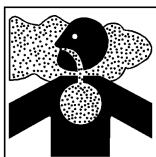
⚠ DANGER

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



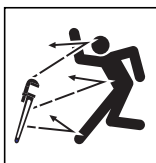
⚠ DANGER

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



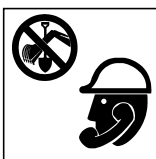
⚠ WARNING

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**

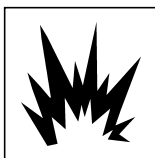
Jobsite hazards could cause death or serious injury. Use correct equipment and work methods. Use and maintain proper safety equipment.

**⚠ WARNING**

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

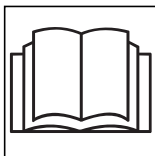
**⚠ WARNING**

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



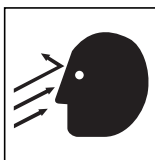
⚠ WARNING

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**

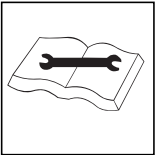
Fire or explosion possible. Fumes could ignite and cause burns. No smoking, no flame, no spark.

**⚠ 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.

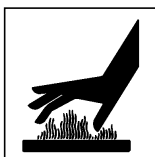
**⚠ WARNING**

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 bore enlargement during backreaming and pullback into account. Check for information about existing or planned structures, elevations, or proposed work that may be taking place at the same time.

One-Call Services

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

Pullback Material

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

Traffic Control

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

Emergency Services

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

INSPECT SITE

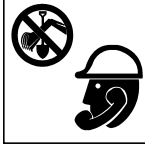
Inspect jobsite before transporting equipment. Check for the following:

- 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 setup, bending pipe, and fluid flow out of hole.

Traffic

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

Space

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

Check that there is enough space to work and to set up electric strike system.

Comfort

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

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

PLAN BORE PATH

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

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

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

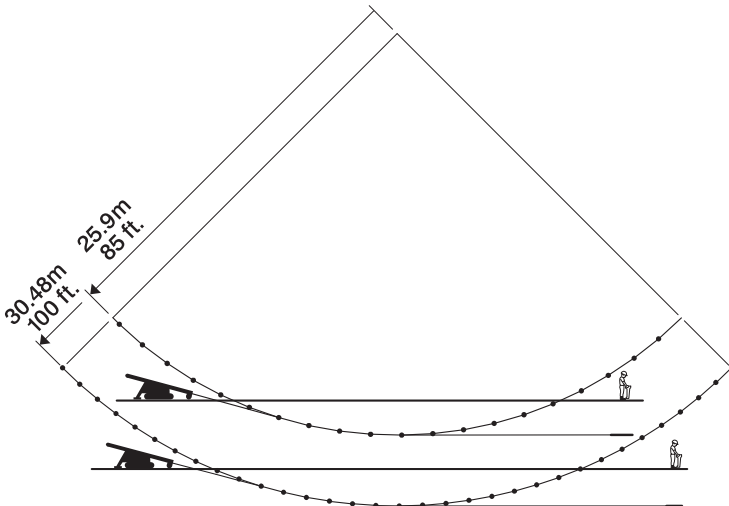
Recommended Bend Limit

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.

JT920 drill pipes have a tested bend radius of 85' (25.9 m), meaning a 90 degree bend, whether during entry and exit or when turning, requires 85' (25.9 m) of forward distance and approximately 134' (40.8 m) of pipe. Use **APPENDIX**, sections A and B, to keep bends within safe limits and make sure pitch changes no more than 7% per pipe.

JT920L drill pipes have a tested bend radius of 100' (30 m), meaning a 90 degree bend, whether during entry and exit or when turning, requires 100' (30 m) of forward distance and approximately 160' (48 m) of pipe. Use **APPENDIX**, sections A and B, to keep bends within safe limits and make sure pitch changes no more than 9% per pipe.

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

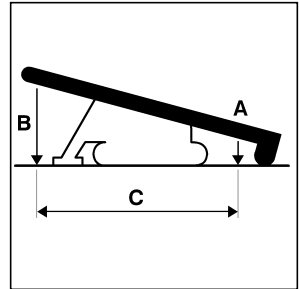


Entry Pitch

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

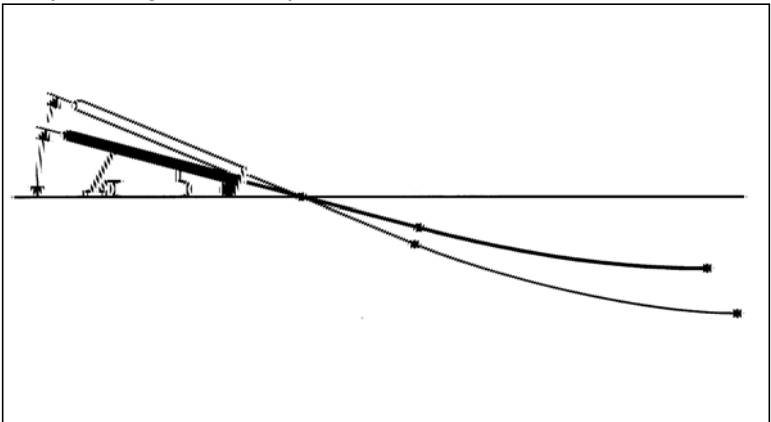
Entry pitch can be determined two ways:

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



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

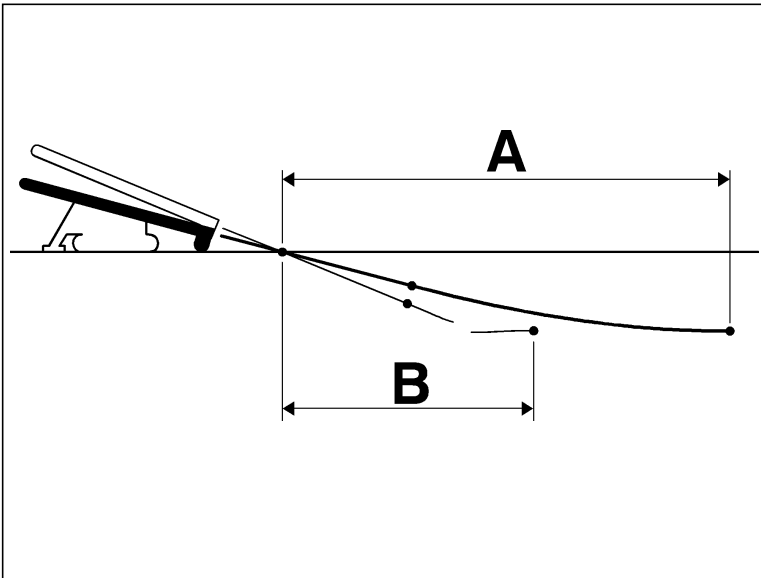
3. A shallow entry pitch allows you to reach horizontal sooner and with less bending. Increasing entry pitch makes bore path longer and deeper.



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.



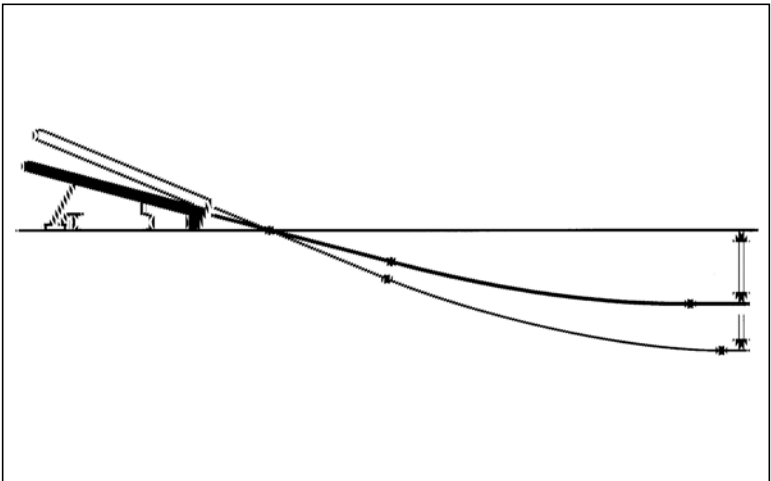
A. Proper setback B. Setback too small

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 spare batteries
- Beacons with new and spare batteries
- Two-way radios with new and spare batteries
- Quick wrench
- EZ-Connect/transition sub
- Anchoring equipment and accessories
- Bits, screens, nozzles
- Adapters, pipe, beacon housings
- Marking flags or paint
- Water and additional hoses
- Fuel
- Drilling fluid additives
- Fuses
- Keys
- Backreamers, swivels, pulling devices
- Washdown hose and spray gun
- Duct tape
- Spray lubricant
- Tool joint compound
- 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
- Drilling fluid 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.
- All vegetation near operator's station must be removed. Contact with trees, shrubs, or weeds during electrical strike could result in electrocution.

Mark Bore Path

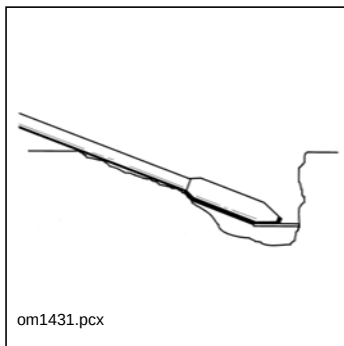
Mark your planned bore path and all located utility lines with flags or paint.

Prepare Entry Point

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

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

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



RECORD BORE PATH

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

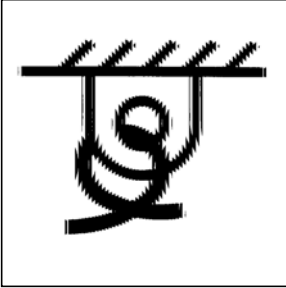
The Subsite Trac Management System is also available for plotting and tracking your bore path. It utilizes the Subsite 750 Tracker, 750 Display, a tracking beacon, and special software. The system can be run in the field using a laptop computer equipped with the Windows[®] 95 or higher operating system.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

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.

TIEDOWN

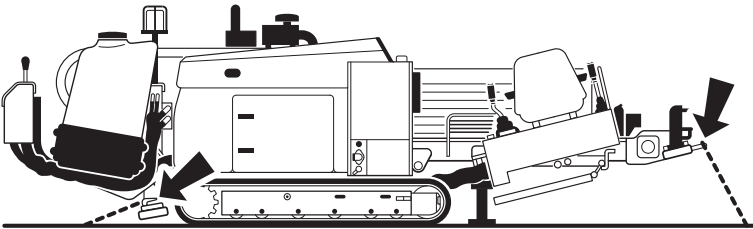


Points

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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HAUL



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. 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

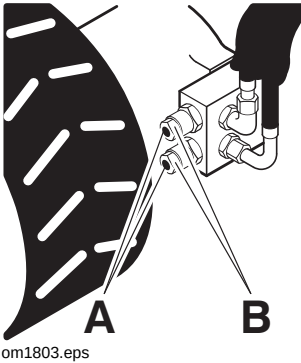
1. Lower trailer or ramps.
2. Start engine.
3. Remove tiedowns.
4. Raise stabilizers.
5. Use track controls to slowly back unit down trailer or ramps.

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 indicated tow points facing towing vehicle.
- Use maximum towing force of 1.5 times unit weight.
- Disengage power to tracks.

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



To disengage track hydraulics:

1. Loosen locknut (B).
2. Turn screw (A) on each counterbalance valve clockwise until it stops.

IMPORTANT: 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.

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 ESID control module, strike system includes bonding cables, barriers and protective boots and gloves. Boots and gloves must meet the following standards:

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

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

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

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

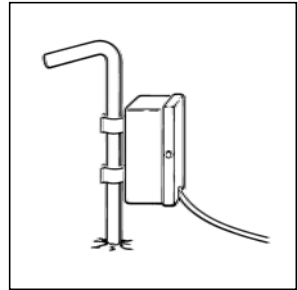
FCC Statement

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

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

Assemble Voltage Detector

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



Test Strike System

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

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

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

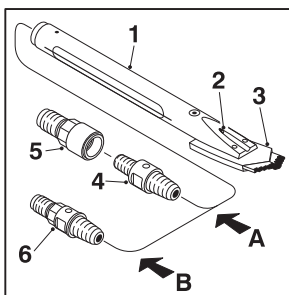
NOTICES:

- 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 STRING

Select Nozzle and Bit

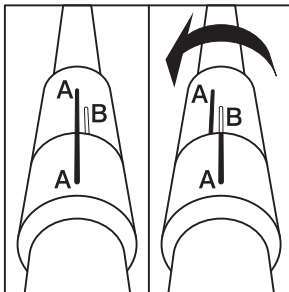
1. Select nozzles and bit. A variety of nozzles and bits are available to suit your particular job conditions. See **APPENDIX**, section D, for information about nozzles. Contact your Ditch Witch dealer for more information.
2. Insert nozzle (2) into beacon housing (1).
3. Attach bit (3) to beacon housing.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



Scribe Line Technique

EZ-Connect uses scribe line technique to achieve proper torque.

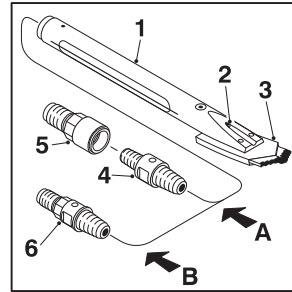
1. Remove all slack from wrench and joint.
2. Scribe straight line across joint on both sides of separating line (A).
3. Scribe second line (B) on moveable side of joint in the opposite direction of tightening action 3/8 in (9.5 mm) away from first line.
4. Turn handle to tighten joint until second line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



Attach EZ-Connect

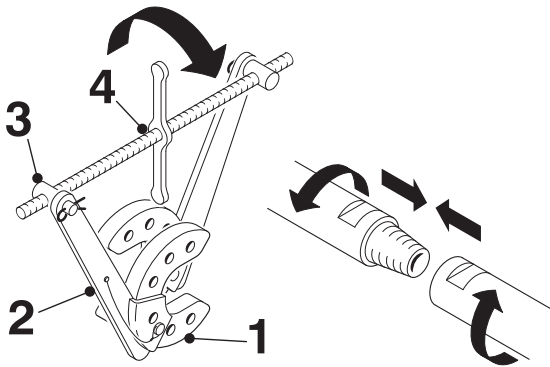
Option A

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



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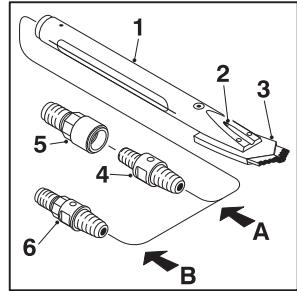
2. Attach quick wrench in joint position.



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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 joint position.
7. Tighten joint using scribe line 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 joint position.
3. Tighten joint using scribe line 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 pin is in row 1 on lower rear of pipe loader frame.
 - 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 until pipe falls into shuttle.
 - Move carriage forward until front end of pipe is aligned with transition sub male thread.
5. Use machine power to slowly rotate spindle and drill pipe onto transition sub male thread.
6. Tighten to full machine torque.
7. Disengage front wrench and move carriage back to top of frame.
8. Turn off engine.

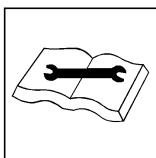
Engage EZ-Connect

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 tool head EZ-Connect pin into EZ-Connect box until shoulders are touching.
4. Back tool head off one flat and slide collar onto pin until retainer bolt hole is visible.
5. Install retainer bolt and tighten.

OPERATION

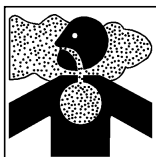
START SYSTEM

This section covers basic operation. For questions about specific situations, contact your Ditch Witch dealer.



⚠ WARNING

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

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

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



⚠ WARNING

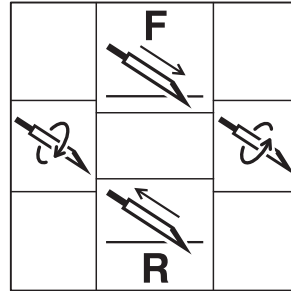
Crushing weight. If load falls or moves, it could kill or crush you. Use proper procedures and equipment or stay away.

NOTICE: Anchor drilling unit properly before drilling.

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

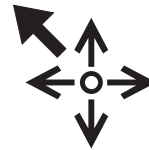
OPERATE THRUST/ROTATION CONTROL

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.



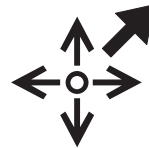
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Moves carriage forward
Rotates pipe clockwise (makeup)



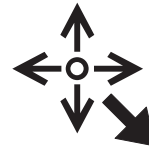
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Moves carriage forward
Rotates pipe counterclockwise (breakout)



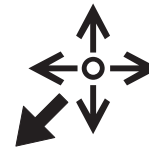
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Moves carriage backward
Rotates pipe counterclockwise (breakout)



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Moves carriage backward
Rotates pipe clockwise (makeup)



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1. Start drilling unit and remote fluid unit, if used. If using onboard drilling fluid tank, remove hose from top of tank. Allow both engines to warm up.

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

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.

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 slowly move carriage back as threads unscrew.

IMPORTANT: Move carriage back only after threads have unscrewed completely to protect threads.

5. Stop rotation and 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.
- Use loader shuttle switch to move pipe to spindle.

IMPORTANT: Ensure that automatic pipe thread lubricator is functioning. 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 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 until pipe screws together.
- Rotate joint slowly until spindle stops turning.
- Lift pipe.
- Use loader shuttle switch to move shuttle under selected row.
- Lower pipe into shuttle (JT920L only).

4. Press top of drilling unit throttle switch until engine is at full throttle.
5. 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.
6. Rotate spindle clockwise, full speed.
7. Move carriage forward slowly. Adjust rotation speed control according to bit size and soil conditions.
8. Locate drill head at least every half-length of pipe.

Option B: Use Autoload Function (JT920L only)

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

NOTICE: Do not attempt to use manual pipeloader controls with pipe autoload selector in drill 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 drill mode and restart cycle.

3. Close front wrench.
4. 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.

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

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

6. Connect new pipe.
 - Slowly move carriage forward and rotate spindle until pipe screws together.
 - Rotate joint slowly until spindle stops turning.
7. Open front wrench. Shuttles will retract and pipe lift arms will lower.

8. Press top of drilling unit throttle switch until engine is at full throttle.
9. 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.
10. Rotate spindle clockwise, full speed.
11. Move carriage forward slowly. Adjust rotation speed control according to bit size and soil conditions.
12. 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.

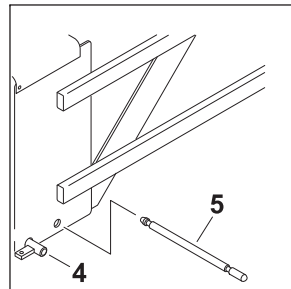
Use hoist capable of supporting the equipment's size and weight. See **SPECIFICATIONS** or measure and weigh equipment before lifting.

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.

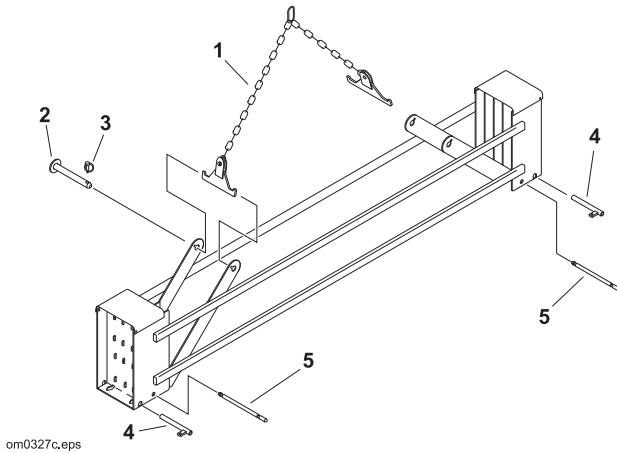
Prepare

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.

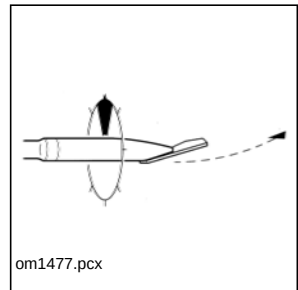
Corrections are made by tracking the drill head, comparing current position to bore plan, and steering drill head as needed.

Basic rules to consider when correcting are:

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

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

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



To position drill head:

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

To change direction:

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

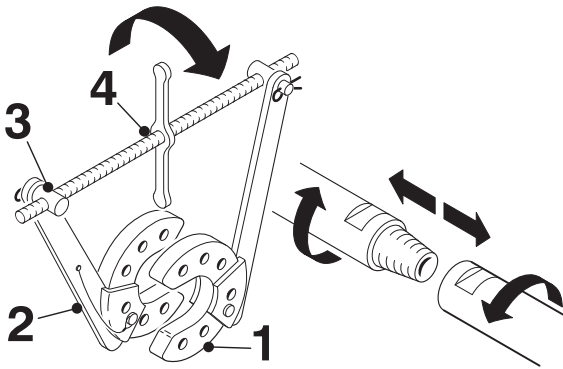
To move forward without changing direction:

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

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.
4. Clean drill head especially around threads.
5. Attach quick wrench in break position.

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



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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.
6. Loosen joint.
 7. Turn screw opposite way two turns to relieve pressure and remove quick wrench components.
 8. Remove drill head.

ASSEMBLE BACKREAM STRING

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

Backreaming Procedure

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



⚠ DANGER

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

NOTICE: Keep everyone away from material being installed.



⚠ WARNING

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



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 and install appropriate nozzles to provide sufficient flow.
3. Attach pullback devices.
4. Press top of drilling unit throttle switch until engine is at full throttle.
5. Set drilling fluid flow.
6. Check that fluid flows through all nozzles.
7. Pull pipe through bore.

Backreaming Tips

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

Select Pullback Devices

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

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

Determine Fluid Requirements

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

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

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

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

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

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

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

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

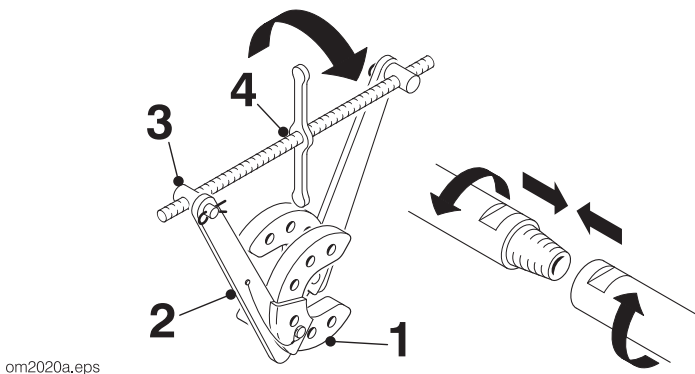
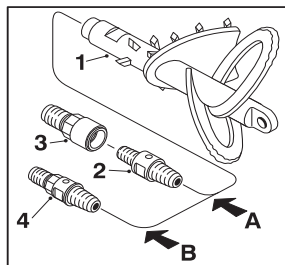
4. Estimate pressure you will be using.
5. Using **APPENDIX**, section C, select nozzles that, added together, supply at least the amount of fluid per minute needed for the flow and pressure you will be using. A combination of nozzles that will supply more fluid per minute is recommended.

Attach 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 join position.

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



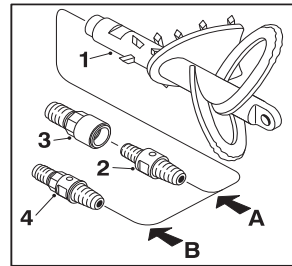
- Place jaws (1) on wrench flats on both sides of joint.
- Pin handles (2) to wrench jaws. Be sure handles are both up.
- Attach pivoting nut heads (3) so that screw (4) is over joint.
- Turn screw to pull handles together.

3. Tighten joint using scribe line technique to achieve proper preload.
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.
8. Turn screw opposite way two turns to relieve pressure and remove quick wrench components.

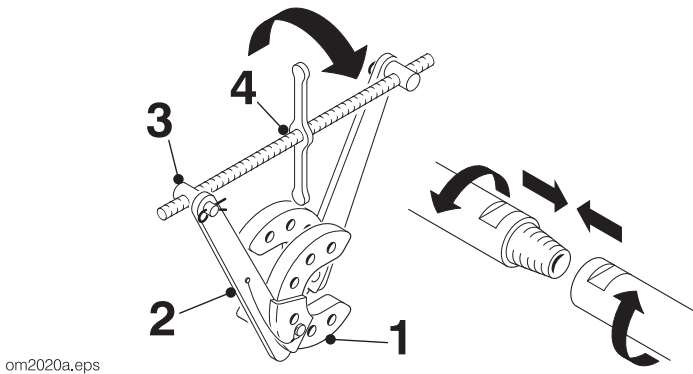
Option B

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

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



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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 using scribe line technique to achieve proper preload.
 4. Turn screw opposite way two turns to relieve pressure and remove quick wrench components.

Attach 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. 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.

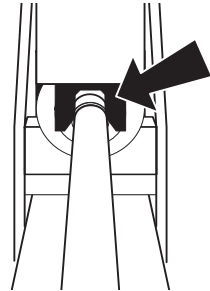
REMOVE PIPE

Option A: Use Manual Pipeloader Controls

1. When pipe joint is between front wrench and pipe wiper, release joystick.
2. Engage front wrench.
3. 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 (JT920L only).

8. Rotate pipe counterclockwise to unscrew bottom joint.
9. Disengage breakout wrench to release pipe.
10. 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 (JT920L only).
13. Attach next pipe to saver sub.
 - 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. Joint should only be tight enough to prevent leaking.
14. Disengage front wrench to release pipe.

Option B: Use Autoload Function (JT920L only)

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

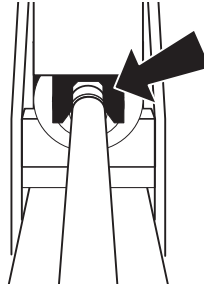
NOTICE: Do not attempt to use manual pipeloader controls with pipe autoload selector in backream mode. If pipeloading is interrupted:

- 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.
3. Move carriage back until pipe joint is between front wrench and pipe wiper.
 4. Release joystick.
 5. Engage front wrench. Shuttles will extend and pipe lift arms will lower.
 6. Rotate spindle clockwise until wrench flats engage into pipe flats.

7. 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.



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

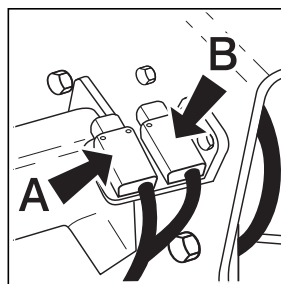
16. Move carriage to back of drill frame. Pipe will automatically be loaded into selected row in pipe box.



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

IMPORTANT: If shuttles do not retract, pipe may not be positioned correctly.

- Adjust pipe so that both lights (A, B) are on.
- Press pipe shuttle switch to manually retract shuttles. This will restart the automation cycle.



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17. Attach next pipe to saver sub.

- 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. Joint should only be tight enough to prevent leaking.

18. Disengage front wrench to release pipe.

REMOVE 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.

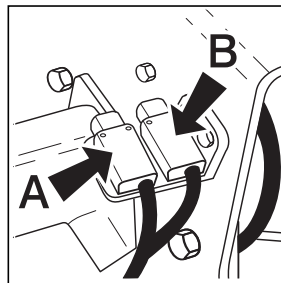
TROUBLESHOOT AUTOMATION

Drill Mode

The most common reason for pipeloader automation cycle interruption in this mode is incorrectly positioned or dirty photoelectric eyes or reflective tape.

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

- Adjust or clean photoelectric eyes or tape so that pipe OK light (B) is on.
- Press pipe shuttle switch to manually extend shuttles. This will restart automation cycle.



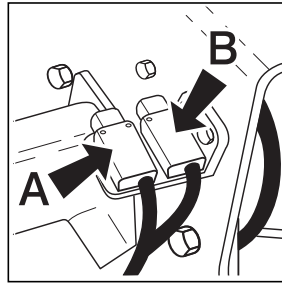
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Backream Mode

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 pipe bad light (A) is off and pipe OK light (B) is on.
- Press pipe shuttle switch to manually retract shuttles. This will restart automation cycle.



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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

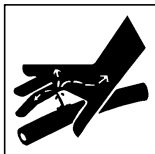
Disconnect and store the following hoses and cables:

- electric cable,
- electric strike system ground stake,
- fluid hose (if used).

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:

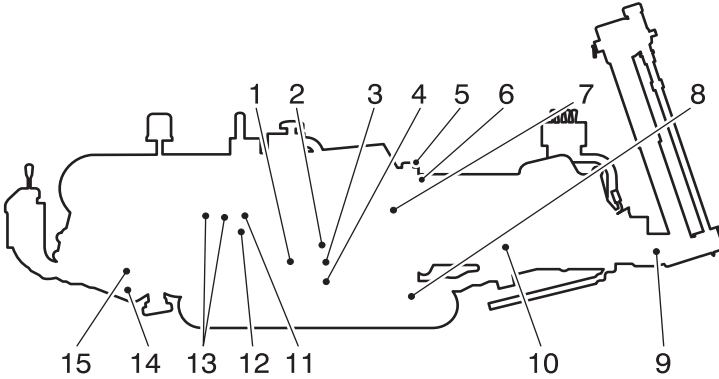
- Before using system, check that all connections are tight and all lines are undamaged.
- Fluid leaks can be hard to detect. Use a piece of cardboard or wood, rather than hands, to search for leaks.
- Wear protective clothing and eye protection.
- If you are injured, seek immediate medical attention.



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.

DRILLING UNIT



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Reference	Hours	Description	Lubricant	Points
13	4	Lube water swivel	MPG	2
1, 2, 3	10	Check engine oil	DEO	1
5, 6, 8		Check hydraulic oil	THF	1
1, 2, 3, 4	50	Change engine oil (initial)	DEO	1
7		Change hydraulic oil filter (initial)		
10		Lube thrust chain	DEO	
15		Check drilling fluid pump oil	30W	1
11, 12		Check rotation gearbox oil	MPL	
1, 2, 3, 4		Change engine oil	DEO	
7		Change hydraulic oil filter		
9		Lube flange bearings	MPG	2
14, 15	750	Change drilling fluid pump oil	30W	1
5, 6, 8	1000	Change hydraulic oil	THF	1
11, 12		Change rotation gearbox oil	MPL	1
	as needed	Lube pipe loader shuttle slide	MPG	1
		Change pipe auto lubricator tube	TJC	1

Lubricant chart:

MPG	Multipurpose grease
DEO	Diesel engine oil
MPL	Multipurpose gear oil (SAE 80W90) meeting API service classification GL-5
THF	Tractor Hydraulic Fluid: Phillips 66 HG Fluid, Mobilfluid 423, Chevron Tractor Hydraulic Fluid, Texaco TDH Oil, or equivalent
TJC	Tool joint compound: standard or summer grade

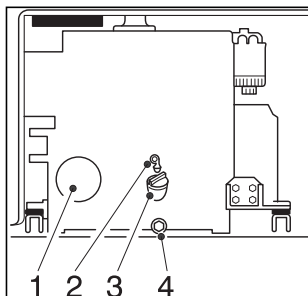
Engine Oil

Check

Check oil every 10 hours at dipstick (2). If low, refill with DEO at fill (3).

Change

Change oil after first 50 hours. After that, change oil every 100 hours. Open drain (4), change filter (1) and refill with DEO.

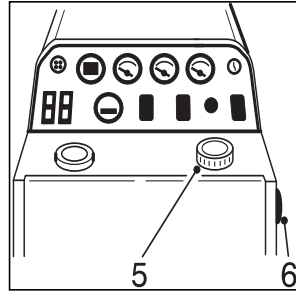


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Hydraulic Oil

Check

Check oil every 10 hours. Maintain fluid level at halfway point on sight glass (6) when engine is off and fluid is cool. Refill with THF at hydraulic oil fill (5).

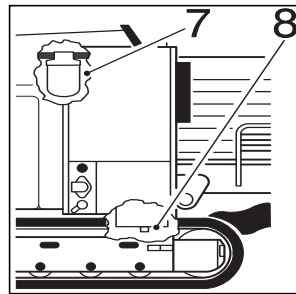


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Change

Change oil filter at 50 hours and every 250 hours thereafter. Change filter sooner if indicated by filter indicator.

Drain hydraulic oil (8), change filter (7), and refill with THF every 1000 hours. Change oil and filter every 500 hours if jobsite temperature exceeds 100°F (38°C) more than 50% of the time.

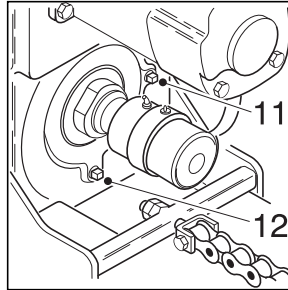


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Frame and Carriage

Rotation Gearbox

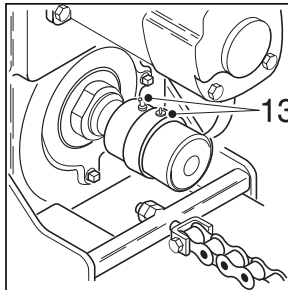
Check gearbox every 50 hours. Oil should be level with fill plug (11). Fill with MPL as needed. Drain oil at gearbox oil drain (12) every 1000 hours.



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Water Swivel

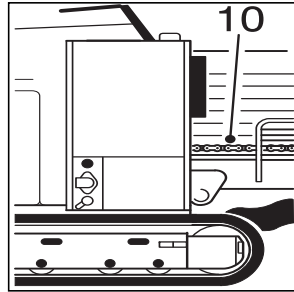
Lube fittings (13) with one stroke of molybdenum based MPG every four hours. Using more than one stroke of grease gun can lead to seal failure.



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Thrust Chain

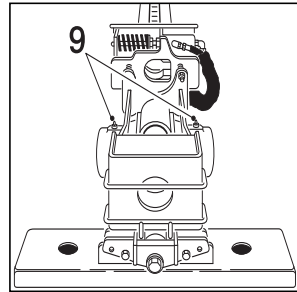
Lube thrust chain (10) with DEO or chain lubricant every 50 hours.



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Flange Bearings

Lube flange bearings (9) with MPG every 250 hours.



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Pipe Loader Shuttle Slide

Lube shuttle slide as needed with MPG.

Pipe Auto Lubricator

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

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

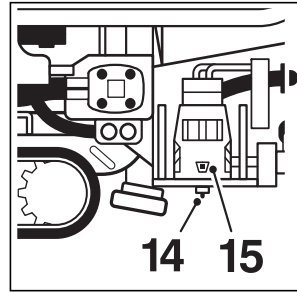
Check pipe auto lubricator tubes approximately every four boxes of pipe. Change tube when handle is all the way inside cartridge.

To change:

1. Pull lock handle back.
2. Unscrew cartridge.
3. Release handle to push tube out.
4. Pull handle lock.
5. Remove caps and insert new tube of TJC.
6. Screw cartridge in.
7. Release handle.
8. Unscrew cartridge 2-3 turns.
9. Watch for grease to come out of weep hole.
10. Screw cartridge back in when grease comes out of hole.

DRILLING FLUID PUMP

Check oil level (15) in crankcase every 50 hours. Refill (15) as needed with SAE 30W engine oil. Drain (14) and refill crankcase every 750 hours. Pump holds 1 qt (.9 L). See pump manufacturer's handbook for additional information.



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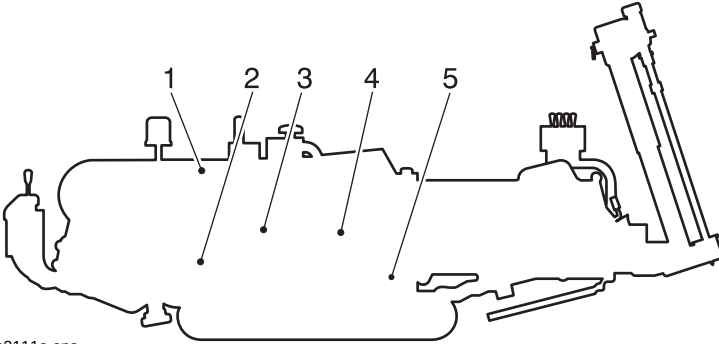
MAINTENANCE

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

OVERVIEW

Hours	Task	Page number
10	inspect hoses	130
50	check battery	131
	check alternator belt	131
	clean radiator	133
	check thrust chain tension	137
250	check track tension and condition	136
1000	change fuel filter	135
as needed	check muffler	135
	replace saver sub	132
	check pipe loader gripper inserts	132
	check pipe loader shuttle inserts	132
	change air filter	134
	clean pipe	140
	repair pipe threads	140
	troubleshoot Electric Strike System	141

GENERAL COMPONENTS



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Ref	Task	Hours
n/a	inspect hoses	10
5	check battery	50
3	check alternator belt	50
1, 2	clean radiator	50
4	replace saver sub	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.

Inspect Hoses

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

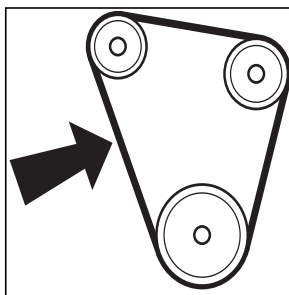
Battery

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

Keep battery clean and free of corrosion. Apply coat of grease to cable clamps after cleaning. In cold weather, battery loses some starting ability. Closely watch voltmeter for signs of battery discharge. If battery will not hold charge, see your Ditch Witch dealer for replacement battery.

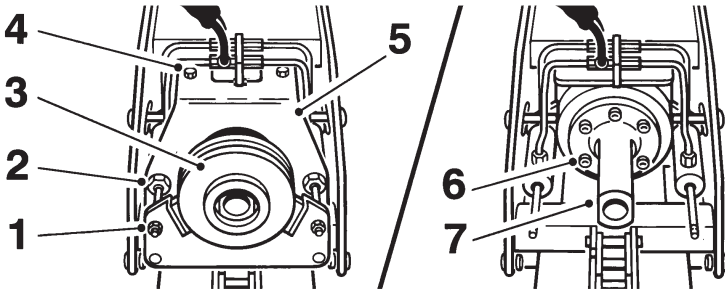
Alternator Belt

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).



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Saver Sub

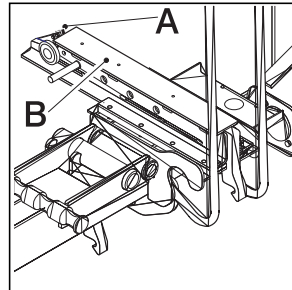


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Remove saver sub as needed. To remove, smooth end of sub with file and remove two nuts (1). Remove wrench collar (3). Then remove two nuts (2) on rod end of cylinders. Remove bolts (4) and shield (5). Remove six screws (6) and saver sub (7).

Pipe Loader

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



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Radiator

Check radiator for dirt, grass, and other foreign matter every 25 hours. Check more often if operating in dusty or grassy conditions.

Clean out with compressed air or spray wash every 50 hours. Be careful not to damage fins with high pressure air or water.

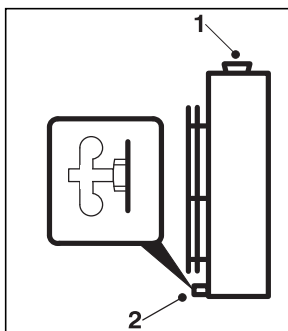
Check coolant level every 10 hours. Add only pre-mixed heavy duty low-silicate coolant containing Supplemental Coolant Additives (SCAs) (p/n 255-006) or equivalent coolant meeting ASTM specification D4985 and containing SCAs meeting John Deere specification JDM H24A2.

Check SCA level yearly or every 600 hours using 3-Way Heavy Duty Coolant Test Kit (p/n 256-032). If SCA levels do not fall within appropriate range, attach tube to drain plug and empty radiator. Refill with approved coolant (p/n 255-006).

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

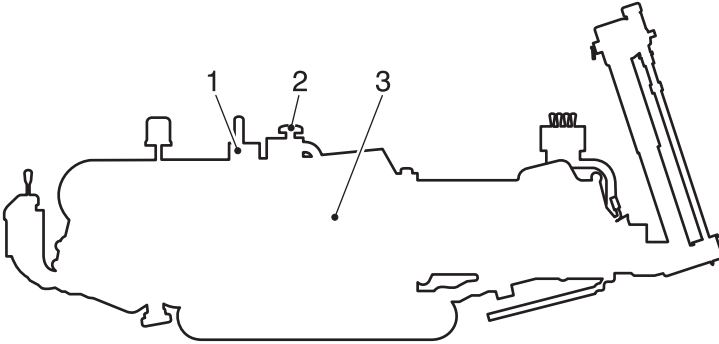
Flush cooling system and refill with approved coolant (p/n 255-006) every 2 years or 2000 hours. See lubrication and maintenance section of engine operator's manual for complete coolant maintenance information.

NOTICE: Do not use water or automotive-type coolant. This will lead to engine damage or premature engine failure and void John Deere engine warranty.



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FILTERS



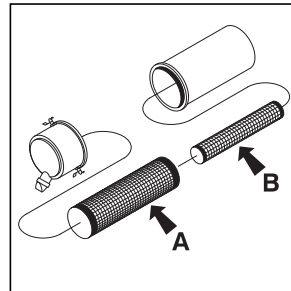
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Ref	Task	Hours
3	change fuel filter	1000
1	check muffler	as needed
2	change air filter	as needed

Air Filter

Change air filter when yellow band on air filter service indicator reaches red line. To change:

- Open air filter case.
- Remove paper element (A) and safety element (B).
- Wipe inside of housing and wash end cup.
- Insert new paper element.
- Close air filter case.
- Reset air filter service indicator.



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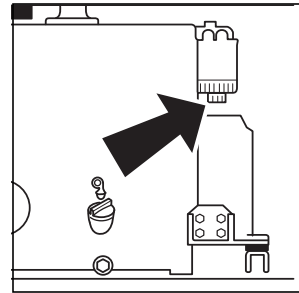
Muffler

Change muffler as needed.

Fuel Filter

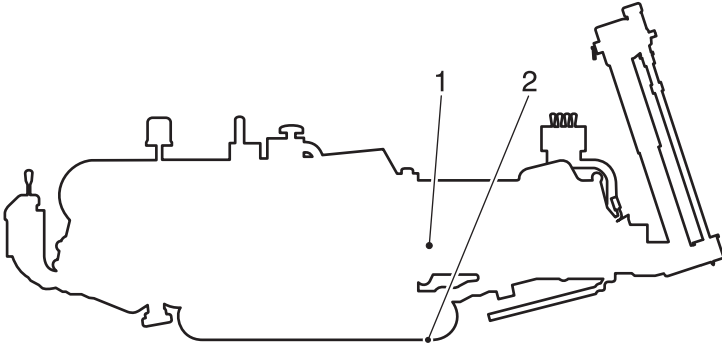
Replace fuel filter every 1000 hours. If you refuel from cans, replace filter more often. To remove:

1. Remove bolt at bottom of filter.
2. Remove cup and paper element.
3. Place new element into cup.
4. Position cup and bolt into place.



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POWER COMPONENTS

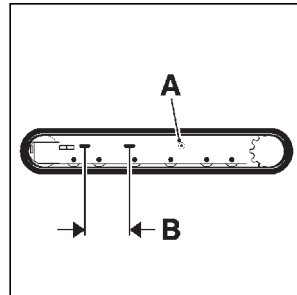


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Ref	Task	Hours
1	check thrust chain tension	as needed
2	check track tension and condition	as needed

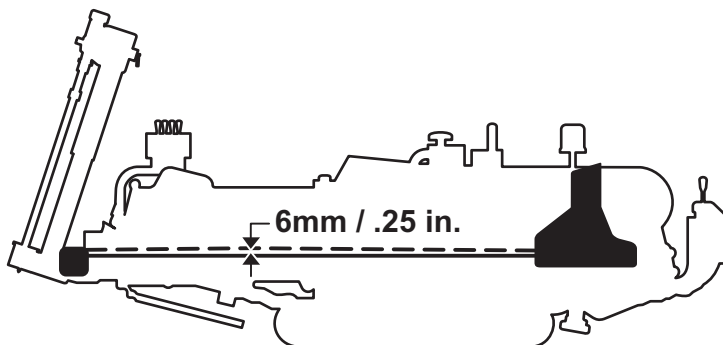
Track

Check track tension as needed. To adjust track tension, pump MPG into fitting (A) until dimension (B) is 15-15.5" (380-390 mm).



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Thrust Chain

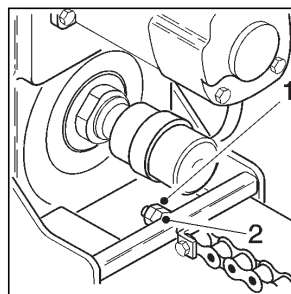


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Adjust thrust chain tension as needed.

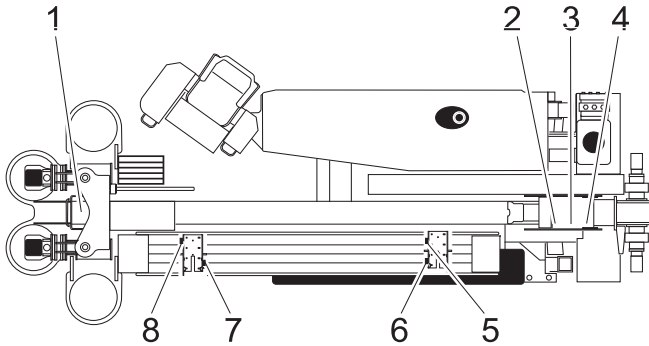
To adjust:

1. Move carriage to front of frame.
2. Loosen jam nut (1).
3. Turn nut (2) clockwise to tighten and counterclockwise to loosen chain. Chain is properly adjusted when bottom of chain is 1/4" (6 mm) above frame when pulled with approximately 20 lb (9 kg) of force.
4. Tighten jam nut against other nut after adjusting.



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PIPELOADER AUTOMATION



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Proximity Switches

Check six proximity switches daily.

- front wrench switch (1)
- rear shuttle retracted switch (2)
- rear shuttle extended switch (7)
- slow zone switch (4)
- stop zone switch (5)
- full back switch (6)

To check:

1. Turn drilling unit key to the on position. Do not start engine.
2. Place metal object in front of each switch.
3. If light on back of switch comes on, switch is functioning.

Photoelectric Eyes

Clean photoelectric eyes (8) and reflective tape with glass cleaner and clean cotton cloth daily. Use of other cleaners will damage lens. Check photoelectric eyes daily. To check:

1. Start drilling unit engine, angle drill frame down, and move carriage to back of frame. Turn ignition key back to on position. Engine should not be running.
2. At this position, green and red LED lights on back of eyes should be on.
3. If eye has toggle switch on back, check that it is in the LO position.

Row Select Pin

Check that row select pin (3) is installed properly. Pin should be pushed completely in and up against snap ring.

PIPE

Before pipe is used first time:

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

Each time pipe is used:

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

Cleaning Threads

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

TROUBLESHOOT STRIKE SYSTEM

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

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

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

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

USE ELECTRIC STRIKE SIMULATOR

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

Current Test

To test for current at normal levels:

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

To test for current at strike levels:

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

With two loops,

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

With three loops,

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

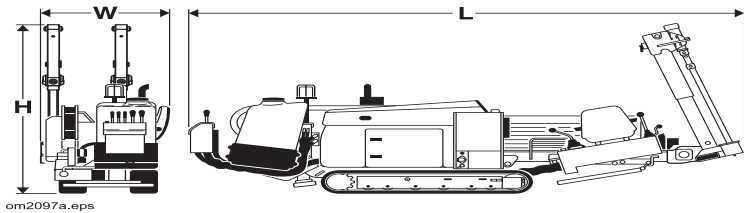
Voltage Test

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

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

SPECIFICATIONS

JT920



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Dimensions	U.S.	Metric
Length	200 in	5.1 m
Height	67.5 in	1.7 m
Width	36-50 in	0.9-1.3 m
Operating weight (empty water tank, fluid system, pipe box and 56 drill pipes)	7325 lb	3322 kg
Drill pipe	U.S.	Metric
Length	78.75 in	2 m
Joint diameter	2 in	50.8 mm
Tubing diameter	1.35 in	34.3 mm
Min. bend radius	85 ft	25.9 m

Operational		U.S.	Metric
Spindle	Speed	0-182 rpm	0-182 r/min
	Torque	1100 ft•lb	1491 N•m
Thrust		7800 lb	35 kN
Pullback		8600 lb	38 kN
Bore diameter		2.5-4 in	63-102 mm
Backream diameter (soil dependent)		12 in	305 mm
Ground drive speed	forward	0-1.8 mph	0-2.9 km/h
	reverse	0-1.8 mph	0-2.9 km/h
Engine		U.S.	Metric
Engine: Lister-Petter Turbo LPWT4			
Fuel: diesel			
Cooling medium: John Deere Cool-Gard 50/50 pre-mixed coolant			
Number of cylinders: 4			
Displacement		113.6 cu in	1.86 L
Bore		3.4 in	86 mm
Stroke		3.1 in	79 mm
Gross power @3000 rpm		55.4 hp	41.3 kW
Maximum governed speed (no load)		3000 rpm	3000 r/min
Operating power @ 2750 rpm		45 hp	33.6 kW

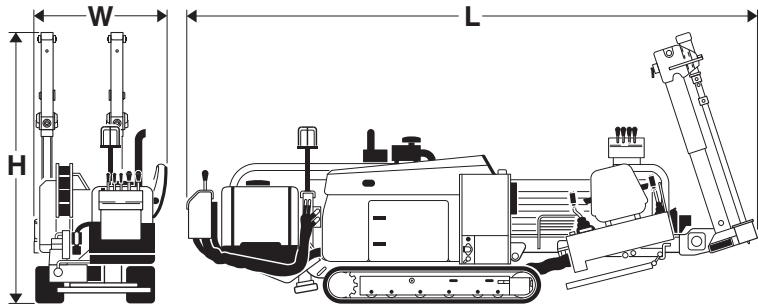
Hydraulic system	U.S.	Metric
Flow rate	36 gpm	121 L/min
Relief setting	2750 psi	190 bar
Fluid capacities	U.S.	Metric
Fuel tank	11.5 gal	43.5 L
Hydraulic reservoir	16.5 gal	62.5 L
Engine oil with filter	6 qt	5.7 L
Drilling fluid system (on-board)	U.S.	Metric
Fluid pressure	750 psi	52 bar
Flow rate (variable)	0-9 gpm	0-34 L/min
Battery		
SAE reserve capacity 120 min, SAE cold crank @ 0° F (-18° C) 800 amps		

Noise Level:

Operator 89 dBA sound pressure per ISO 6394.

Operator 106 dBA sound power per ISO 6393.

JT920L



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Dimensions	U.S.	Metric
Length	200 in	5.1 m
Height	87 in	2.2 m
Width	50 in	1.3 m
Operating weight	7560 lb	3430 kg
Drill pipe	U.S.	Metric
Length	120 in	3 m
Joint diameter	2 in	50.8 mm
Tubing diameter	1.625 in	41 mm
Min. bend radius	100 ft	30 m

Operational		U.S.	Metric
Spindle	Speed	0-182 rpm	0-182 r/min
	Torque	1100 ft•lb	1491 N•m
Thrust		7800 lb	35 kN
Pullback		8600 lb	38 kN
Bore diameter		2.5-4 in	63-102 mm
Backream diameter (soil dependent)		12 in	305 mm
Ground drive speed	forward	0-1.8 mph	0-2.9 km/h
	reverse	0-1.8 mph	0-2.9 km/h
Engine		U.S.	Metric
Engine: Lister-Petter Turbo LPWT4			
Fuel: diesel			
Cooling medium: John Deere Cool-Gard 50/50 pre-mixed coolant			
Number of cylinders: 4			
Displacement		113.6 cu in	1.86 L
Bore		3.4 in	86 mm
Stroke		3.1 in	79 mm
Gross power @3000 rpm		55.4 hp	41.3 kW
Maximum governed speed (no load)		3000 rpm	3000 r/min
Operating power @ 2750 rpm		45 hp	33.6 kW

Hydraulic system	U.S.	Metric
Flow rate	36 gpm	121 L/min
Relief setting	2750 psi	190 bar
Fluid capacities	U.S.	Metric
Fuel tank	11.5 gal	43.5 L
Hydraulic reservoir	16.5 gal	62.5 L
Engine oil with filter	6 qt	5.7 L
Drilling fluid system (on-board)	U.S.	Metric
Flow rate (variable)	13 gpm	49 L/min
Battery		
SAE reserve capacity 120 min, SAE cold crank @ 0° F (-18° C) 800 amps		

Noise Level:

Operator 89 dBA sound pressure per ISO 6394.

Operator 106 dBA sound power per ISO 6393.

APPENDIX

A. BEND LIMITS

JT920 Power Pipe Drill Pipe

Turns in the bore path should be made gradually. All Ditch Witch pipes have recommended bend limits. JT920 drill pipes have a tested bend radius of 105' (32 m), meaning a 90 degree bend requires 105' (32 m) of forward distance and approximately 165' (50.3 m) of pipe. Make sure pitch changes no more than 6% per pipe.

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

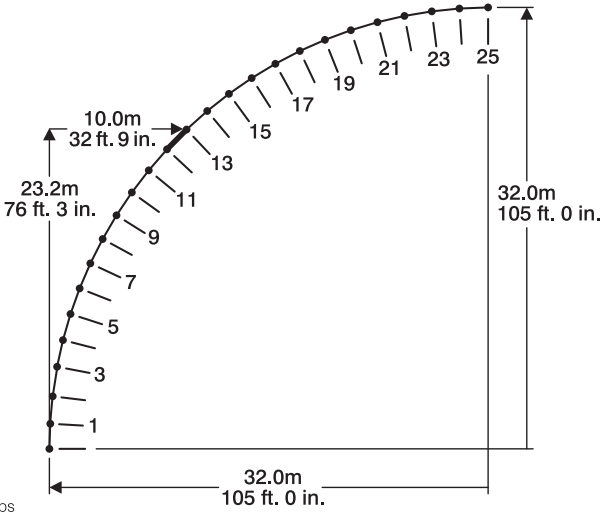
JT920L Power Pipe Drill Pipe

Turns in the bore path should be made gradually. All Ditch Witch pipes have recommended bend limits. JT920L drill pipes have a tested bend radius of 100' (30.5 m), meaning a 90 degree bend requires 100' (30.5 m) of forward distance and approximately 157' (48 m) of pipe. Make sure pitch changes no more than 9% per pipe.

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

Bending pipe beyond recommended limits will overstress pipe and cause damage that may not be seen. This damage adds up and can lead to sudden pipe failure. Use the following charts to keep bends within safe limits.

JT920 Power Pipe Drill Pipe



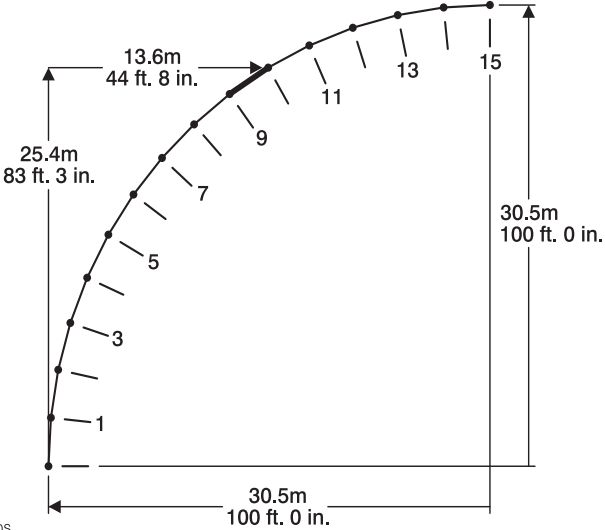
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JT920 Power Pipe Drill Pipe

Pipe No.	U.S.		Metric	
	Forward	Lateral	Forward	Lateral
1	6 ft 7 in	0 ft 2 in	2.00 m	.06 m
2	13 ft 1 in	0 ft 10 in	3.99 m	.25 m
3	19 ft 7 in	1 ft 10 in	5.96 m	.56 m
4	26 ft 0 in	3 ft 3 in	7.92 m	.99 m
5	32 ft 3 in	5 ft 1 in	9.84 m	1.55 m
6	38 ft 5 in	7 ft 4 in	11.72 m	2.22 m
7	44 ft 6 in	9 ft 11 in	13.56 m	3.01 m
8	50 ft 4 in	12 ft 10 in	15.34 m	3.92 m
9	56 ft 0 in	16 ft 2 in	17.07 m	4.93 m
10	61 ft 5 in	19 ft 10 in	18.72 m	6.05 m
11	66 ft 8 in	23 ft 10 in	20.31 m	7.27 m
12	71 ft 7 in	28 ft 2 in	21.81 m	8.58 m
13	76 ft 3 in	32 ft 9 in	23.23 m	9.99 m
14	80 ft 7 in	37 ft 8 in	24.56 m	11.49 m
15	84 ft 8 in	42 ft 10 in	25.80 m	13.06 m
16	88 ft 4 in	48 ft 3 in	26.93 m	14.71 m
17	91 ft 9 in	53 ft 11 in	27.96 m	16.42 m
18	94 ft 9 in	59 ft 9 in	28.87 m	18.20 m
19	97 ft 5 in	65 ft 9 in	29.68 m	20.00 m
20	99 ft 8 in	71 ft 11 in	30.37 m	21.91 m
21	101 ft 6 in	78 ft 2 in	30.94 m	23.82 m
22	103 ft 0 in	84 ft 7 in	31.39 m	25.77 m
23	104 ft 1 in	91 ft 0 in	31.72 m	27.74 m
24	104 ft 9 in	97 ft 7 in	31.92 m	29.73 m
25	104 ft 11 in	104 ft 1 in	31.98 m	31.73 m
26	105 ft 0 in	105 ft 0 in	32.00 m	32.00 m

Dimensions given at minimum bend radius--105' (32 m)

JT920L Power Pipe Drill Pipe



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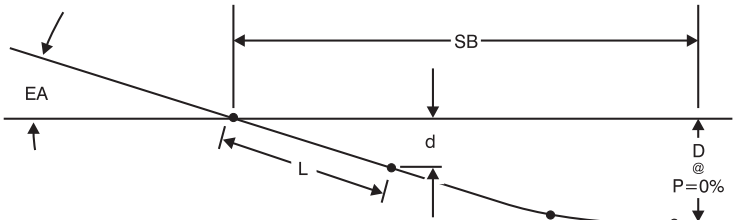
JT920L Power Pipe Drill Pipe

Pipe No.	U.S.		Metric	
	Forward	Lateral	Forward	Lateral
1	9 ft 10 in	0 ft 6 in	3.00 m	.15 m
2	19 ft 7 in	1 ft 11 in	5.96 m	.59 m
3	29 ft 1 in	4 ft 4 in	8.87 m	1.32 m
4	38 ft 4 in	7 ft 8 in	11.69 m	2.33 m
5	47 ft 3 in	11 ft 10 in	14.40 m	3.62 m
6	55 ft 8 in	16 ft 11 in	16.97 m	5.16 m
7	63 ft 7 in	22 ft 10 in	19.38 m	6.95 m
8	70 ft 10 in	29 ft 5 in	21.60 m	8.97 m
9	77 ft 5 in	36 ft 9 in	23.60 m	11.20 m
10	83 ft 3 in	44 ft 8 in	25.39 m	13.61 m
11	88 ft 4 in	53 ft 1 in	26.92 m	16.19 m
12	92 ft 6 in	62 ft 0 in	28.19 m	18.90 m
13	95 ft 10 in	71 ft 3 in	29.20 m	21.73 m
14	98 ft 2 in	80 ft 10 in	29.92 m	24.64 m
15	99 ft 7 in	90 ft 7 in	30.34 m	27.61 m
16	100 ft 0 in	100 ft 0 in	30.5 m	30.5 m

Dimensions given at minimum bend radius--100'(30.5 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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JT920 Power Pipe Drill Pipe

EA	SB	d	D
-18	24 ft 9 in (7.54 m)	1 ft 1 in (.34 m)	2 ft 9 in (.84 m)
-20	26 ft 9 in (8.14 m)	1 ft 3 in (.37 m)	3 ft 3 in (1.00 m)
-22	28 ft 8 in (8.74 m)	1 ft 4 in (.41 m)	3 ft 10 in (1.16 m)
-24	30 ft 7 in (9.32 m)	1 ft 6 in (.44 m)	4 ft 4 in (1.33 m)
-26	32 ft 5 in (9.90 m)	1 ft 7 in (.48 m)	4 ft 11 in (1.51 m)
-28	34 ft 4 in (10.46 m)	1 ft 8 in (.51 m)	5 ft 7 in (1.70 m)
-30	36 ft 2 in (11.02 m)	1 ft 10 in (.55 m)	6 ft 3 in (1.90 m)
Based on: 1. 105' (32 m) minimum bend radius 2. L = beacon housing, EZ-Connect, and transition sub, and 1/3 of first drill pipe (totalling 6't 3" [1.9 m]) in the ground before steering			

JT920L Power Pipe Drill Pipe

EA	SB	d	D
-18	25 ft 0 in (7.26 m)	1 ft 4 in (.40 m)	2 ft 11 in (.88 m)
-20	26 ft 11 in (8.19 m)	1 ft 5 in (.44 m)	3 ft 5 in (1.04 m)
-22	28 ft 9 in (8.76 m)	1 ft 7 in (.49 m)	3 ft 11 in (1.20 m)
-24	30 ft 7 in (9.31 m)	1 ft 9 in (.53 m)	4 ft 6 in (1.37 m)
-26	32 ft 4 in (9.86 m)	1 ft 10 in (.57 m)	5 ft 1 in (1.55 m)
-28	34 ft 1 in (10.40 m)	2 ft 0 in (.61 m)	5 ft 8 in (1.74 m)
-30	35 ft 10 in (10.92 m)	2 ft 2 in (.65 m)	6 ft 4 in (1.94 m)
Based on: 1. 100' (30.5 m) minimum bend radius 2. L = beacon housing, EZ-Connect, and transition sub, and 1/3 of first drill pipe (totalling 7' 5" [2.26 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

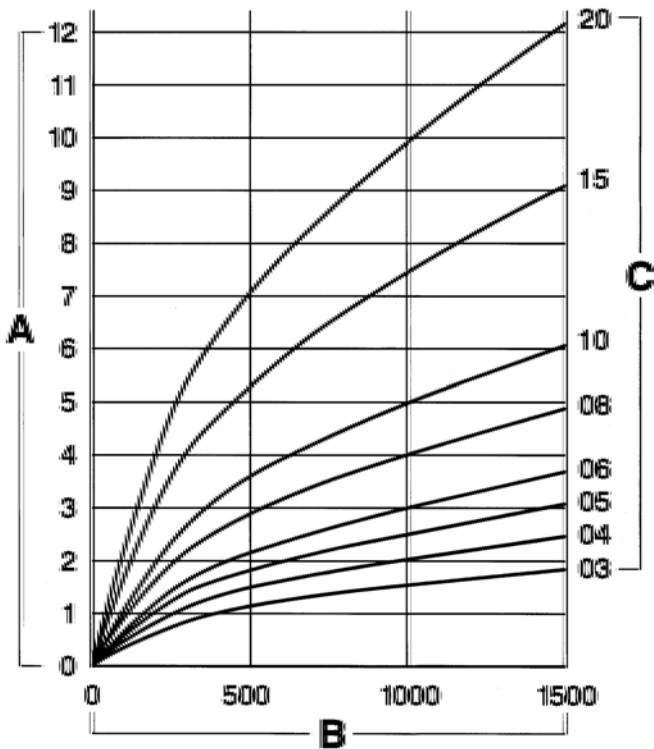
Select nozzles that will supply **at least** the amount of fluid per minute needed for the flow and pressure you will be using. A nozzle that will supply more fluid per minute is recommended.

U.S. Nozzle Flow

A - Flow per nozzle, gallons/minute

B - Nozzle pressure, psi

C - Nozzle size

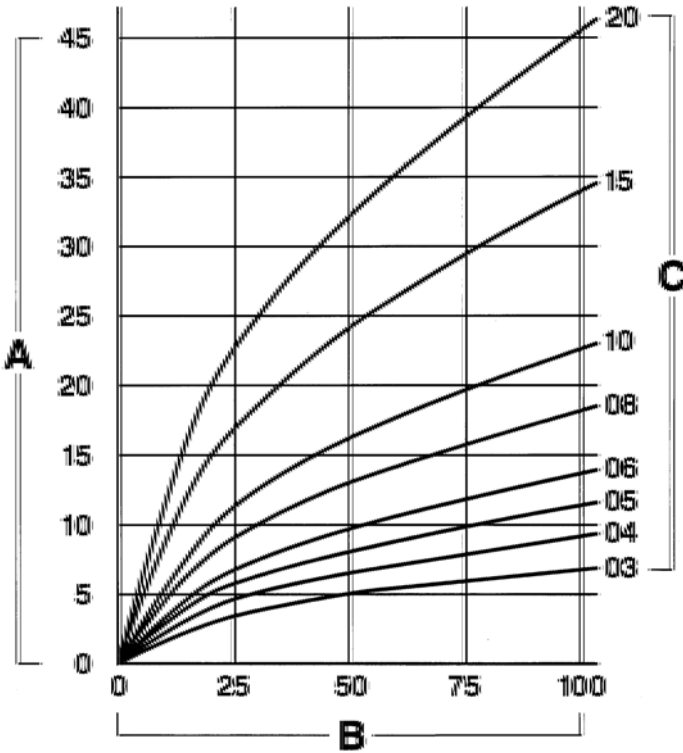


Metric Nozzle Flow

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)

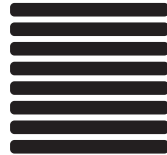


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City

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Nation

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Phone Number With Area Code

Model

Serial Number

Attachments/Accessories

Serial Numbers

Attachments/Accessories

Serial Numbers

Attachments/Accessories

Serial Numbers

Name of Ditch Witch Dealership

Your Signature

